DESIGN OF A QUANTITATIVE COST PERFORMANCE ANALYSIS METHOD FOR IT CONSUMPTION IN BUSINESS ECOSYSTEMS

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Master thesis

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Preface

My final project assignment is part of the master's Business IT program at the University of Twente. I pursued my thesis internship at Shell International, Den Haag from April until September 2022 for a duration of around 6 months. During this time, I focused on my final graduation assignment topic in this report.

Shell is an international energy multinational company, currently headquartered in London, United Kingdom. Shell has employees of nearly 80,000 in more than 70 countries across the globe. Its main goals are focused on powering progress by providing more and cleaner energy solutions, generating shareholder value that provides financial strength to achieve the same (Shell, 2020). Shell has the ambition to progressively move towards predominantly low carbon solutions such as hydrogen and incorporate carbon capture technology as part of energy transition initiatives (Shell, 2020).

In a blend of Operated and Non-Operated Ventures (NOVs), the NOVs are envisioned to contribute a significant portion of Cash flow for Shell with revenue targets set for 2025. However, the benefit value tracking from an IT perspective for the IT service consumption of these ventures is currently decentralized. My goal is to be track them uniformly by designing a quantitative cost performance for IT consumption in the business ecosystem through establishment of tested best practices i.e., an analysis method.

During the assignment, I focused on the design of a quantitative cost performance analysis method for IT consumption in business ecosystems for Non-Operated Ventures (NOVs) in terms of IT solutions delivery. I worked as an Intern for Information and Digital Technologies (IDT) team in Liquefied Natural Gas (LNG) space across East and West.

I would like to thank my professors Maria Iacob & Marten van Sinderen, supervisor Jacqueline Chindea, mentor Marwan al Khamis, sponsor Steven Jansen, Rianne Honhoff and every other stakeholder who had been very committed to developing and co-creating my final project and helped me to reflect and think as an innovative individual. The biggest takeaway on my character or mindset was to be a productive working professional and constantly driven to inculcate the trait of curiosity in me.

Finally, I also want to extend my gratitude towards my family and friends especially Suresh, Praba, Santhosh, Manojkumar Tamilvel and Lokesh Moorthy who supported me to take up master's program at the Netherlands and guiding me to always persevere.

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List of Abbreviations

AHP	Arithmetic Hierarchical Process
AIS	Architecture of Information Systems
BPMN	Business Process Model and Notation
BPMS	Business Process Management Systems
COBIT	Control Objectives for Information Technologies
EA	Enterprise Architecture
EA	Enterprise Architecture
FAIR	Findable Accessible Interoperable Readable
FTE	Full Time Employees
GTL	Gas-To-Liquid
IDT	Information & Digital Technologies
IDTM	Information & Digital Technology Manager
IG	Integrated Gas
IoT	Internet of Things
IT	Information Technology
ITaaS	IT as a Service
ITSM	Information Technology Service Management
JV	Joint Ventures
LNG	Liquefied Natural Gas
LOD	Lines Of Defence
LT	Leadership Team
MCS	Monte Carlo Simulation
NOV	Non-Operated Ventures
NPV	Net Present Value
PM	Product Manager
PPI	Process Performance Indicators
RNG	Renewable Natural Gas
SLA	Service Level Agreement
SME	Small and Medium Scale Enterprise
TOE	Target Operating Environment
TOGAF	The Open Group Architecture Framework

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Abstract

The thesis presents a methodology for estimating the benefit value of IT service consumptions in business ecosystems. A business ecosystem is an environment of organizations and service providers working together to share collective values between responsible stakeholders. Currently, the literature shows Net Present Value (NPV), architecture analysis, business value propositions, Monte Carlos Simulation (MCS) and so on as quantitative analysis method of IT solutions in energy industries. ArchiSurance is used as an illustration example to explain the design of artefact i.e., the proposed method.

In the proposed method, the sequence of steps was design of architectures, modelling E3 value and statistical model to determine probability of failure of an IT solution. The expenses are weighed against the advantages that emerge from that decision in a cost-benefit value analysis using the E3 value model. The E3 value model is a technique that is used to evaluate whether to pursue or not a defined course of action in IT goods and service delivery. Architectural specification possibilities are studied to understand the efficiency of an architecture pattern by showing how the IT services are delivered to the NOVs. Based on the stakeholder interviews, the proposed method was found to serve as centralised benefit value estimation technique that breaks information silos between different departments.

Keywords: IT Strategy; cost; benefit value model; cost estimation; quantitative analysis techniques; IT consumption; business ecosystems.

1. Introduction

In this chapter, the research is introduced with the motivation behind the problem statement. The research goal and objectives are described with the formulation of research questions followed by the research approach implemented for respective chapters of the thesis and finally the thesis structure with conclusion by the end of this chapter.

1.1 Motivation

Shell is a well-known world-leading organization in the business of Energy relying on renewable and non-renewable sources of energy such as Oil & Gas, Solar, Wind, Biofuels, and Hydrogen. Shell is a publicly traded company, headquartered in London in the United Kingdom (Shell, 2022). Although their major presence is across the Oil and Gas value chain, it is transforming towards more renewable sources of energy. The major lines of business are its Upstream, Integrated Gas & Renewables and Energy Solutions, Downstream, and Projects & Technology. The thesis is aimed to help the NOV team in LNG under the Upstream line of business.

The thesis is initiated with understanding the available method for estimating the benefit value for NOVs as currently Shell IDT finds challenges in this area. In Shell, the proposed method in thesis will be tested in Shell to estimate the benefit value of Shell IT services consumed by the Non-Operated Ventures (NOVs). NOVs are joint ventures of Shell with Shell as IT service provider to NOVs. Shell Information and Digital Technology (IDT) team provides support to its ventures such as the operated and Non-Operated Ventures (NOVs). The NOVs are supported by Shell IDT so that they perform well independently using the guidelines from Shell. The NOVs are supported in this fashion because there is no controlling power for Shell in NOVs. Shell holds minority share ownership in NOVs.

The NOVs belong to the LNG (Liquefied Natural Gas) line of business in Upstream operations. The Upstream division oversees crude oil, natural gas, and natural gas liquids exploration and extraction. It also markets and distributes oil and gas, as well as manages the infrastructure required to get them to market. The LNG activities and the production of GTL fuels and other products are managed by the Integrated Gas (IG) organization. Shell's Renewables and Energy Solutions division is dedicated to creating commercial solutions to satisfy their clients' changing energy needs. as shown in Fig. 1.

There are numerous sets of ventures and projects that Shell invests also as part of the powering progress strategy at Shell. Different teams under the IDT organization provide services to both operated and NOVs based on the foundational framework (Shell Annual Report, 2020) that is in place for articulating foundation principles, management of crucial activities, processes, and structural components to deal with businesses, IT & related functions. There are a few steps in the framework which are strategy, planning, appraisal, and individual performance reviews.

Shell continues to provide its IT support to build IT capabilities for its Joint Ventures (JVs) in countries where the technology was difficult to acquire and the industries that request support from Shell so that these ventures create value for the IT services consumed from Shell. In today's fast-changing world, we can also find an inevitable advancement in the field of IT as there are multiple services and software tooling platforms in the industry best practice which puts the organization in a situation on how to deliver the IT services. The IDT could dedicate appropriate services to NOVs by using insights from the proposed method.

To solve the dilemma of unknown benefit value, towards the NOV space as there is little research and information availability in this domain. It is also quite a challenging field within the Shell organization due to lack of research foundations. By performing an intensive literature study, stakeholder interview and the thesis experiments, the research contributions towards the NOV domain helps in understanding how to efficiently track benefit value of IT services in an energy industry.

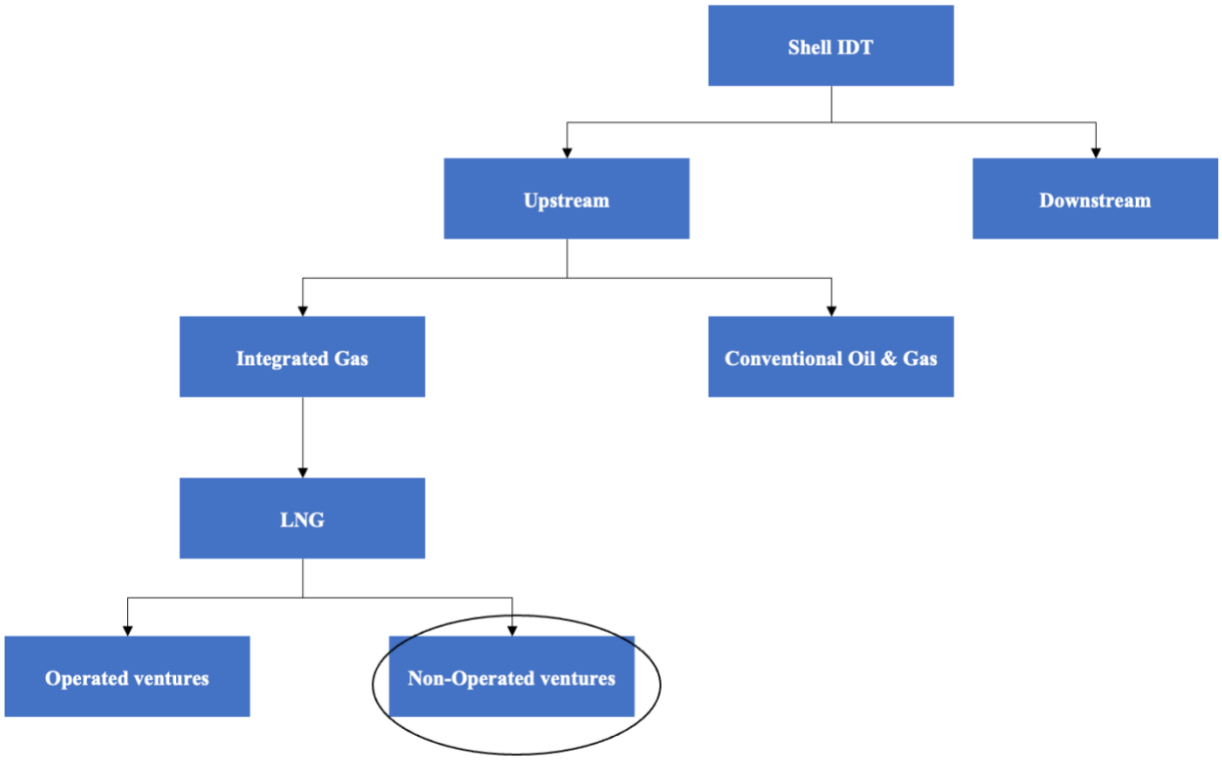

Figure 1: Focus Area of Research

1.2 Research Objective

The objective of this research is to create a method that helps in best practices for Shell to estimate the benefit value of their IT services consumed by the NOVs. By doing so, Shell IT LNG successfully understand the value of their services and dedicates solutions accordingly to their NOVs with accurate time and efforts of their resources.

This thesis was initiated to fit the identified gap in the theory because there is limited information about the IT consumptions and benefit value estimation techniques for IT solutions in the NOVs. By completing this thesis, the research also aims to help Shell IT to rethink on business value propositions to perceive NOVs as customers consuming Shell IT services. Therefore, implementing the proposed method will assist to uncover the benefit value of the Shell IT services consumed by NOVs.

1.3 Research Questions

Shell is offering IT services in the hope to build IT capabilities for the NOVs to justify the resource allocation by Shell. As NOVs are in Shell IT business ecosystem, the IT capabilities offered by Shell to NOVs are to improve their IT and business performance which result in generating better revenue through shareholder value.

Currently, the IT with NOVs is not for profits or at costs. It is rather focused on attaining a break-even status quo for achieving better returns on revenue over shares (Shell sustainability report, 2020). The revenue gets better when the performance of NOVs is in turn high.

Based on the knowledge gained through the research topics assignment by interviewing stakeholders to gather requirements and conducting literature study to synthesise the information relating to the topic, the main research goal was then translated to a design problem as below:

Primary research question: How can we design a quantitative cost performance analysis of IT consumptions in business ecosystems?

The limitation with NOVs is that despite efforts to question the benefits enjoyed by IT services, NOVs are **not obliged** to share this information. However, the IDT function wants to justify why Shell allocates time, effort, and cost for the resources to improve the IT capabilities of NOVs. Hence, the main goal are achieved by answering multiple sub-questions, as knowledge questions, as described below:

RQ1: What are the available methods for estimating the value of IT services in business ecosystems with central control?

Rationale: Several techniques and methods help in estimating the value of IT services exist in Shell organization and externally with the research fields. However, the answer to the knowledge question RQ1 would provide the specific information on methods

that are suitable for the estimation of value for IT services while also making sure to accommodate for benchmarking NOVs with operated ventures.

RQ2: How do we specify an architecture of the IT service consumption?

Rationale: An architectural specification provides a centralized tracking mechanism for the enterprise level understanding on the consumption of IT services by the NOVs while also conveying the cost figures attached with the services offered by Shell IT. Answer to RQ2 would also reveal how the IT is realized from Shell to NOVs by architectural specification.

RQ3: How does the functionality of IT solutions provided generate the high-level benefits?

Rationale: The value propositions on high level would share insights for the IT consumptions from one company to another. Typically, the IT solutions provided are estimated to add benefit value for organizations that consume the services. However, a validation for such benefits generated could be answered and realized by answering RQ3.

RQ4: How can we trace the performance gains of NOVs to IT consumption capabilities?

Rationale: Understanding the factors impacting the NOV performance from an IT perspective to validate if the costs figures for solutions are defined and hence mapped to the benefits value estimation appropriately. On solving the RQ4, the method for benefits value estimation could be leveraged for improving NOV performance on IT capabilities or not. The RQ would also provide information about the assessment of NOV performance gains in terms of benefits generated.

1.4 Research Approach

Design science was modelled and coined for defining the cycle of proposing new systems to validate the implementation and further improve the system in use through iterations (Peffers et. al, 2007). The Design Science Research Methodology (DSRM) has been simplified and explained further to design, demonstrate, evaluate the artifact (Wieringa, 2014).

In this thesis, the methodology is mapped to the planning of the experiment as shown in Fig. 2 to simplify the process of building the method in iterations through design science cycle. Here, the proposed method is the design artefact to estimate the benefit value of IT services. The steps taken in this thesis is further explained in the next section describing DSRM mapped to each chapter of this document.

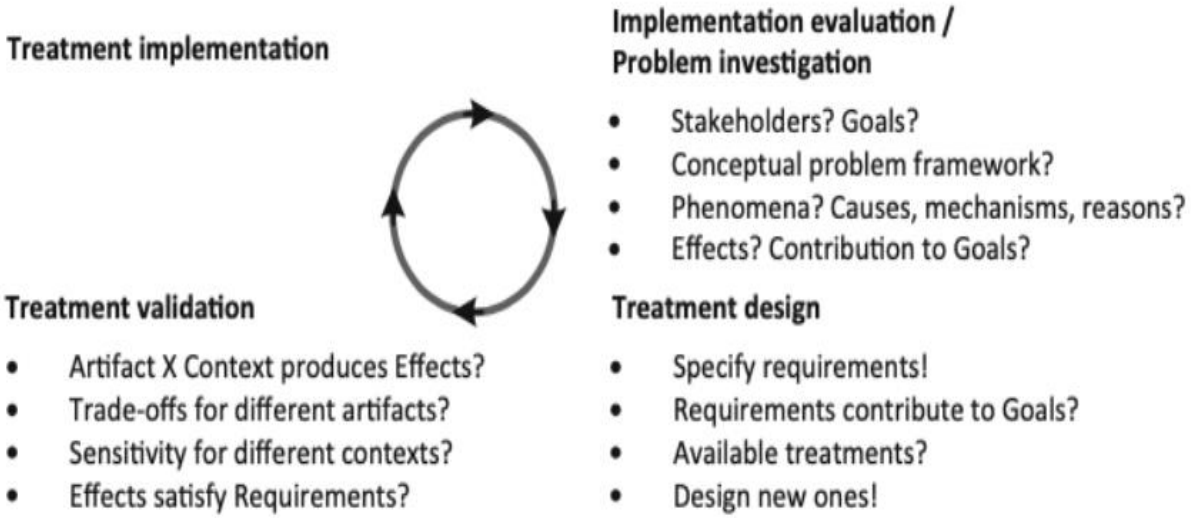

Figure 2: Design Science Research Methodology (Wieringa, 2014)

1.5 Thesis Structure

In this section, the chapters of the research are categorised based on the DSRM principles. The requirements are gathered for problem investigation. During the problem investigation, the literature study from research papers and internal readings from Shell were investigated to understand the definitions and existing best practices related to the design problem. On gathering requirements, the requirements are elicited to design artefact as part of the treatment design as shown in Table 1.

The treatment design is designed with the use of ArchiSurance case study for knowledge on available meaningful components of the method to be proposed for Shell design problem. After designing the artefact, it is demonstrated in Shell context. The proposed method is then validated by evaluating through stakeholder interviews. Finally, the limitations in the method were documented under the conclusion of this research.

Table 1: DSRM Mapping to Thesis Chapters

S. No.	DSRM	Chapter
1	Problem investigation	Literature study (Chapter 2), State of the art (Chapter 3)
2	Treatment design	Design of artefact (Chapter 4)
3	Treatment validation	Demonstration of artefact (Chapter 5), Evaluation of proposed method (Chapter 6)

1.6 Conclusion

The research questions formulated would assist in approaching the solution for research goal to achieve the identified objectives. Thereby, the research goal is aimed to be answered by creating a method for Shell IDT.

The thesis is executed by implementing DSRM in stages, categorically divided to respective chapters of this document as given in Table 1. In the next chapter, the research method implemented to gather requirements and state of the art knowledge from research papers is discussed. The interview method to acquire tacit knowledge from Shell is also discussed along with the definition of the strategies utilised for obtaining the literature from research journals.

2. Literature Study

In this chapter, the methodology adopted to approach the research questions and hence the research goal is discussed. The literature study includes search string implemented to gather the literature for design requirements. The design requirements are components supporting research to execute designing of artefact.

2.1 Approach

The research goal would contribute to learning about the **state-of-the-art knowledge** on the topic and to explore further into the area of benefit value estimation in IT projects. Based on the research goal, the search terms and literature study were framed and conducted respectively by obtaining the key words from the main research question.

Based on the findings from the study (Snyder, 2019) and systematic literature study (Kitchenham, 2007), the literature study has been conducted for a literature review based on a search strategy with relevant search strings, research journals, and filters for the year.

Table 2 states the design science research methods employed to approach each of the research questions created. The research questions hence formulated would be answered from the analysis of thesis experiments executed and findings for those knowledge questions would serve for answering the design problem. However, the research also included stakeholder interviews to gather requirements to solve the design problem as shown below in Fig. 3. The evaluation of artefact was based on stakeholder interviews. The steps to evaluate responses from interviews are documented in the appendix.

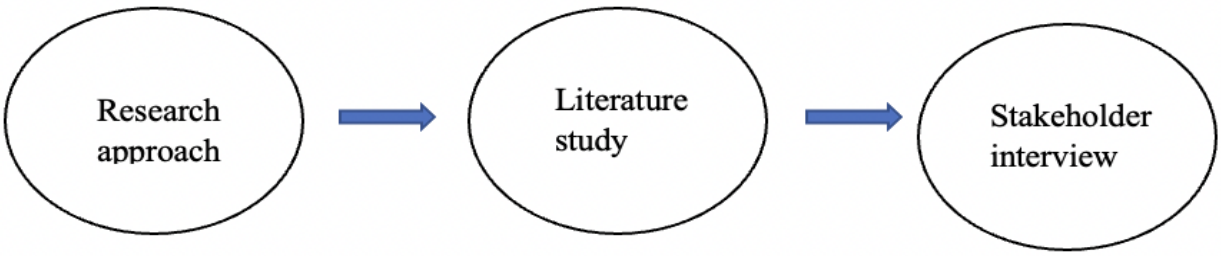

Figure 3: Research Stages for Requirements Gathering

Table 2: Research Question and Methodology Approach

Research Question	**Methodology**
RQ1. What are the available methods for estimating the value of IT services in business ecosystems with central control?	Requirements gathering through Literature study, stakeholder interview
RQ2. How do we specify an architecture of the IT service consumption?	Design and demonstrate artefact from stakeholder interview to validate assumptions and architectures.
RQ3. How does the functionality of IT solutions provided generate the high-level benefits?	Demonstrate artefact by mapping architecture to E3 value model by designing for a test use case and validating the applicability and relevance of demonstrated artefact through stakeholder interview.
RQ4. How can we trace the performance gains of NOVs to IT consumption capabilities?	Demonstrating Monte Carlo Simulation for probabilistic analysis of loss % in a project investment and evaluation of artefact using stakeholder interview.

The stakeholder interview method was a combination of the questionnaires as given in appendix A2.2 that was used as a guiding principle for requirements gathering about NOVs and their functions with Shell. The interviews also helped in learning about the problem statement and validation of assumptions to execute the background research.

The stakeholders such as the IDT Managers (IDTMs) and Product Managers (PM) responsible for specific IT solution deployment were interviewed based on the identified gap to articulate the problem statement. These qualitative answers helped for the validation of assumptions and the problem statement before executing the experiment steps. Finally, the second set of questionnaires

assisted in the validation of the design artefact. The list of stakeholders expanded in the validation phase as their relevance to the design artefact were of importance.

2.2 Inclusion and Filtering Criteria

However, **inclusion** of the literature findings, method requirements, and data collection is performed for working towards the end deliverable through the methods of interviewing stakeholders in iterations as per the strategy of feedback mechanisms in non-experimental research works (Makady et. al, 2017). The requirements are obtained by interacting in a dialogue with documentation of definitions and citing the justification from stakeholder interviews. The search terms formulated based on the research goal are tabulated in the Fig 4. as shown below. The synonyms are shown within the same columns whereas the different rows show the "AND" terms in the search query.

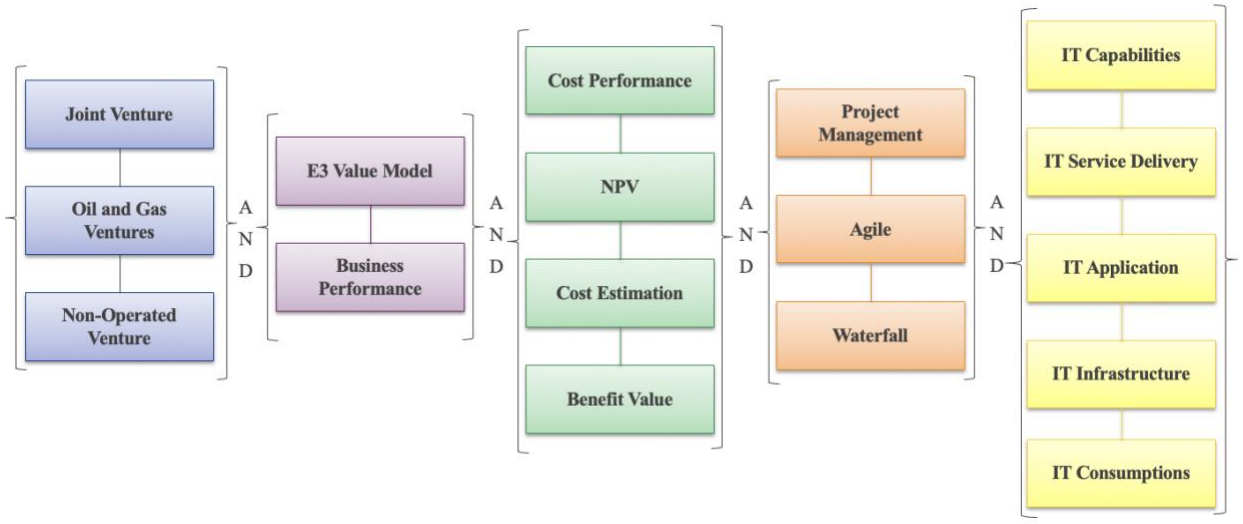

Figure 4: Search Keywords

The study of systematic literature review (Kitchenham et. al, 2007) has helped in the selection of papers relevant for appropriate papers depending on a search strategy that assists in providing meaning in developing the relevant research questions by performing a meta-analysis on existing literature. The conceptual depiction of systematic literature and its components is shown in Fig. 5. The research topic was part of initial literature research to initiate the assignment.

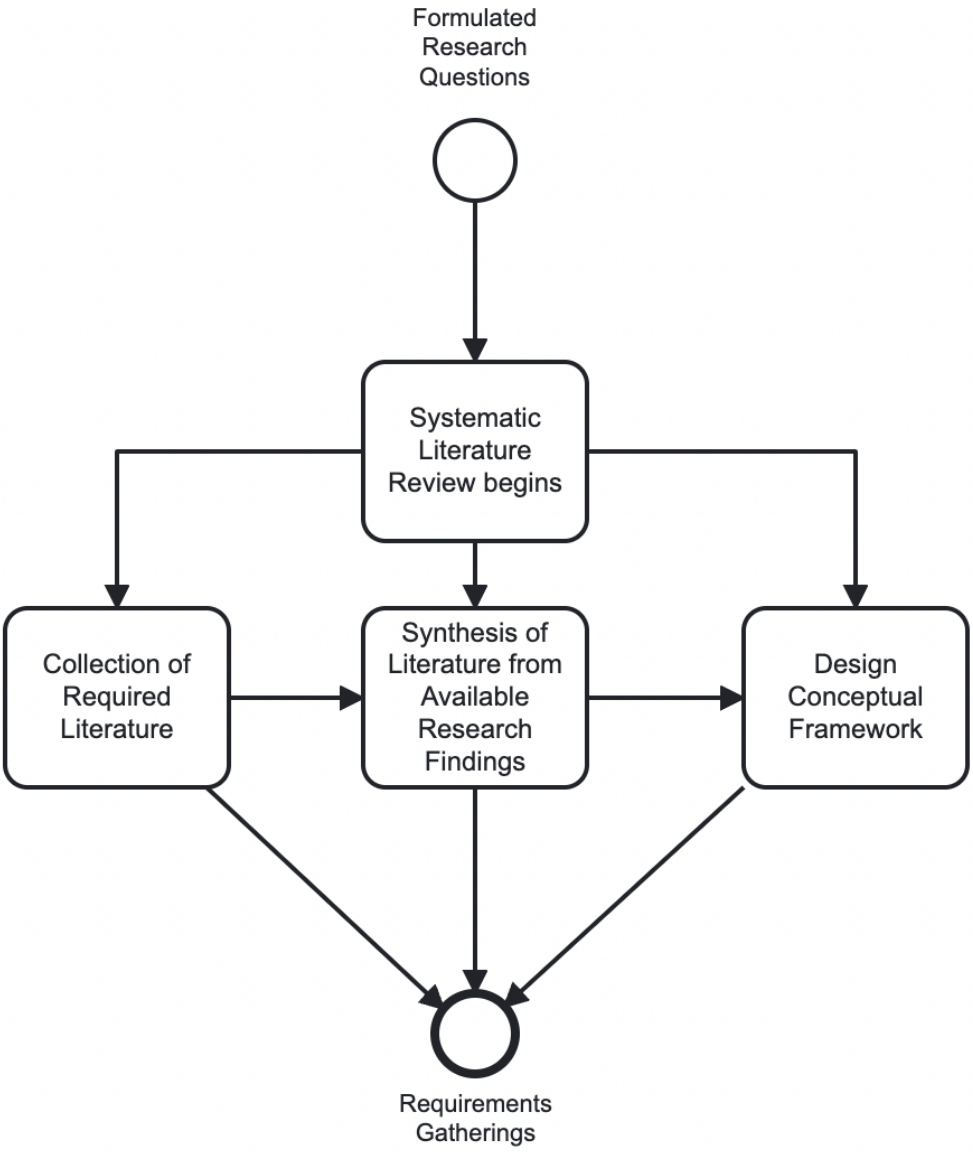

Figure 5: Systematic Literature and its Components

The **filtering** of relevant papers from the exhaustive list of papers obtained was successful with the use of the search query to narrow on research papers that were only relevant to the context of the design problem. Using the filtered set of research, the synthesis on the literature study section is performed. The literature study would provide information on existing state-of-art best practices.

2.3 Search Strategy

The search query below was used to obtain the research articles primarily from well-reputed impact factored journals such as **Scopus, IEEE, Google Scholar, Research Gate, Web of Science, Elsevier & Science Direct**. In every journal, a filter was to be pre-set for obtaining only scientifically valid research reading articles and journals. A filter to narrow down the search terms indicates the exclusion criteria outside which the scope doesn't permit research articles as relevant to the search.

To facilitate that, the year of relevance filters chosen were flexible to a certain extent over the last **20 years** as JV research was found to be a defined concept in the last **50 years** and gained popularity in the last 3 decades with the IT advancement on tracking tools. Especially in the energy domain, research has increased immensely since the 90s though lacking the literature on non-operated ventures. Hence, the research focus was restricted till the year **1991** to define the relevance of literature from research papers. The terms outside the abstract defined after consultation with Shell and University of Twente are exempted from the search string as part of **exclusion criteria**.

To supplement the search strategy based on the research goal formulated, the relevant search terms with inclusion criteria were utilized to form a single search query in specific databases as below:

("Joint ventures" OR "Oil and Gas ventures" OR "Non-operated ventures")

AND

("IT capabilities" OR "IT service delivery" OR "IT applications" OR "IT infrastructure" OR "IT consumptions")

AND

("Agile" OR "Waterfall" OR "Project Management")

AND

("e3 value model" AND "business performance")

AND

("Cost estimation" OR "IT Benefits value" OR "Cost performance" OR "NPV")

2.4 Planning

The thesis execution was managed by hybrid project management principles. It involved the Agile and Waterfall methodology as the main series of steps with sectionally targeting the deliverables. The deliverables were organized sequentially while the feedback for continuous improvement of the research question were iterated through stakeholder interviews at each stage.

The stakeholder interviews contributed for defining the problem statement, formulation primary research question and henceforth secondary research questions in iteration loops. There is an overlap with the design science research methodology as shown in Fig. 6 depicting the design science cycle for realizing the design problem and design solutions.

In iterations, the project is developed keeping the Design Science Research Methodology (DSRM) (Johannesson et. al, 2014), agile (Inayat, 2015), and waterfall (Ruël et. al, 2010) as references, and the prototype is developed in iterations. By using the framework of the design cycle, the research goal followed by research questions based on the literature findings and internal stakeholder interviews is to be answered.

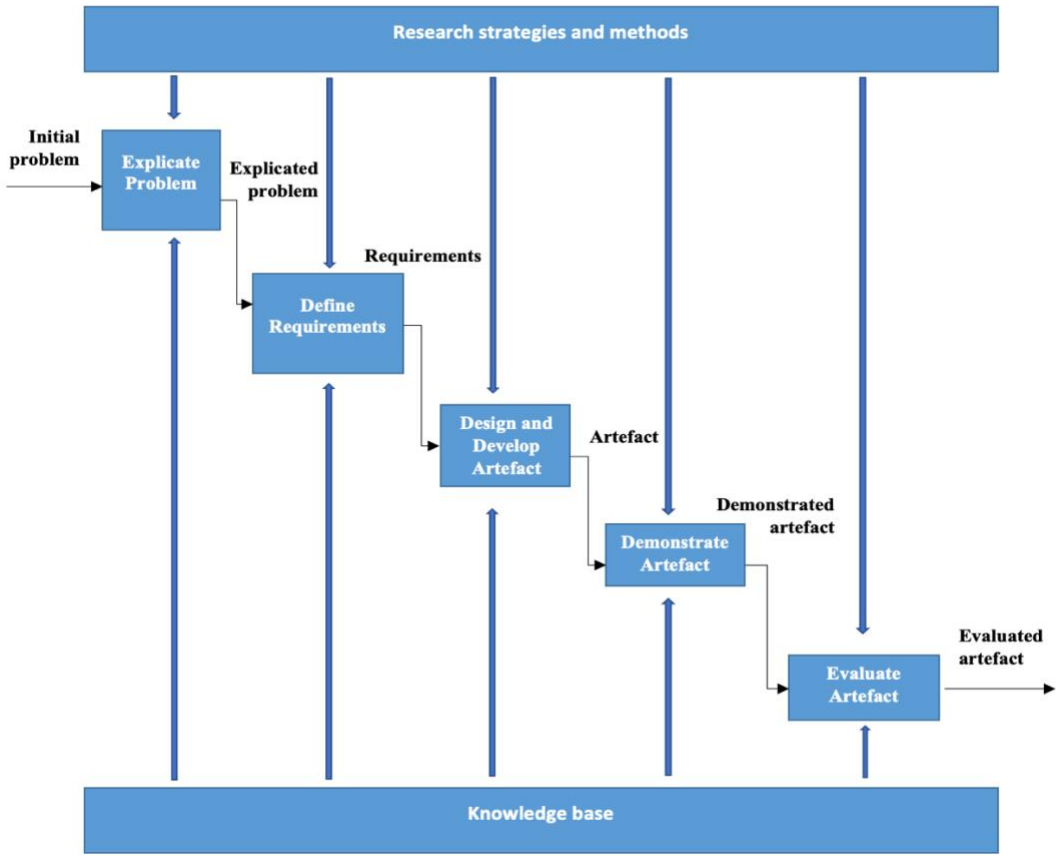

Figure 6: DSRM cycle (Johannesson et. al, 2014)

In relevance to the planning, the time sheet shown in appendix section depicts 6 months duration of research work at Shell to complete the thesis assignment. There were iterations to adjust the time planning as per extension requirements for tasks such as the stakeholder interview to validate the research questions as per acceptable industry expectations. In the appendix is also a questionnaire in an open-ended interview fashion to gather the bottlenecks in the current method of value estimations.

2.5 Selection of Papers

The papers were selected based on the process as shown below in Fig. 7. The assessment on exclusion was implemented to remove the exhaustive set of research papers and narrow to the relevant set of literature to be synthesized.

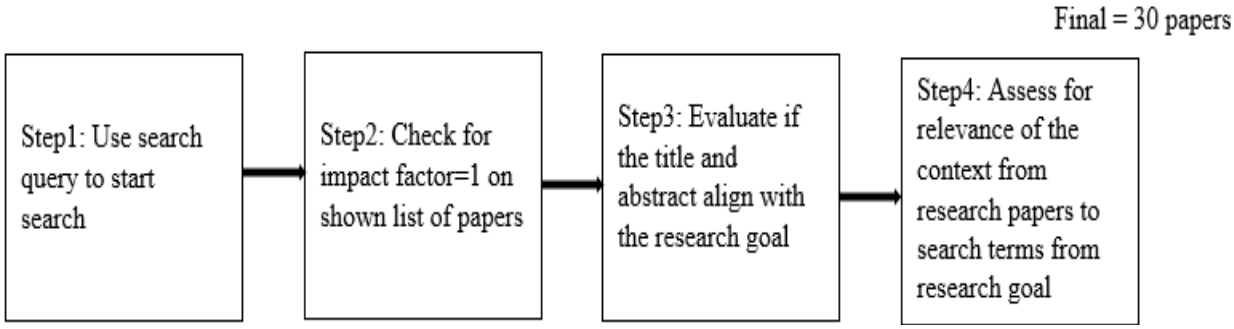

Figure 7: Assessment of Research Papers

The filtering of research journal papers provided final insights of 25 papers from which the data and information extraction was performed. Additionally, internal references and few websites to support research assumptions were referred counting to **30** in total. The Table 3 as shown below gives detail on the key inclusion and exclusion criteria executed to achieve the value adding research articles that can be aimed to be graded as good.

Table 3: Inclusion and Exclusion Criteria

Inclusion Criteria	**Exclusion Criteria**
Title, abstract and focus area relevant to the problem statement	Unrelated terms in the title, abstract and summary
Reputed journal and conference publishings	Low impact factor journals
Year of publishing filter extending upto 1991	Duplicate articles repeating in different journals

The references were graded, and it resulted in a final list of 30 research and literature. The literature study and background were graded as good or unfit based on the relevance to the research goal that we are aiming to solve. The highlight of the information on data extraction along with assessing as good and fairly good based on the relevance, indicating the motivation for literature review had been documented as shown in Table 4.

Table 4: Quality Assessment of References

No.	References	About	Quality	Source
1	(Shell, 2020)	Company's functions and their IT	Good	Official website
2	(Shell, 2022)	Transformation towards digital era	Good	Internal
3	(Shell Annual Report, 2020)	IDT services to different lines of businesses within organization	Good	Official website
4	(Snyder, 2019)	Literature review on business areas	Good	Journal of business research
5	(Makady et. al, 2017)	Stakeholder interview mechanisms (non-experimental)	Good	Elsevier
6	(Kitchenham et. al, 2007)	Systematic literature review study and research methodology	Good	Research Gate
7	(Johannesson et. al, 2014)	Implementation example of the design science research methods for planning project	Good	Springer
8	(Inayat, 2015)	Agile methodology for iterative feedback and project planning	Fairly good	Elsevier
9	(Ruël et. al, 2010)	Sequential approach of the project in waterfall method	Fairly good	Research Gate
10	(Nippa et. al, 2019)	Discusses about the equity and partnerships to support joint ventures	Good	Springer
11	(Channon et. al, 2015)	Advantages in offering possible capabilities and controls for venture organizations	Good	Research Gate
12	(Ojiako et. al, 2012)	Importance of IT service delivery and tracking mechanism on business processes	Good	Research Gate
13	(Cuypers et. al, 2009)	Establishment of a JV and correspondingly the stakeholder definition	Fairly good	Springer
14	(Zimola et. al, 2014)	Corporate stakeholder management to leverage business value	Good	Science Direct
15	(Lagemann et. al, 2013)	IT service delivery and capabilities KPIs such as FTEs, hours, revenue and resources	Good	Elsevier
16	(Benitez et. al, 2022)	Controlling variables such as Firm size, country and industry proposed due to positive influence of IT governance capability	Good	Research Gate
17	(Tamm et. al, 2011)	Value addition of EA towards business processes in organizations using TOGAF framework	Fairly good	AIS library
18	(Jansen et. al, 2010)	Cost for IT services and alignment reduction with the strategic mapping using EA	Good	Springer
19	(Jonkers et. al, 2003)	Importance of EA with example use case on costs associated to application deployment at end user side	Good	IEEE

20	(Sawy et. al, 1999)	IT infrastructure growth with the EA and alignment to allocate services for customer's IT requirements	Good	MIS Quarterly, JSTOR
21	(Henderson et. al, 1993)	IT governance for strategic alliance with joint ventures and dedicated IT capabilities using EA and Business IT	Good	IEEE
22	(ŽIžlavský, 2014)	Calculation of NPV using the investments on project and discount costs	Good	Elsevier
23	(Value engineers, 2018)	Relevance of e3 value model for validation of business model and trace the profitability of services offered	Good	Value Engineers website
24	(Roy et. al, 2010)	Cost estimation on engineering processes for both quantitative and qualitative aspects	Good	Engineering design journal
25	(Baloi et. al, 2003)	Risk factors such as technological, poor cost performance, scientific were captured risk assessments techniques	Fairly good	Elsevier
26	(Nguyen et. al, 2019)	Quantitative and qualitative analysis of information modelling techniques such as the ANOVA, linear validation, and data analysis	Good	Hindawi
27	(Sullivan et. al, 2017)	Performance comparison to cost, quality, and deliverable schedules of the project delivery	Good	ASCE
28	(Foundational work NOV)	Discovers the KPIs for tracking the NOV performance and IT services deployed for NOV	Good	Internal
29	(De Vos, 2021)	Benefit value KPIs such as return of investment efficiency, IT strategy, IT business process plan and data storage discovered	Good	Resolute blog
30	(ArchiMate® 3.1, 2019)	ArchiMate modelling to understand the architecture of NOVs functions and data source from EA and service deployments	Good	Open Group website

The systematic analysis of the research papers helped to formalize the structure in investigation and synthesis of the information. Followed by the evaluation and selection of research papers that supported the thesis assignment, a literature study was performed to synthesize findings as discussed in the next section.

2.6 Conclusion

In conclusion of the literature study method and interview method formulated helps acquire state-of-the-art knowledge related to the topic. The interview questions were knowledge questions to gather requirements for the proposed method to be designed. In the upcoming chapter, the the synthesis of research papers and background study on the NOVs in depth will be explained.

3. State of the Art

The chapter explains the synthesis of literature as the primary source for reference on the state-of-the-art method related to the topic and principles to collect the research findings from the academic journals (Snyder, 2019). The literature synthesized in this report is based on the alignment of themes such as joint ventures, NPV, business models and business processes that leads to the designing the artefact to be tested.The structure of the chapter is shown below in Fig. 8.

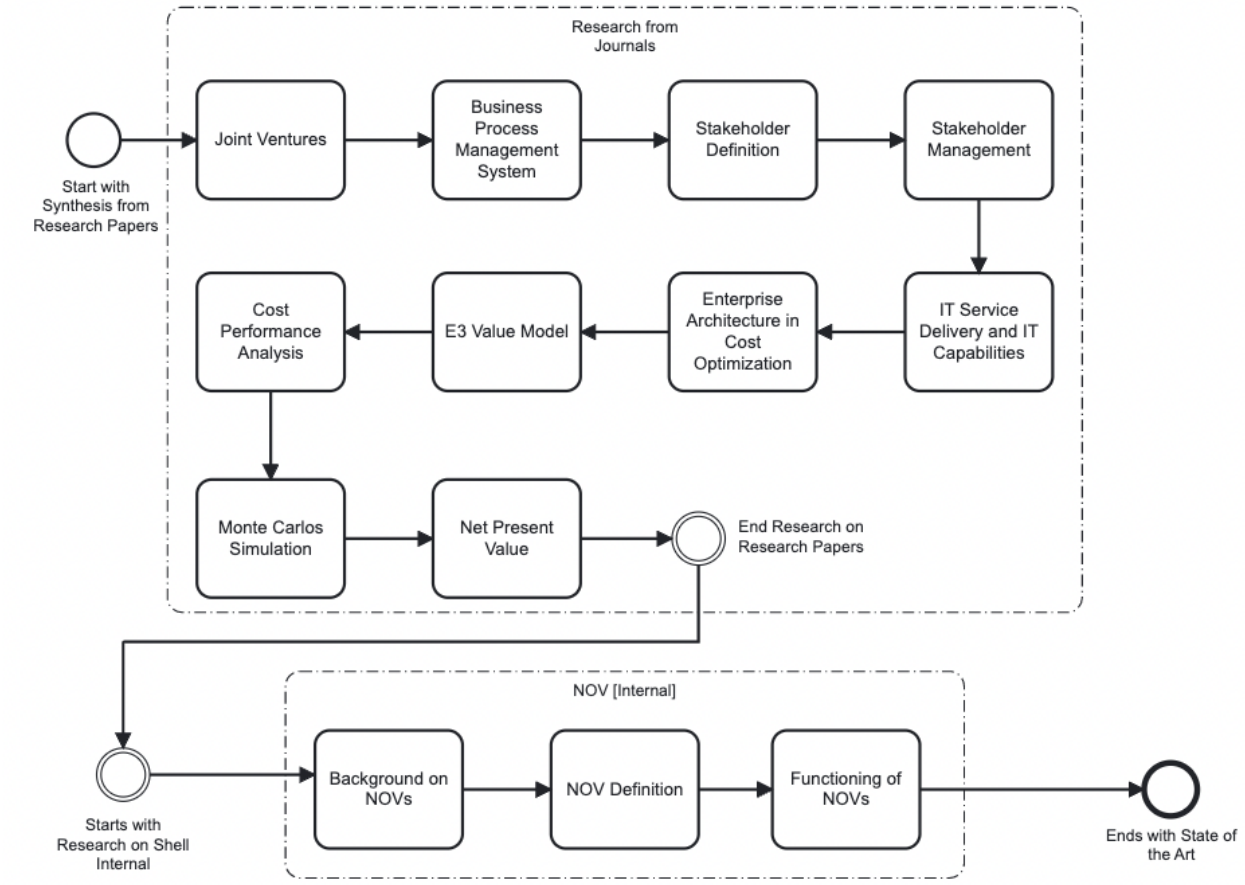

Figure 8: Steps to reach State of the Art

3.1 Synthesis from Research Papers

The systematic literature study creates the **foundational framework** for the thesis in a structured methodology starting with a study on topics that associate to the topic leading to formulation of research questions. In the literature study, collection of the existing knowledge base revolves around the topics on IT service delivery, joint ventures, stakeholder management, cost estimation frameworks, and the value of the IT services offered to refine the assignment and relevant components for justifying claims on upcoming sections.

Joint Ventures (JVs)
JVs invite a major space for research in its definition as an inter-organizational collaboration across borders around the globe with proper examination and control over the equity arrangements (Nippa et. al, 2019). Equity unfolds in multiple domains starting with capital, knowledge, and market access as part of the strategic partnership with foreign investments. The sharing of information simply relies upon the parent organization with its ventures as the parent organization holds a major stake in the control over its ventures.

JVs generate a partnership to develop and progress in the overall offerings of capabilities and resources to stand out over the competitors (Channon et. al, 2015). It is advantageous in several areas of development such as revenue sharing, available inventory control, sophisticated tools, and technologies to ramp up the in-house capabilities. The research and study also showcase that a joint venture is a better strategy for a company to enter the foreign markets than achieving through acquiring an organization mainly because of the profit margins that can be upscaled. However, several disadvantages can be observer with the approach of establishing joint ventures to expand the business operations of an organization such as information about the capital exchange operations, benefits, share profits, and costs to the company in terms of remittances.

Business Process Management System (BPMS)
BPMS proves to be a global norm for an organization to bring uniform service delivery workflow and reference for IT capabilities management (Ojiako et al., 2012). The BPMS can be defined as a central hub for intellectual knowledge sharing and removing discrepancies in information management. It reduces the complexity of contracting the resources to facilitate the required service with Service Level Agreement (SLA) in place. The BPMS is related to the IT strategic plan documents recommending best practices for implementing the delivery of IT service offerings.

In this study (Ojiako, 2012), it can be noticed that the BPMS is a storage platform for the human resource onboarding processes in IT lens as well, assist in analysing the gaps in the system to evolve and supplement the missing gaps for new customers. Continuous improvement is a well-known objective in the IT delivery industry. The vitality and relevance of the business assets contained in the BPMS are directly connected to their utility to the delivery community. Information Technology and Information Systems have potentially been seen as the fundamental driver for fast-tracking the progress towards the improvement of service delivery, The author explains the importance of IT service delivery and factors contributing to the significant development of IT performance in client organizations.

Stakeholder Definition

Stakeholders are perceived as the internal players such as the board of directors, managers, and employees, meanwhile, external players were politicians, regulatory authorities, intellectual property rights boards, and legal bodies. Uncertainties of any nature are an important criterion to be considered in the establishment of a JV and determining the percentage of ownership over the ventures by the parent organization (Cuypers et. al, 2009). Some of the key identified uncertainties are in the areas of exchange rates, traditional values, organizational data inventory for the foreign joint venture companies, and so on. It is observed that in the joint venture space, we can relate the use of NPV based on the cost of investment. If the price of the flow in investment is higher, then it translates that the NPV is a more relevant parameter of evaluation as it reflects the requirement of the resources for operation. The comparison of endogenous and exogenous uncertainty is discussed based on whether the solutions provided by the company straighten out the issue at stake. If the problem is fixed by the solution provided, it can be regarded as endogenous uncertainty, and if not then it can be classified as exogenous uncertainty. Based on these estimations and calculations, the companies can determine the real option that they can consider for operating their joint venture.

Stakeholder Management

The study on corporate stakeholder management focuses on how organizations can leverage maximum in the field of their business among competitors (Zimola et. al, 2014). Each stakeholder group will have its own set of claims against the corporation, which are frequently at odds with the organization's broader goals. The method of collecting information centred on identifying the company's goals and customer perspective, defining interested framework for the analysis, clarifying key metrics for stakeholder requirements in each group of stakeholders, and describing regulations and policies to resolve conflicts between the organization and its clients. Figure 9 shows respective stakeholder and expectation criteria assessment from the empirical study performed for understanding the social claims of stakeholders using the Arithmetic Hierarchical Process (AHP). A key reason why companies should deal with critical stakeholder relationships is their ability to impact a company's overall performance and survival.

Stakeholder	Expectation Criteria	Weight
Owners	Profit	0.339
	Growth in Enterprise Value	0.305
	Investments	0.356
Managers	Growth in Productivity	0.305
	Maximization of Turnover	0.410
	Pay and Managerial Benefits	0.285
Employees	Wages and Benefits	0.482
	Working Conditions	0.240
	Professional Growth and Education	0.278
Suppliers	Stable Sales	0.375
	Timely Fulfilment of Commitmens	0.355
	Payment Conditions	0.270
Customers	Product Quality	0.394
	Product Price	0.386
	Service, Warranty Conditions	0.220

Figure 9: Enterprise Owner Goal Analysis (Zimola et. al, 2014)

According to Enterprise Theory, a common trait of all firms is that identifying a single target behaviour is extremely difficult. Each stakeholder group has its own goals and, depending on its relative power, influences the company's intended behaviour. An enterprise's target equilibrium can be altered to varying degrees. Based on the study in Czech, the importance of stakeholders was found to be in the order of Owners > Customers > Managers > Suppliers > Employees. For the long run of an organization's benefits, consistent risk management and measures to upscale growth and competence must be encouraged by the management.

IT Service Delivery and IT Capabilities

In an operational venture, the key performance indicators used for service delivery are first-time fix rate (FTF in %), operating time (in hours), process stability (in %), estimating the difference between operation time and average standard deviation in the operating time, On-time delivery (%), mean time to problem solution of hours, costs incurred, revenue generated, resource utilization percentage and the acceptance rate (%) tending to primarily be focusing on operating ventures service delivery (Lagemann et. al, 2013). The service performance relevance measures are calculated based on whether relevance is low, moderate, or high with numerical indicators as 1, 2, and 3 respectively to help management and the planning divisions in an organization solve the inefficiencies and jot down root causes of problems. In this report, the focus will be on the NOV value such as the progress tracker of senior business stakeholders at Shell on NOV performance parameters such as Resourcing, IT capabilities, Cyber, and Delivery performance.

Information Technology resource investments indicate the expenses incurred on the organization's budget for digital transformations while determining who the stakeholders must be for decision making (Benitez et. al, 2022). The implementation of IT governance process capabilities to govern resource allocation, and investments in several IT metrics such as the IT infrastructure, IT service delivery, and IT monitoring are stressed. The authors propose a research model as shown in Fig. 10, suggesting that IT governance process capability contributes to better IT performance, increases business performance, and permits firms to generate value from IT investments.

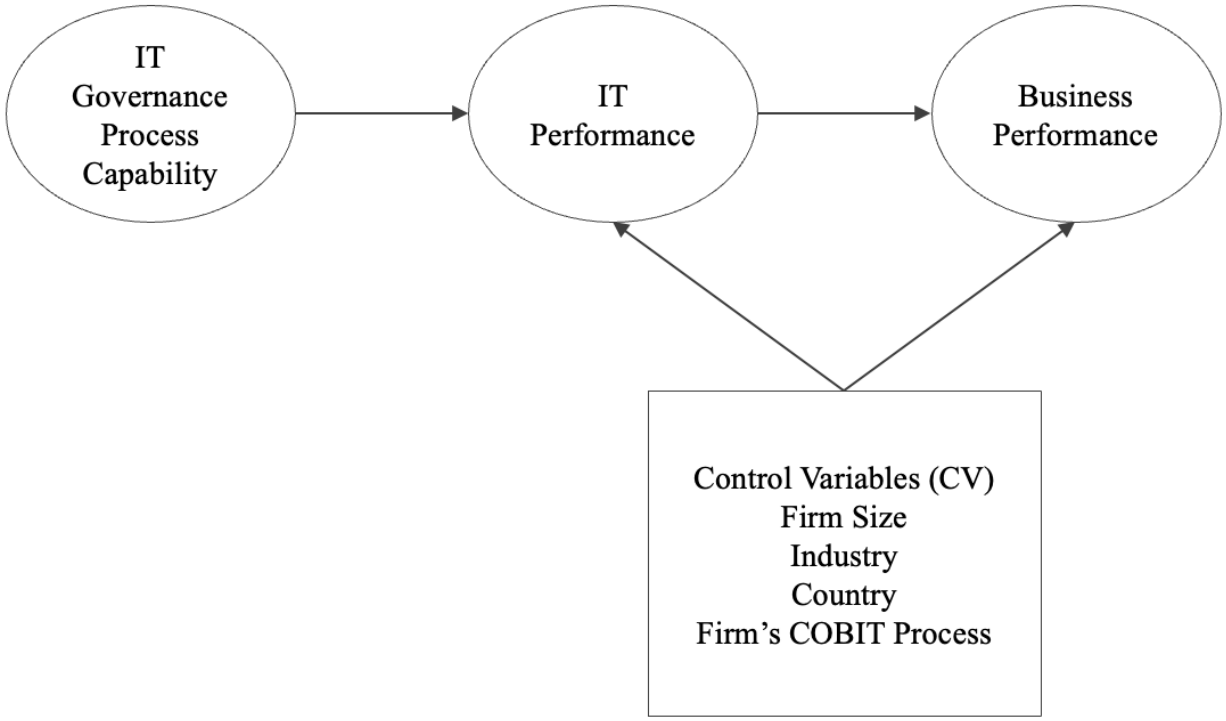

Figure 10: IT Governance Process Capability Research Model (Benitez et. al, 2022)

Enterprise Architecture in Cost optimization

The Enterprise Architecture (EA) is an overview of the processes carried out on the IT and business perspective levels that helps to distinguish the business processes involved in an organization and reduces the duration of decision making. There are several factors responsible for an enterprise architecture based on the business process and key IT operations that help to manage the IT environment and improve risk management approaches to maintain the IT assets (Tamm et. al, 2011). The commonly referred to as-is and to-be situations help to envision the current state and the target architecture typically assisting to develop a strategic gap analysis for the artefact to be assessed. The gap analysis includes architectural diagrams, roadmaps, and artefact. From an organizational perspective, the benefits of EA are designated in the academic studies such as

increased responsiveness and readiness to change, improved decision making, enhanced communication, strategic business, and IT alignment, re-use of resources, improved integration, mitigated risks, compliance to regulations and legality and finally stability in the organization. The integrated use of the The Open Group Architecture Framework (TOGAF) standards in ArchiMate. ArchiMate is a modelling language that visually aids for clear representation of the organization.

In the study of EA contribution to the achievement of organizational goals, the investment decisions have been proved to be beneficial while scoped from an architecture of an enterprise as EA enables better communication for the responsible stakeholders and enhanced scope definition for IT projects (Jansen et. al, 2010). An architecture is easier for accommodating the changes in organizational structures and henceforth contributes to portfolio planning. The costs for the IT services and alignment are reduced when consolidated in the operation of the IT management. Using the relationships matched appropriately in an EA, strategic mapping of stakeholders with applications and technologies over business processes could be drafted positively.

Composition of relations in EA models, the definition of transitive closure elucidates that without a precise definition of the meaning of the models, the architecture models can be sketched (Jonkers et. al, 2003). The visualizations are modelled to address the concerns of the targeted audience to give more clarity from respective viewpoints with appropriate details of the ArchiMate models. In insurance model shown in Fig. 11, the model uses the organizational service to obtain the requirement for defining the cost to be incurred.

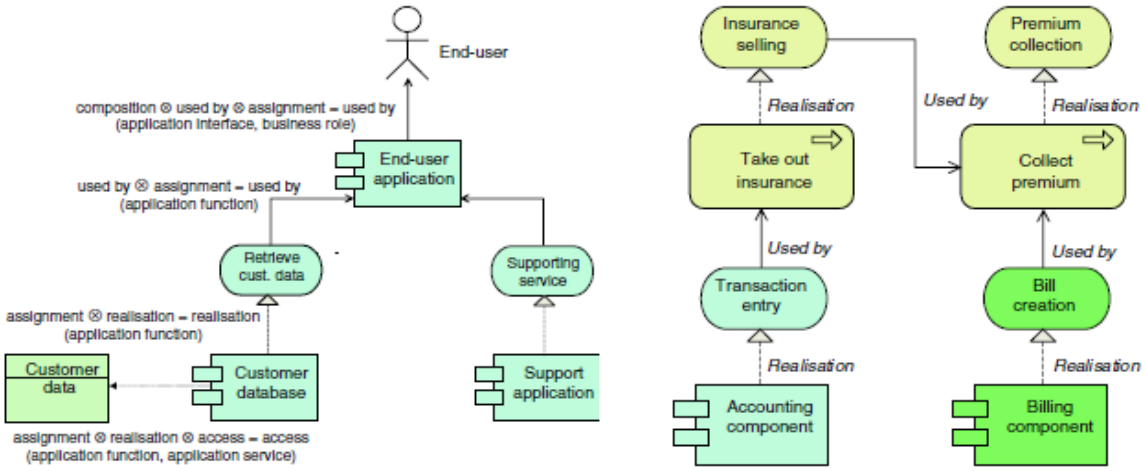

Figure 11: Developed Cost and Insurance Models (Jonkers et. al, 2003)

To uncover the IT value generated, the example of electronic economy is studied (Sawy et. al, 1999). EA creates new perspectives to understand the IT infrastructure with EA and its growth in the economy. The major issue faced in the value creation was the surmounting demand from the quick customer feedback on the produces and the economic advancements in the way of product creation. Due to these changes, there is also a demand to change during strategic actions and portfolios to approach products differently and sustain the competence requirements of the market. With a certain unpredictability in the market, competition for migration patterns becomes a significant value proposition.

The misalignments are cured with an EA view on the strategy that helps to improve the quality of services provided to the customer. Being customer first approach also assists in operationalizing customer demands. To envision this operation, a fair understanding across all layers of the operation such as the EA is imperative. The key elements proposed in the study for alignment are strategy, organizational principle, compensation scheme, and IT towards the customer's voice. The EA also helped the industry to develop new practices for becoming an IT organization. Yearly budget allocation for the IT projects streamlines the process of budget for testing phases as well. The practice, however, requires the IT-specific expertise to be owned by the best possible resource designated.

Strategic alignment to leverage IT to transform organizations (Henderson et. al, 1993) explains about the internal domain focuses on the administration whereas the external domain focuses on the business functionality. Strategic alignment has three different areas such as the IT scope, systemic competencies such as the cost-performance levels and interconnectivity, and finally the IT governance for strategic alliances such as joint ventures and IT capabilities. In the EA alignment (Joosten et. al, 2020), coherence between the elements within the architecture discusses the ArchiMate EA model, monitors the EA quality by implementing standardized rules for better management of processes and henceforth Business IT alignment. The standardization of rules could be achieved through the establishment of a meta-model that facilitates the concrete guidelines for structuring the models with appropriate relations.

E3 Value Model

The E3 value model to uncover the value for the consumption of services provides a broader perspective on the goods and services consumed by the client organizations as shown in Fig. 12. Organizations, customers, and middlemen are examples of profit-loss accountable actors. A market segment is a term used to describe a collection of comparable players (such as a pool of users). "Provider A," "Provider B," "User A," and "User B" are actors in the "flat-rate" case.

Transfers of value items, such as money or service delivery, are called value transfers. All the lines between two actors in the flat-rate example represent value transfers. Each transfer has a value associated with it that may be changed using the context menu. Money, services, products, information, and experiences are all examples of valuable objects that may be exchanged. The context menu of value objects can be used to attach them to value transfers.

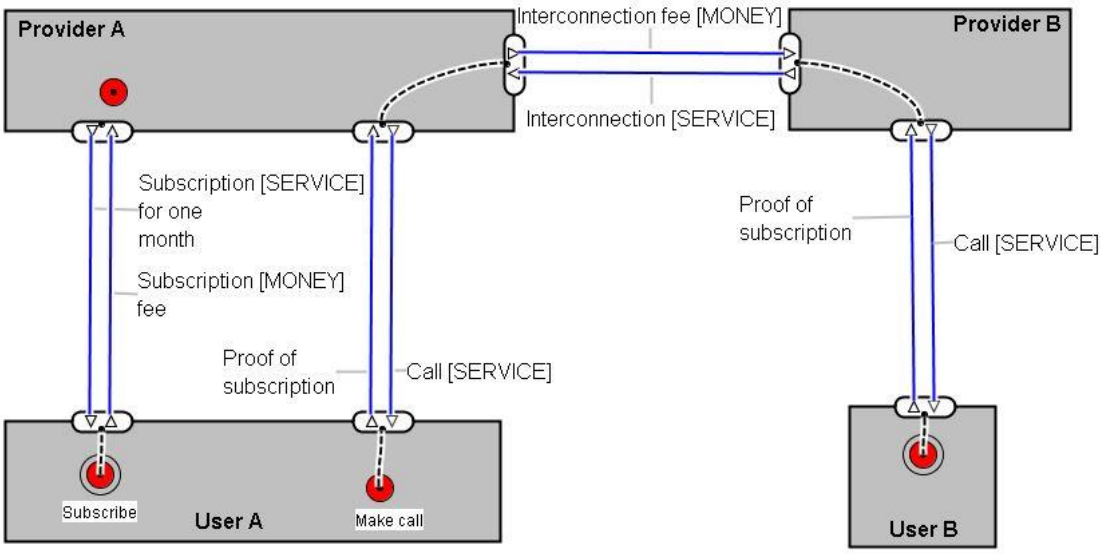

Figure 12: Conceptual E3 Value Model (Value engineers, 2018)

Dependency routes are a series of economic transactions linked together. There are two dependency routes in the flat rate example: one for the subscription and one for the calling. Processes are not represented by dependency pathways. They simply state that a consumer demand activates a certain set of economic activities within the contract time, without specifying when or how these transactions are carried out. Economic transactions are triggered by start cues. Each initial stimulus has an occurrence rate that may be changed via the context menu. "Purchase" and "Call" are two such demands in the flat-rate example.

Cost Performance Analysis

The study focused on developing a set of technical Cost Estimating Relationships (CERs) that incorporate both quantitative and qualitative non-recurring airframe engineering input into the design process (Roy et. al, 2010). Based on the CER development, the quantitative and qualitative design efforts were divided at first and combined at the end of the development phase to obtain a final CER. Based on the normally restricted product specification in the conceptual design stage, the results show that these newly created CERs can anticipate future design.

However, there are global risk factors that requires attention are included in building a cost performance as explained in risk modelling (Baloi et. al, 2003). Few of the risk factors that weigh in for considering the build of cost performance are risk models, assessments, and management. However, we find that the global factors are typically applicable to only the scope of a project. Based on the risk parameters, the questionnaires are utilized to shape the framework for requirements gathering and the severity analysis of the cost performance parameters. Some of the pressing factors would be based on the taxonomy of risk such as the technological, administrative, scientific, mechanical, societal, industrial, budgetary, entrepreneurial, and political disciplines. In the study, the analysis of the poor cost performance is observed when there is an influence by the competition with level playing companies, the size of the initiatives in terms of a project, and the nature of it. Management of uncertainty is key in the risk assessment and mitigation strategies

while estimating the cost performance as there may occur unforeseen circumstances incubating the charges over project execution. Mapping to the status of non-operated ventures, the replica could be seen in terms of contractual bindings where the limitation is the visibility of their business strategies and project durations. A probabilistic approach as suggested would be an effective mitigation strategy.

In the study of synergistic effects of integrated project delivery, the research reveals and discusses the performance measures on both quantitative and qualitative analysis for building information modelling (Nguyen et. al, 2019). Prediction models are ideally perceived as a complicated measure because of the varying external factors digressing the cost of time delays and quality improvements.

The quantitative cost performance analysis in the study elucidates the implementation of the means, variance, range, standard deviation, and median calculations under the statistical performance over data. Using ANOVA (Analysis of variance), linear validation models are performed for the data analysis. Key indicators such as project performance, efficiency, and enhancement qualitative measurements help to convert them quantitatively based on the legends that are collected in stakeholder interviews as part of validation.

The performance comparisons to quantitatively analyse information on cost, schedule and quality depend on the project delivery (Sullivan et. al, 2017). Such a project delivery is explained with the example of a construction department where architectural and design specifications define how to identify the risks in a project that uncovers personnel and operational risks. These identified risks are then differentiated related to the stakeholders and the project time of delivery. In the paper, two of the listed cost performance metrics are cost growth and unit cost. The cost growth captures the ability to predict the final summation of the project whereas the unit cost determines the cost based on units such as the dollar value of the number (count) of infrastructures.

Monte Carlo Simulation (MCS)

A Monte Carlo Simulation (MCS) reduces uncertainty by considering many possibilities. The flexibility of the simulation helps us to predict outcomes through changing risk factors across several parameters. From the tacit knowledge of IT service parameters estimated with briefings from stakeholders, the Monte Carlo simulation was found to be appropriately matching to the thesis topic.

The approach produces results that are comparable to those produced by analytical methods while also adding details about index variance (Godha et. al, 2011). For each load point, the sequential analysis provides information on the likelihood that a failure will occur, the length of the failure, the number of customers who will be impacted, and the probability distributions for operational metrics. The reliability of values estimated using MCS was found to be profound with more randomized value figures (Benson et. al. 2020). The proposed method gave insightful recommendations for predictive failure estimations.

Net Present Value (NPV)

An NPV calculation essentially provides when the cash could be obtained after operation for a designated period by the managers at the organization (Net Present Value, 2017). The cash flows

(both positive and negative) for each year connected with the investment, discounted to today's dollars, is the NPV. The discount rate is derived in its most basic form by computing the "actual" cost of capital utilized in the invention, that is, the weighted average cost of equity and debt used to fund the project (ŽIžlavský, 2014). After reviewing the empirical literature on innovation performance measurement and the implementation of the NPV method, it was discovered that there are important shreds of evidence supporting the beneficial impacts of using NPV for inventive performance assessment and data that cast a more critical light on the projected advantages of its adoption.

Currently, the available context about the NOVs is minimal and it is relatively a niche area unexplored in the research fields across research journals. Due to this reason, there is a requirement to refer internally for defining the NOVs and management principles around the NOV space.

3.2 Background on the NOVs

The section discusses about the background knowledge on NOVs from Shell. The study on background tacit information will add context to the topic of JVs, NOVs, and the structure in which they operate. The functioning of these ventures are backed by a conceptual framework that guides stakeholders to participate and take decisions based on the internal framework.

3.2.1 Definition of NOV

The NOVs and definitions are based on an internal control framework that serves as a foundation as shown in Fig. 13 as the conceptual depiction of the internal framework. The framework shows several topic areas such as contracting and procurement, risk register, ethics & compliance, data privacy, monetary, tax, human resources, health regulations, safety protocols, security and environment, and legal and access controls. The structure for the framework also means that there is a list of management processes to achieve the following:

1. The understanding of business objectives,
2. Understanding the risks that could prevent the company from achieving business goals,
3. Developing adequate risk responses and
4. Assuring that the risk responses are effective to address the risk that could impact the ability to accomplish the identified objectives.

Based on responses from stakeholder interviews and internal reference readings, NOVs are Non-operated Ventures as opposed to Shell's Operated Ventures. The difference in ownership over the ventures when it comes to operated vs non-operated depending on the vested business interests. We can map based on the independence of the NOVs and technological knowledge for these ventures and understand what Shell can offer to these organizations. Technology investments require investments to show benefits for business.

In most situations, we can witness that a financial business investment for NOVs depends mostly on political and organizational rather than just three other parameters as the control share over NOVs are profitable only with a systematic analysis of all parameters.

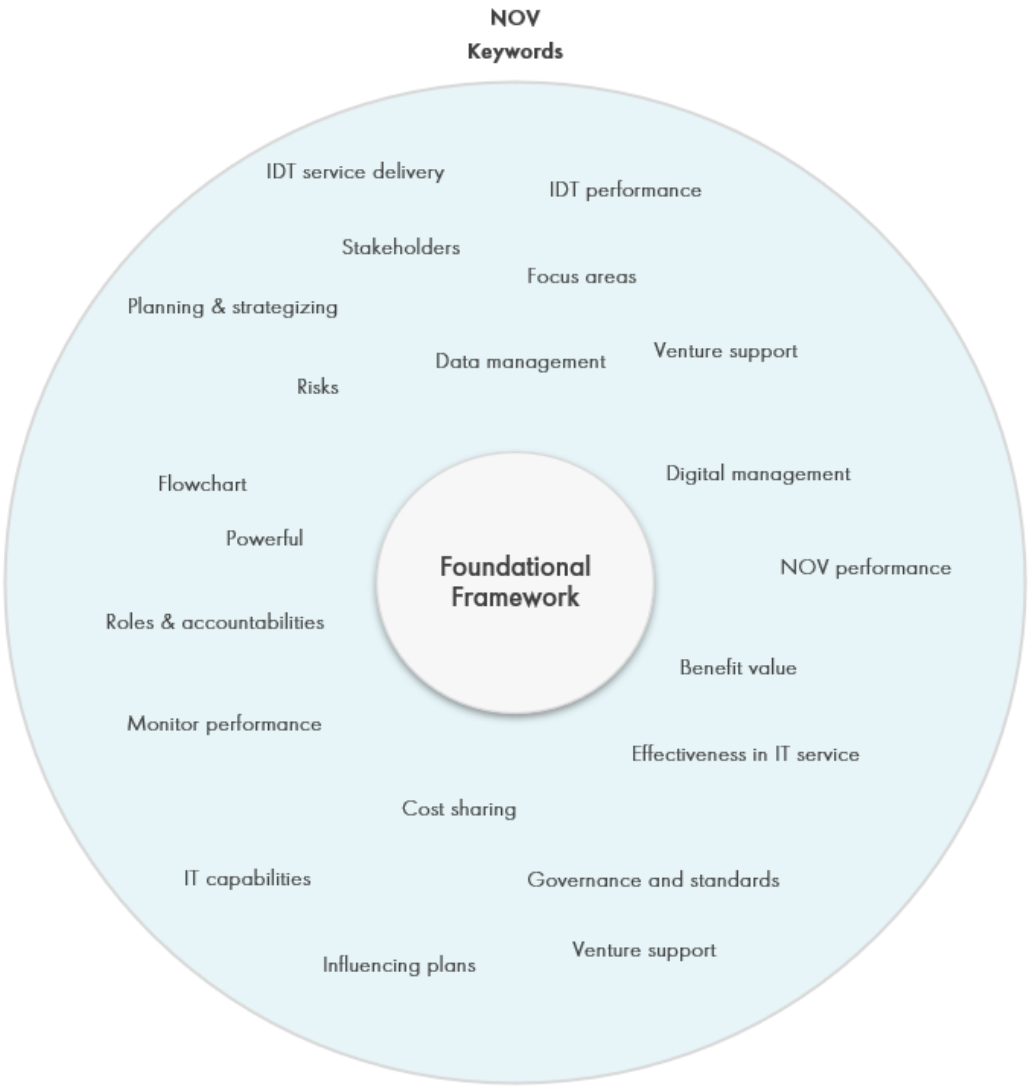

Figure 13: Conceptual Depiction of Joint Venture [Foundational work, Internal]

3.2.2 Functioning of NOVs

Based on the internal references, and stakeholder interviews, this section would essentially discuss the functioning of the joint venture in the NOV space.

JV is an association of two or more participants who engage in business together, share profits, production, costs, and liabilities, and between them exercise control over the businesses through a JV business organization or structure. However, to understand better, the journey and purpose of JV are explored in this section.

Some of the quantifiable factors that are responsible for understanding the benefits of joint venturing were identified as capital requirements, risk and mitigation strategies, access to technology, access to resources, ability to pool assets, capacity to enter or gain a market position and on the political and regulatory requirements.

The capital requirements are some projects can be noticeably big for a single company to take charge of. The risks and mitigation strategies are ideally referred to the risk profile, let us say risk analysis with risk register categorically analysed.
The access to technology focuses on the complex or new markets that require access to multiple technologies as per the needs of certain business cases.

The capital or technology are referred to the access to resources. The dependency includes the ability to pool assets that also provides capacity to enter or gain a market position through mergers and acquisitions to potentially leverage economies of scale. The political and regulatory requirements are in certain scenarios might require foreign companies to partner to understand the legal side of business operations.

Identified cash flow from operations for the JVs were estimated to account for a significant percentage of the cash flow where ventures may include renewables, entrepreneurial start-ups, and large, traditional oil and gas infrastructure. It could involve diverse fields such as the Oil industry, non-energy sectors, governmental institutes, and trading organizations at times. In the identified segment, several elements, and pockets such as non-controlling interest, controlling interest, Shell Operated Venture, Non-Operated Venture, Incorporated JV, and unincorporated Venture are types of the formation in joint ventures.

Controlling and non-controlling means voting rights or rights to exercise an influence to control the venture’s management. It could also mean that the policies of an entity to obtain benefits from activities are included as part of the governing track. Incorporated JV is a separate entity for carrying out JV’s business. It could mean that the company could own the assets in its name and include limited liability and listed companies as part of its own. An unincorporated JV would be set up by just a legal contract or an agreement as they do not own their assets and the shareholders hold assets in proportion to their interest.

Operational control – One party owns the rights to control the operations where typical operator services could include general management of JV, asset operations or company operations, subcontracting services, and execution of decisions made by the board, management committee, or shareholders. – Branches to Operated and NOVs. JV document agreement or contract stipulates

who has operating controls. NOVs are further split into self, partner, third party, and jointly operated ventures. But a control framework for all the assets would be common.

Documentation on these joint ventures could potentially involve a set of following components:

1. Shareholder consensus
2. JV contracts
3. Participation acceptance and
4. Association parameters

Some of the exclusions from the JV governance standards were distributorships, research agreements, royalty-paying licenses, and investment securities. The JV Asset Management Fundamentals are based on the core level of dependencies starting with NOV management principles, governance standards, JV practioners and to monitor the performance of the NOVs. In NOV management principles, the objective of governance teams ensuring NOV were not Shell-controlled organisations. Shell's approach with NOVs has been outcome-focused, fit for purpose, lean and scalable measured based on its business performance.

The governance standards typically apply to all joint ventures for both incorporated and to listed companies of Shell's interest. Within the Incorporated and unincorporated, it is with limited liability and listing only based on legal terms. The management model serves as a guiding principle for Shell IT to develop and build NOV capabilities in a safer and efficient way. The JV practitioners work together in harmony to help safely and sustainably create and protect value for Shell.

In terms of management, Shell IT requires a strategy that assists the IDT where we are going with the venture. Shell considers several strategies (its own, partner or operator strategies) to identify gaps. Shell defines if the strategic objectives are aligned, what are the parameters to be identified as a risk, and whether partner concerns and capabilities offered are addressed. Monitoring the performance of the JVs in areas where controlling the internal risks is coherent with the operator in control.

To track the NOV performance, understanding the outcome of the NOVs is critical. The risks are considered from two different perspectives such as one from the operator and the other from Shell. In focus areas, the NOV framework helps in event of the absence of stakeholders such as the Asset team's influence and support. This way the focus areas are determined.

Focus areas are based on the significant gaps in performance and the JV asset management team seeks to engage and influence operators and other partners on focus areas. At a certain point in time, only a certain number of focus areas are actively working. The gap analysis and the operator's plan overlap the important focus areas of which active monitoring and regular monitoring are part. This helps to maintain accountability in delivering the plan. It could refer to gaps in the operator's performance where the operator has no credible plan to address them. A good focus area can be defined as one that has a shorter period and is owned by an individual in the JV asset management team responsible for engagement and the influencing plan.

Influencing and relationship management is central to the achievement of the focus where the strategic relationship management model is the basis for JV influencing. It is an art and skill that everyone should tune from time to time.

The final important criteria in the NOV space is the Line of Defences (LoDs) assessment. The LODs are assisted with the implementation of assurance plans should go through the responsible stakeholders. In the assessment, there are 3 lines of defence. The three layers as explained in the lines of defence are based on three assessments carried by internal, external, and ventures.

In conclusion to the literature study and the background research on NOVs, the research benefits were identified and discussed in the next section.

3.3 Discussion of Findings

The findings from the research articles of scholarly journals and stakeholder interview questions summarized around the NOV domain of the Shell JVs. This contributed to shape the cost and value parameters and their demands for standardizing a tracking mechanism along with the validation for the quantitative cost performance analysis of IT in business ecosystems.

Figure 14 represents the identified benefits to-be achieved as targeted by using the proposed method to-be designed. The findings shed that through such a method, there will be transparency in the cost and value generation, helps to uncover the hidden costs, reduces the manpower requirements to refer costs and value and also provide competitive advantages to the NOVs. NOVs can be influenced and advised to implement IT solutions so that NOVs reap the appropriate benefits for the functionality of the IT solutions.

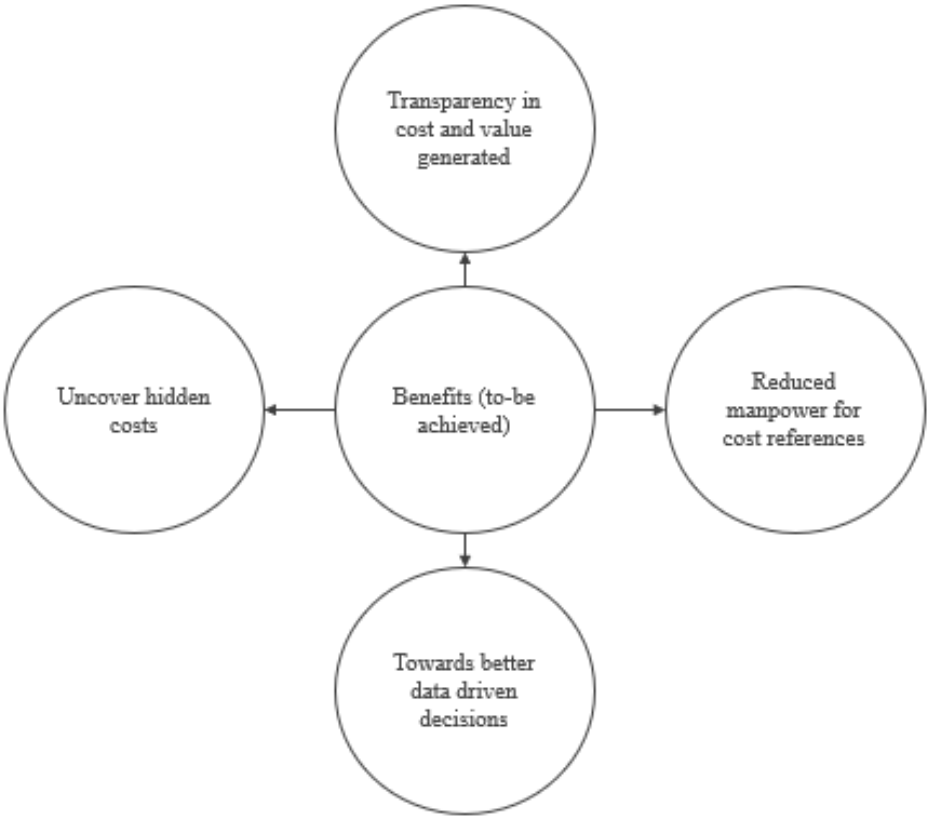

Figure 14: Estimated Benefits from Thesis Research

3.4 Conclusion

From the literature, NPV has been recognised as the core component for the cost analysis under the method to be designed for estimating the value of services provided, especially IT services in this case for a designated period. The background knowledge and the study on NOVs helps in understanding the limitation that when the parent companies estimate the IT services that they offer to these ventures using NPV estimation, parent companies are unclear on the validity of their claims. The value of IT services generated may typically be different and unavailable.

From stakeholder interviews, the identified pressing issue is that Shell would want to understand if the value of IT services provided is the same as what they estimate. In the upcoming chapter, we will look deep into the solution design using illustration example to create the method that uncovers financial benefit value.

4. Design of Artefact

In this chapter, the design problem is discussed in depth to understand the issue Shell faces with their NOVs. The scope of design problem and the societal significance indicating the importance of the research for Shell LNG IDT is described below.

Following this, the solution design is introduced, and the method to estimate the benefit value of the service provided has been designed as the artefact. The ArchiSurance case will illustrate the steps from artefact as an example. On explaining the designed artefact through the illustration example, the method will then be demonstrated on Shell use case in next chapter.

4.1 Problem Scope

The project scope expands to the IG LNG assets in the NOV space. Considering the limitation of the non-mandatory requirement for the NOVs to share the benefit value generation of the respective assets, there is a limitation to understanding the validation of the existing internal model and descoped.

The cost and value of IT infrastructure are de-scoped since there is currently no tangible information retained in the controlled assets to benchmark with internal infrastructures and NOVs hold their costs on the IT infrastructures. Hence, the problem focuses on mainly the application services provided to Shell LNG NOV customers.

4.2 Societal Significance

The impact of the thesis assignment on society is of high relevance considering the Russia-Ukraine conflict. The reason is due to the current shift towards leveraging the existing LNG joint ventures in the NOV business. The IDT team functions towards providing compelling support for these joint ventures to train and equip them with the IT capabilities so that they perform independently themselves efficiently and henceforth become star players in the energy business. This in turn reduces the dependence on external sources for the gas supply and in powering progress towards cleaner operation of the assets.

4.3 Existing High-Level Design

Shell has invalidated benefit value estimation techniques for Shell IT services consumed by NOVs in the joint venture partnership with Shell as the parent organization. However, the understanding being a service provider to NOVs is that the monetary benefit value for those Shell IT services provided to NOVs is tracked as it is internally stored information.

Understanding the benefit value behind the IT services consumed would assist the parent organization to target the ventures appropriately in terms of the IT service delivery of applications, support, and IT capabilities. Strategy & Planning team aims to create an investment proposal plan requiring benefit value estimation. Existing high-level design of the process involved are:

1. Shell IT services are provided to the NOVs.
2. NOVs consume the Shell IT services.
3. The benefit value is currently unknown to Shell.

Based on ad-hoc requests from IDTMs, architects provide architectural analysis of how the IT services are deployed to NOVs. Similarly, the product management brainstorm on the benefits of IT solutions with IDTMs before proposing the solutions to NOVs. From this perspective, the information on benefit value of IT services is currently siloed within different departments of Shell IDT limiting the access to complete methodology required for the LNG IDT team.

The benefit value for the performance of IT solutions was estimated for the cost, SLA, return of investment (ROI) efficiency, and results (Dairo et. al, 2021). The parameter of internal business process, from the study of benchmarking IT strategy, the internal business process plan includes the capability for real-time communication (visually and speed), ability to capture and store the data, accessibility through a user-friendly interface (de Vos, 2021).

The IT service offerings are focused, an operated venture may consume lot more capabilities because it is controlled within the organization and business interests generally are perceived to be more for internal interests.

Meanwhile, in the case of a non-operated venture, since the controlling rights may vary as per the interest of the company, complete knowledge transfer of the backend information is not translated to them as part of internal confidentiality. We find that the service agreement is termed commonly as the SLA for a time-to-time service offering with the non-operated ventures and intellectual property rights protect the information of ventures within themselves.

This results in driving the sector to think about growth in the NOV space, however, the nature of NOVs business on their IT departments and their businesses progress only with more IT capabilities developed by them to solve IT problems by themselves.

To decrease the information silos between departments and reduce manpower by proposing a solution design to estimate the benefit value of IT consumptions in business ecosystems that helps to predict the value of Shell IDT services provided to NOVs, in order to estimate the unknown value and not be dependent on the data from NOVs. Hence, the solution will be designed, demonstrated, and evaluated as shown in the flow diagram below in Fig. 15.

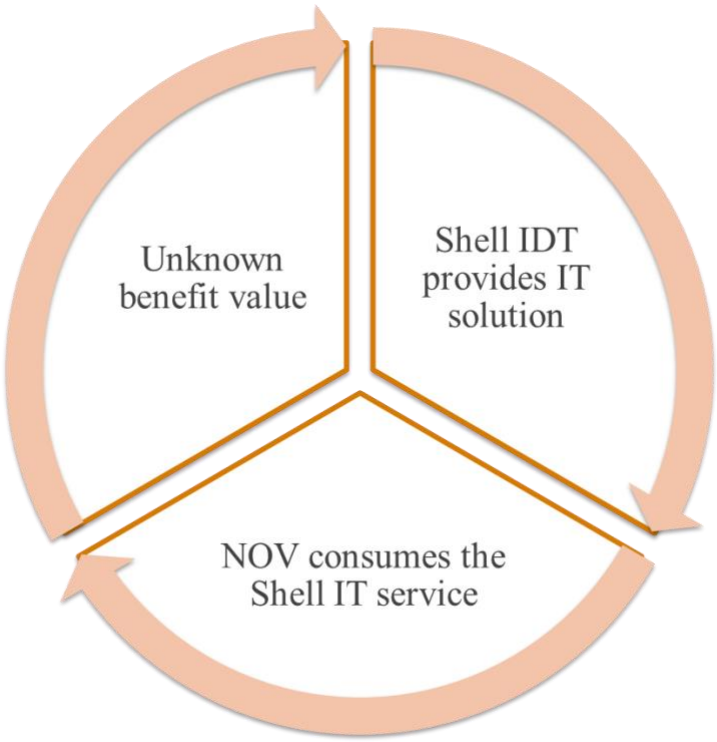

Figure 15: Existing High-Level Design

4.4 Proposed Solution Design

As shown in the Fig. 15, the solution artefact to be designed is introduced as step 4 to the complete high level design to find the unknown benefit value. The solution design is expected to assist the Shell IDT to predict the benefit value of their IT solutions provided to NOVs. As part of the proposed solution design, i.e., the method, the artefact design steps are introduced in this section.

The solution design has been modelled and to test its acceptance for acquiring insights. Based on the insights from the illustration example, the steps will then be demonstrated to solve the design problem in Shell. By using the solution design, the information silos are estimated to be eliminated.

Mapping of architecture to business models and back provides advantages to business model-driven migration from baseline to a target architecture (Iacob et. al, 2012). The relation between the architectures and business models are explained as shown in Fig. 16. To analyse the cost and revenue, the business models are designed and then analysed with their business components. The analysed business components would reveal the connection between the business elements from architecture world to the business world that helps to perform the data analytics.

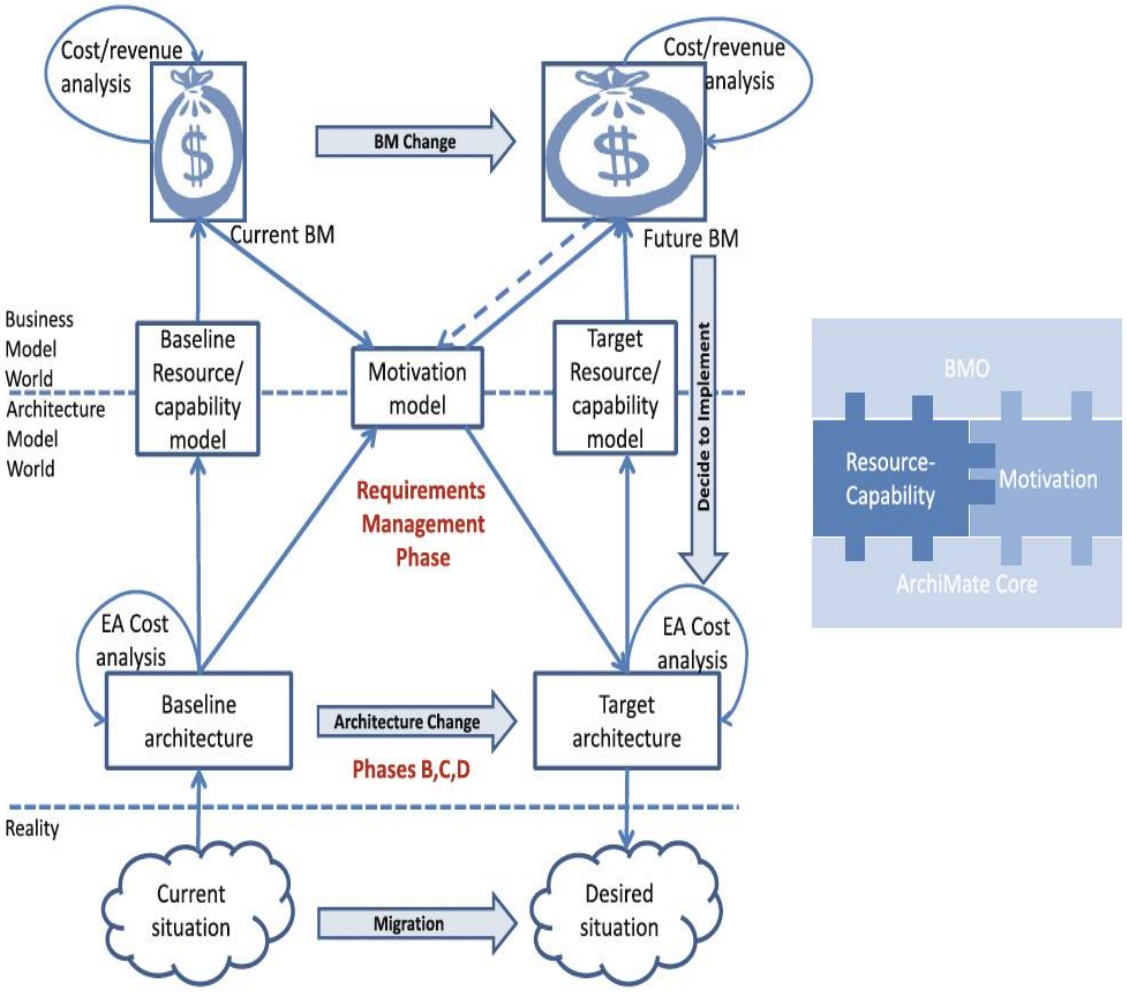

Figure 16: EA to Business Model and Back (Iacob et. al, 2012)

However, in the current design problem, the target state is focused as the proposed solution is the to-be situation for Shell IDT. Hence, the target state that translates sequential steps to map architecture and business model world is defined as shown in Fig. 17.

The solution design has been proposed as a method with three steps defined. The architecture analysis shows the business consumptions as the specification standards for enterprise architectures. As business model specification framework, the E3 will be introduced. To analyse the parameters from the E3 framework, the cost and revenue is represented using Monte Carlos Simulation (MCS). The proposed method is the solution design modelled as an artefact followed by illustration using the ArchiSurance use case.

The steps in proposed method are described as below:

1. Target architecture – The step focuses on mapping the architecture elements and processes involved in deploying an IT solution. The three layers namely business, application and technology are mapped to understand the available components responsible for IT solution provided. This step serves the purpose for identifying the elements responsible for delivery of an IT solution.

2. Target business model – In this step, the input from architecture models gives the responsible business elements to be translated in the E3. The E3 value model explains the value estimation parameters and factors to calculate the benefit value.

3. Cost and revenue analytics – In the final step, the factors obtained from the E3 value business model, the data analytics operations are carried out to estimate the NPV as the final output. Using the MCS, the failure of an IT project is determined.

All the steps defined in the proposed method as shown in Fig. 17, the steps will be illustrated with its respective advantages using the artificial case study of ArchiSurance. After the illustration in ArchiSurance, the steps will be demonstrated on the real-world case of Shell IDT. The steps will be referred to the Fig. 16 to approach in solving the benefit value estimation at Shell. The utility of the method is displayed using the Shell case.

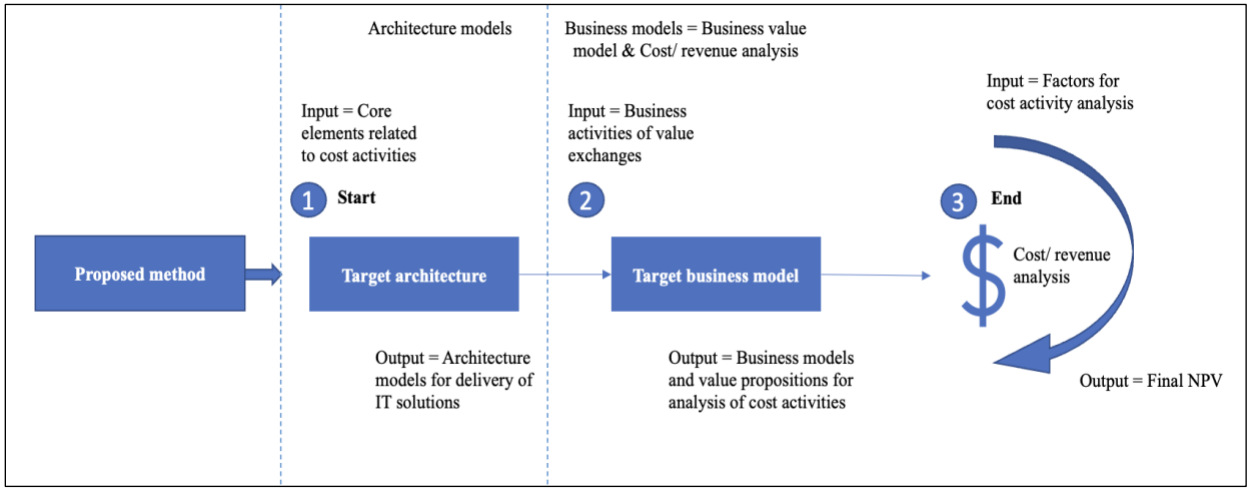

Figure 17: Steps of the Proposed Method

The implementation of the steps in proposed method will be executed in a sequential manner as shown in Fig. 18. The BPMN has been created using the fundamental BPMN tools that describes the activities carried out for proposed method to be implemented in illustration case and its applicability in Shell case study.

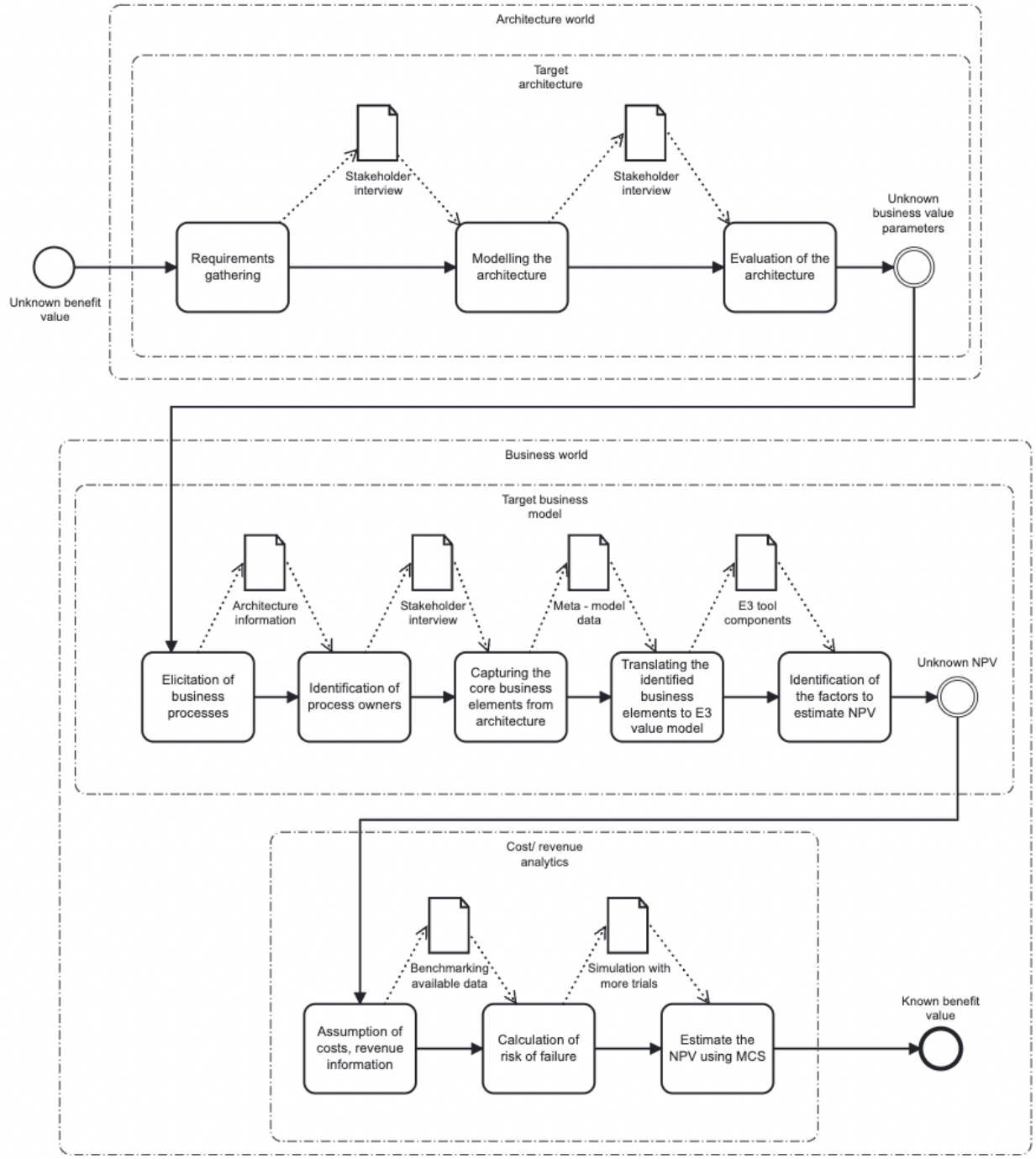

Figure 18: Execution Activities in Proposed Method

4.5 Description of Design Artefact

4.5.1 Method in Step 1 of Design Artefact

The framework utilized for visually representing the potential motivation rolling up from the technology layer is drawn as per the TOGAF standards complying with the ArchiMate modelling language (ArchiMate® 3.1, 2019). The ArchiMate modelling benefitted in understanding the architecture of functions and data source overview from an enterprise perspective. Fig. 19 shows the advantages of using the Hub & spoke topology to depict the IT solution deployment from an architectural perspective.

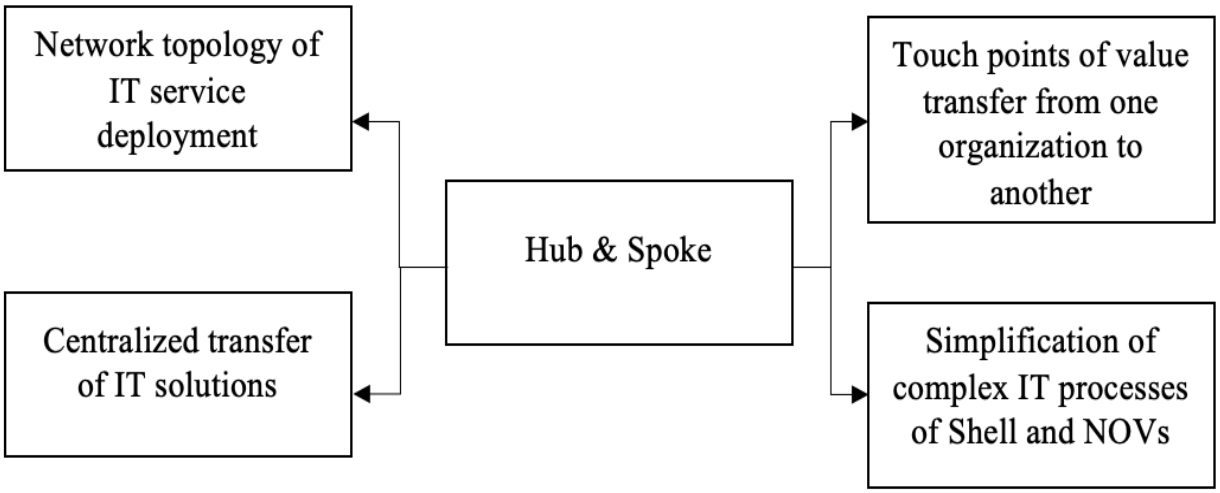

Figure 19: Benefits of Hub & Spoke

The identified topology was modelled in meta model version to analyse the value behind the viewpoint of selection. The advantages were identified for the selection of this viewpoint as drafted in Fig. 20. The implementation and deployment viewpoint discussed broadly on the two layers namely application and the technology layers with its respective advantages.

The implementation viewpoint has been modelled with simplified components such as the technology interface and the application components such as the application function, application interface, application function and the responsible data object that stores the information required as given in Fig. 21.

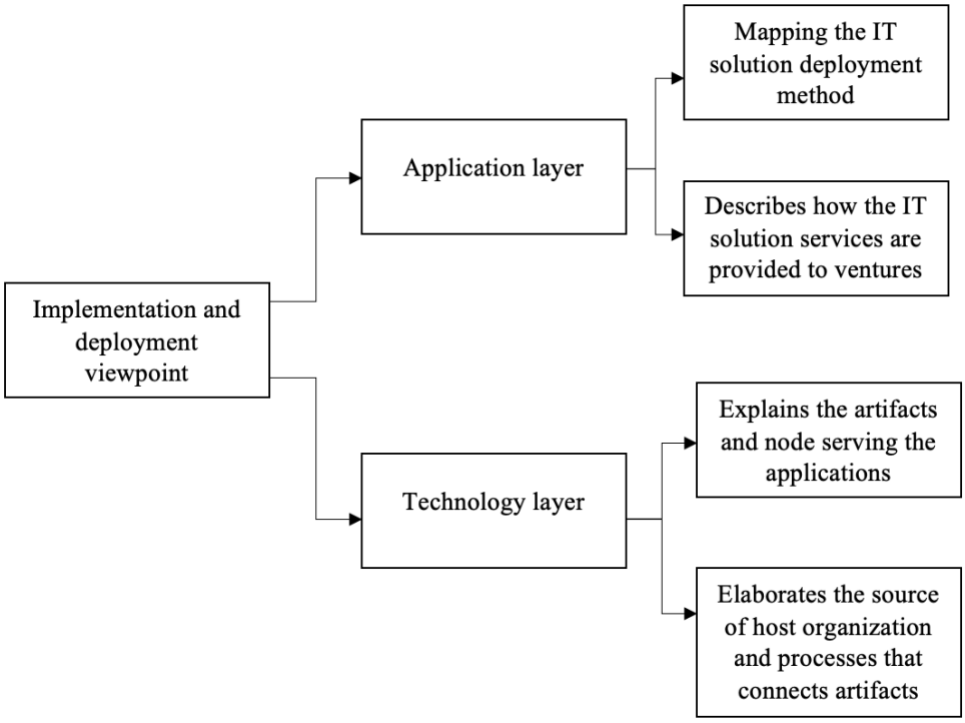

Figure 20: Advantages of Implementation and Deployment Viewpoint

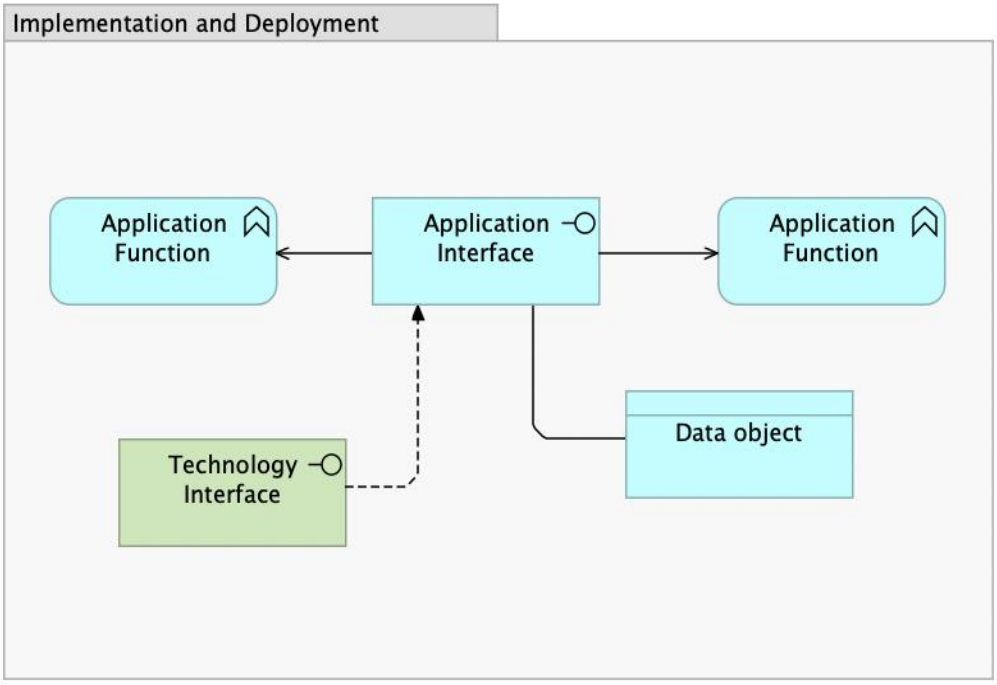

Figure 21: Implementation of an IT Solution

However, the modelled viewpoint does not reveal the actors responsible for realization of business services and processes involved to deliver a solution. To represent this perspective, the available architecture viewpoints were researched for their benefits. Based on readings on TOGAF and use case examples in TOGAF standards (ArchiMate® 3.1, 2019), the service realization viewpoint was found to add value in visually representing the requirements of services and the stakeholders.

The key benefits identified to implement the service realization is shown in Fig. 22. The advantages were based on the business and application layers to show how the application components in the application layer translates to serve the requirements of an organisation in the business layer.

A service realisation viewpoint represents the core business layer where value exchanges between organisations take place. The applications that serve for a business layer are shown in a service realisation viewpoint indicating the data objects that stores the information in application components of the application layer.

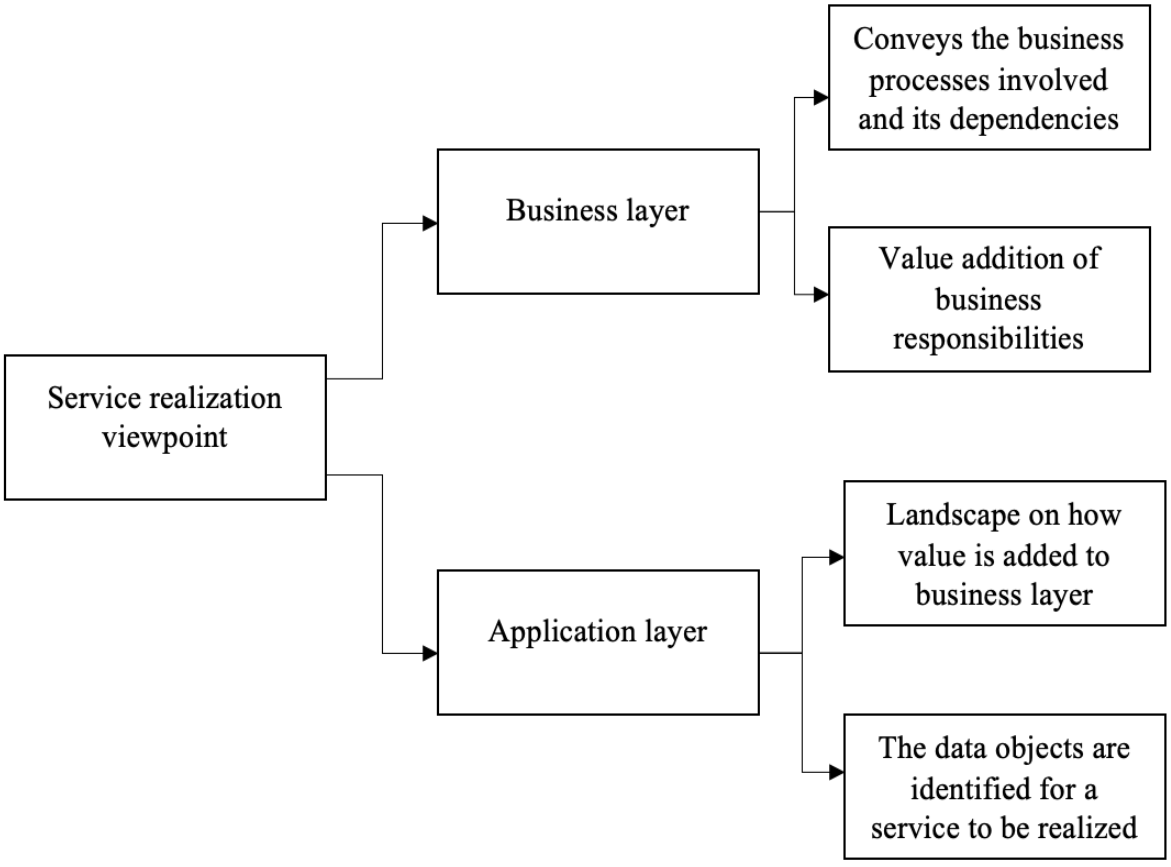

Figure 22: Advantages of Service Realization Viewpoint

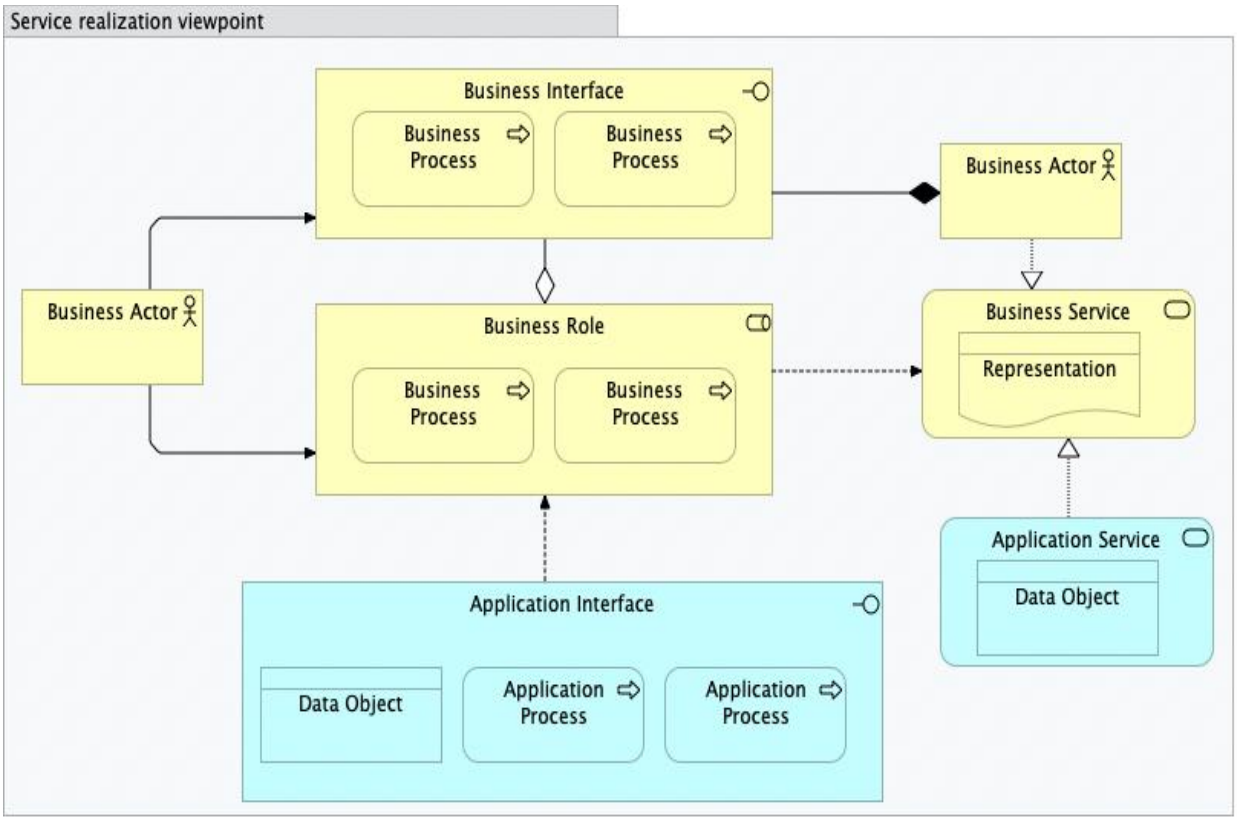

Figure 23: Service Realization Viewpoint Meta-Model

The service realisation viewpoint modelled indicates the application interface to discuss about the application processes involved storing the required data objects. The application interface then flows the information to the business layer where the business actors take the required action through the business interface using business processes. The other business components in business layer are business roles and business services responsible to deliver the IT solution as modelled in Fig. 23.

4.5.2 Method in Step 2 of Design Artefact

With the models from architectural specification, the elements from ArchiMate were mapped to the meta-model of an E3 value proposition. The process of mapping core elements from ArchiMate was performed based on the relevance of elements between both TOGAF and E3 respectively.

Business value propositions traceability points the relation between value port in E3 and the business interface where actors are directly involved (van Sinderen et. al, 2021). Actors from business interface ideally were found to face the external actors outside the organisation and hence serve directly in translating the value of service provided.

The enterprise architecture explores further on the value of the business and IT alignment through simplification processes such as the business models and relation to the architecture elements (van Sinderen et. al, 2019). The quantitative alignment reveals the identification of stakeholder in scope (van Sinderen et. al, 2021). The definitions of the elements in both ArchiMate and E3 assists in assigning the relations responsible for the mapping of the tools. However, the economic transition in 1-1 would be feasible in this as only group mapping of architecture elements is applicable in this proposed method.

4.5.1 Method in Step 3 of Design Artefact

MCS is proposed as the final step of the solution design. The simulation can be done in excel to calculate the probability of loss for any solution to be deployed as NPV. The MCS indicates the loss percentage taking the difference between inflow and outflow of cash based on the parameters such as revenue, fixed cost, and variable costs within the estimated standard deviation.

To determine the loss, using the "what-if analysis" function from excel in 500 trials provides accuracy. The references from internal and external discussions revealed that with a greater number of trials, the more accurate average values are obtained. The "what-if analysis" depicted loss for uncertain costs involved. Using the profit and loss margin with the number of solutions provided, determining the probability of loss can directly provide the probability of success and failure of a project.

The average mean, standard deviation, minimum and maximum loss are parameters to-be calculated to show the outcome of the simulation. The outcome from MCS is to also provide the stakeholders with more visibility of the possible outcomes. The risk of loss is the probability of events that could encounter a loss of investment. To calculate the risk of loss percentage, the profits column can be checked for the number of times the profit was less than 0, i.e., indirectly the loss value and hence the loss % itself. The format for the simulation based on the what-if analysis is shown below in the Fig. 24.

Using the output from MCS, the graphical representation can be designed for verifying the normal distribution curve. Normal distribution in MCS provides information on the probabilistic distribution where cost data has uncertainties.

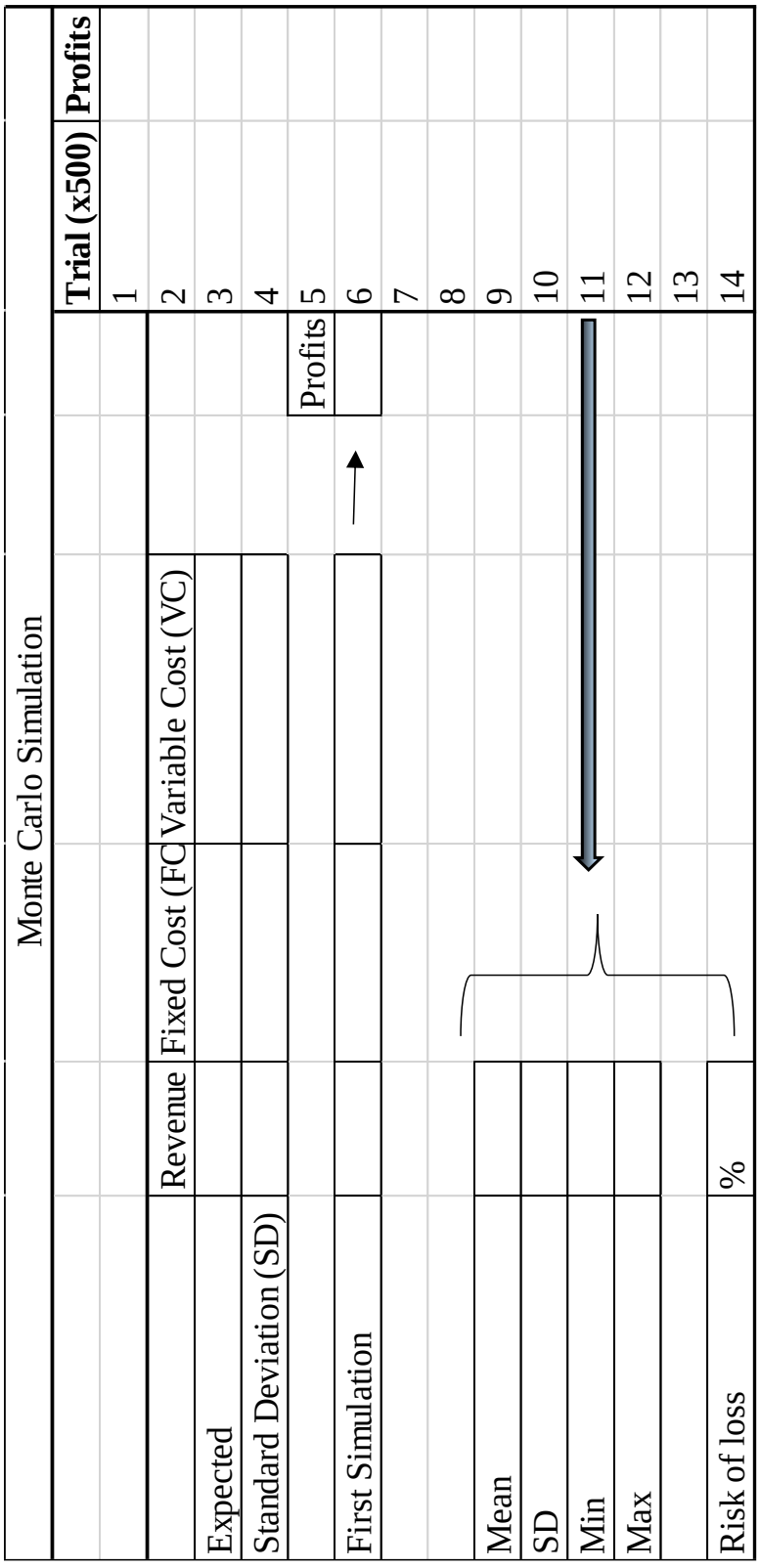

Figure 24: Determining the Failure of an IT Project

4.6 Illustration of Solution Design in ArchiSurance Case

The experiments executed to approach the problem descriptions are discussed in this section. During the design phase of the artefact, the relevant use case of ArchiSurance was implemented to illustrate the designed artefact and build observations, findings, and insights to then apply to Shell case for achieving the research goal.

4.6.1 Target Architecture

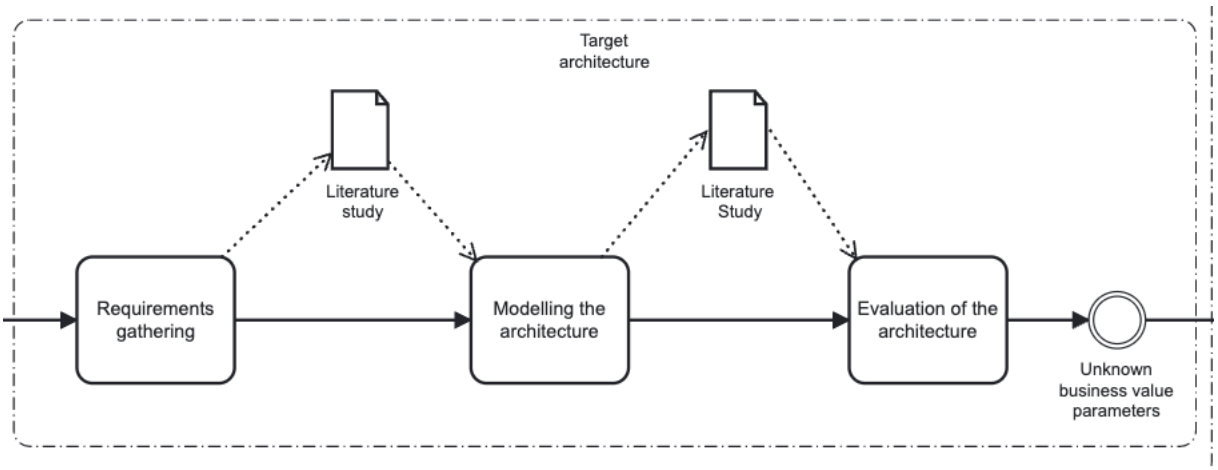

Figure 25: Activities in Step 1 - ArchiSurance Target Architecture

The target architecture modelling required literature study on the ArchiSurance case study for illustration. As step 1 in the execution of the proposed method, the benefit value elements from target architecture were derived through the activities as shown in Fig. 25.

Application of TOGAF standards as graphical representation on the ArchiSurance (Iacob et. al, 2009) reveals the processes involved in the Claims services under customer support. To visually represent in architecture perspective, the hub & spoke topology was investigated further as services were provided keeping ArchiSurance as the central hub towards its customers. ArchiSurance viewpoint is shown in the Fig. 26.

The network concept in hub & spoke topology depiction over the viewpoint reveals the use case of ArchiSurance. Here, the management dashboard is in place to serve for both the internal database management and external shared service centre. The dashboard was supported using a server as technology interface transferring the technology data to the application interface. The dashboard stores information regarding the document management from shared service centre along with the data objects of front-end and back-end systems.

The implementation and deployment as modelled in the solution design was then translated for illustrating the ArchiSurance example as step 1 to simplify how the IT solutions has been deployed. Figure 26 discussed the direct relations between application elements and the technology interface.

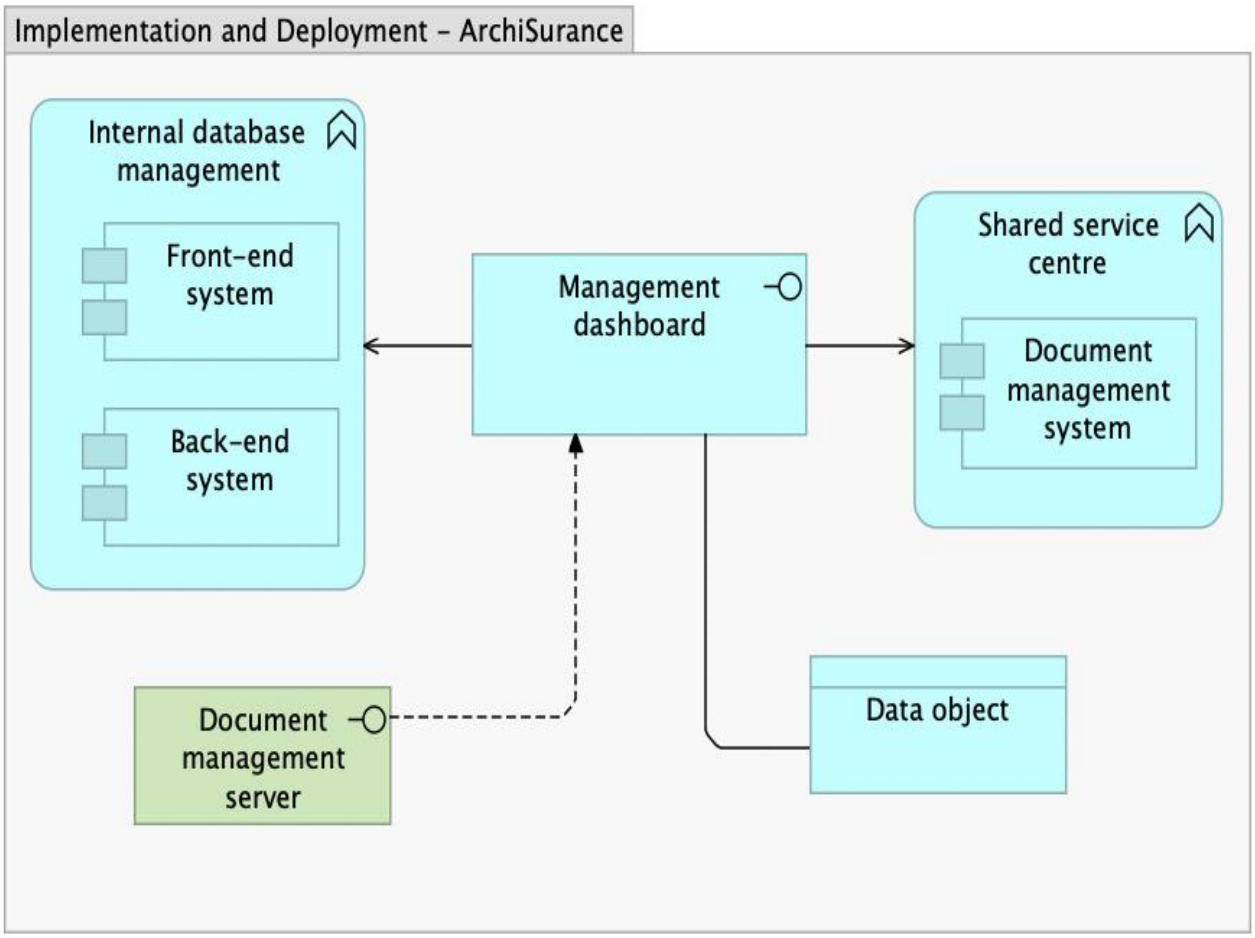

Figure 26: TOGAF on ArchiSurance Case

The meta-model was modelled in service realisation to clearly specify the elements from ArchiMate, and overall skeleton as specified in Fig. 23 of previous section. The meta-model was then translated to the ArchiSurance use case for enterprise visualisation of the Claims business service delivered from the company to their customers.

A customer raises a request using the dashboard that stores the dashboard request data. From the company, the customer service layer is facilitated by the Customer claim interface. In this interface, the ArchiSurance customer support agent validates the claims initiated by the customer. The claim validation aggregates business processes such as the investigation of issue or request that has been initiated by customer along with consistent information that is provided to the customer.

However, to understand the underlying principles from the application perspective, the scanning, printing, administration, and payments were tracked in the application service i.e., the claims dashboard of ArchiSurance. The viewpoint is specified as shown in the Fig. 27.

The identified business process translates how the customer service is provided to their customers. However, to find business benefit value behind the service, translating the architecture to business value proposition could highlight the areas of value exchange between the involved stakeholders, roles, and business processes.

We will investigate the context of a business value proposition tool E3 in the next section. As step 2, the illustration of ArchiSurance example has been examined to provide the relation between the architecture world and the business model world.

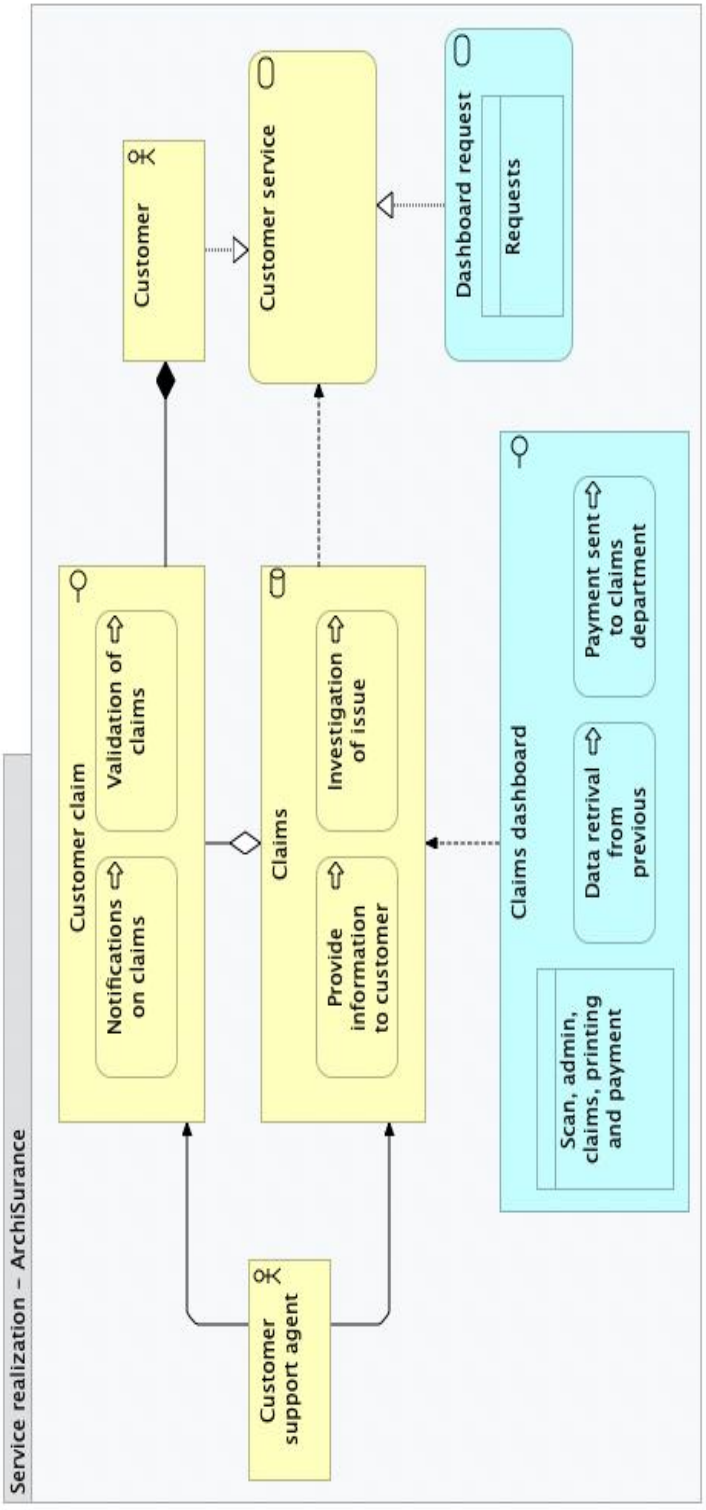

Figure 27: Service Realization of IT Consumptions Based on ArchiSurance

4.6.2 Target Business Model

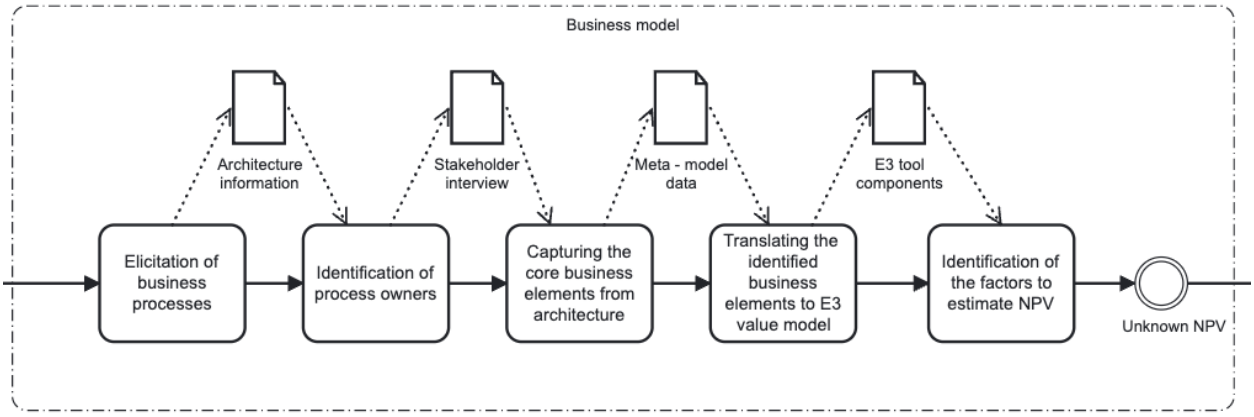

Figure 28: Activities in Step 2 – ArchiSurance Target Business Model

The elements in E3 represented in the value proposition business model were mainly the market segment, actors, customer needs, and value interface. The business layer components from architecture specification served as the input for illustrating the business model of ArchiSurance as shown in the Fig. 28. The activities that leads to the completion of step 2 are explained in this section.

The business layer of architecture was mapped as they indicate business and service partnerships between ArchiSurance customer support, and customers. The outcome of mapping architecture elements to the value proposition model (Iacob et. al, 2012), simplifies the understanding of business context and value exchanges between organisations.

As discussed in the literature study, the E3 method expresses the exact track points of IT services and their corresponding value interface between different parties. However, the ArchiMate as pointed out in the study had a richer context of the IT service offerings as it demonstrated a wider perspective of realizing IT solutions.

As modelled in the Fig. 29, the architecture elements from ArchiSurance such as the notification of claims and investigation of issue are windows of value exchange interface between the company and its customers. In the value exchange, the customer pays for the support from company.

In the E3 value model, the actors were customer (external) to the company and the customer support of ArchiSurance. Here, the value activity was driven by claims handled in customer support. The value exchange between the Claims and Customer provides the information for the value activity that adds revenue for the ArchiSurance, and the costs incurred in providing their customer support service.

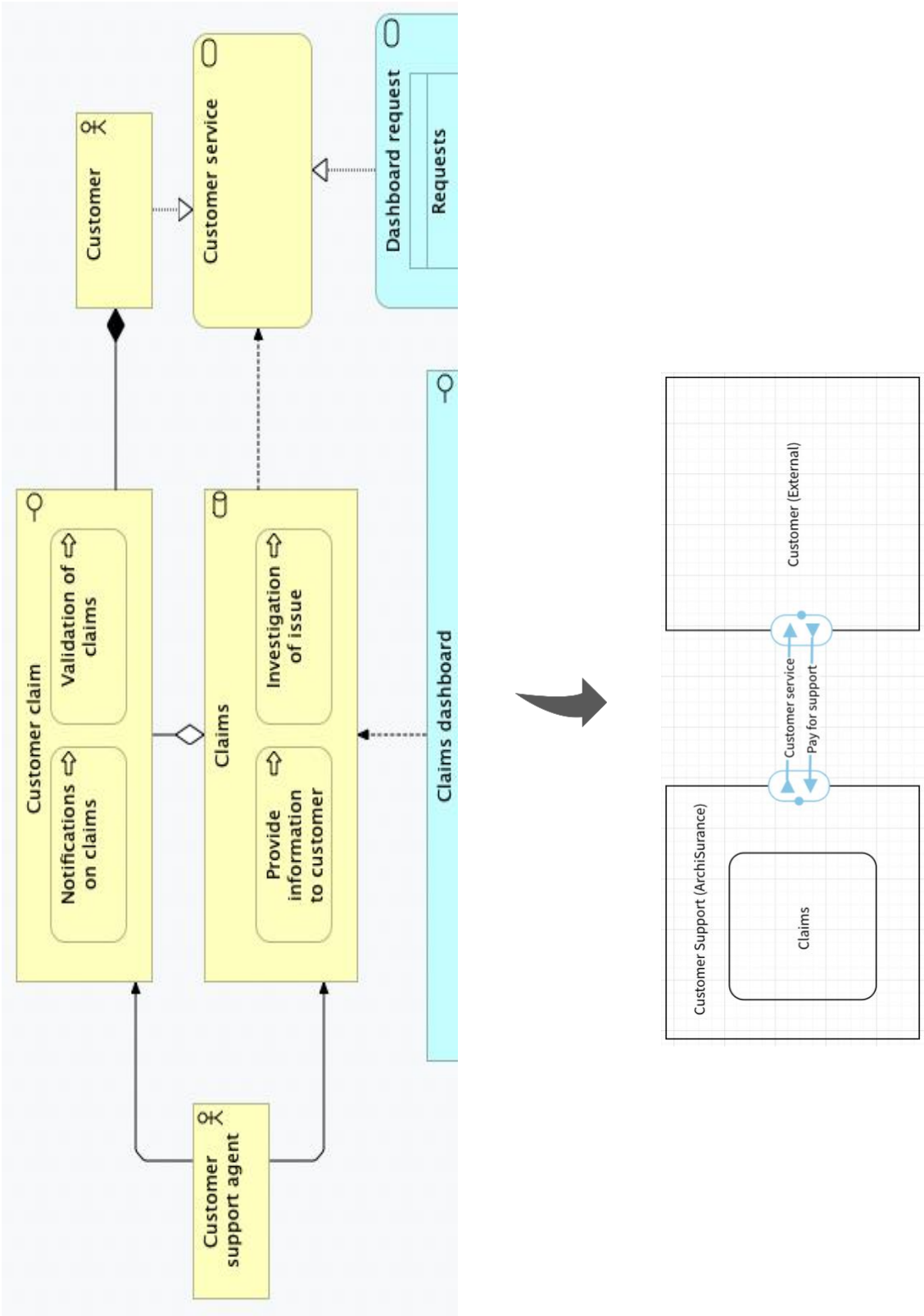

Figure 29: Mapping Elements from TOGAF to E3

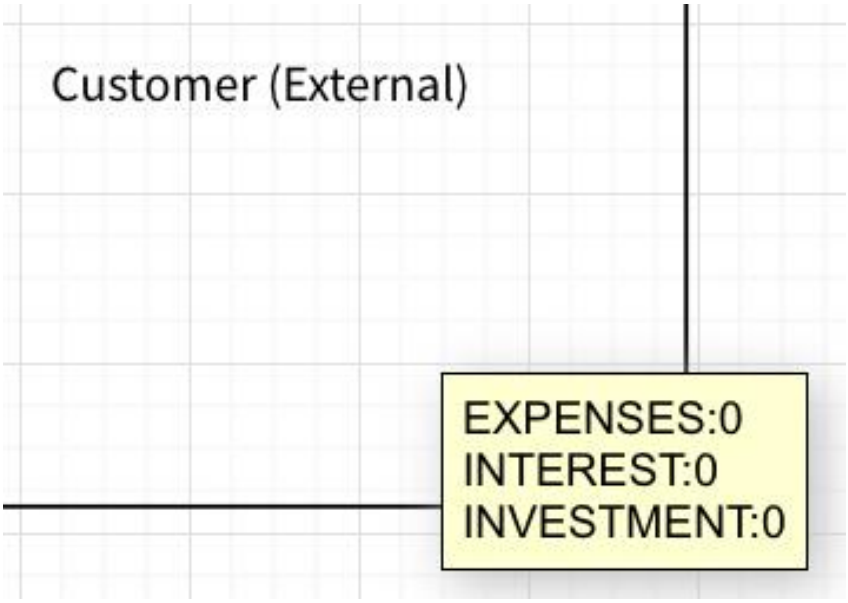

Figure 30: NPV Factors in ArchiSurance E3 Model

The graphical representation in E3 helped to investigate and analyse the quantitative data. To measure the quantitative data, E3 qualities provide the factors responsible in the model created. They indicate the calculation of NPV that delivers benefit value estimation of service provided.

However, the parameters to which the data points were required were Interest (%), Investments, Expenses as shown in Fig. 30. The responsible factors to estimate NPV are used to analyse the quantitative cost performance for the service provided. The expenses are taken as the variable and fixed costs collectively. The interest rates were considered as 0 in this use case.

Finalising the elements that were required for translation from the architecture to the business value proposition, the meta-model elements from both ArchiMate and the E3 were mapped as in Fig. 31. The elements from ArchiMate were grouped and the 1-1 mapping was not feasible with E3, as only few subsets were agreeable in mapping.

The mapping is unidirectional due to the nature of grouping from ArchiMate to E3. The relationships such as the flow, serving and triggering were indicated with value exchange boundary in E3 because the value exchange reveals the port from external to internal of customer support service in ArchiSurance.

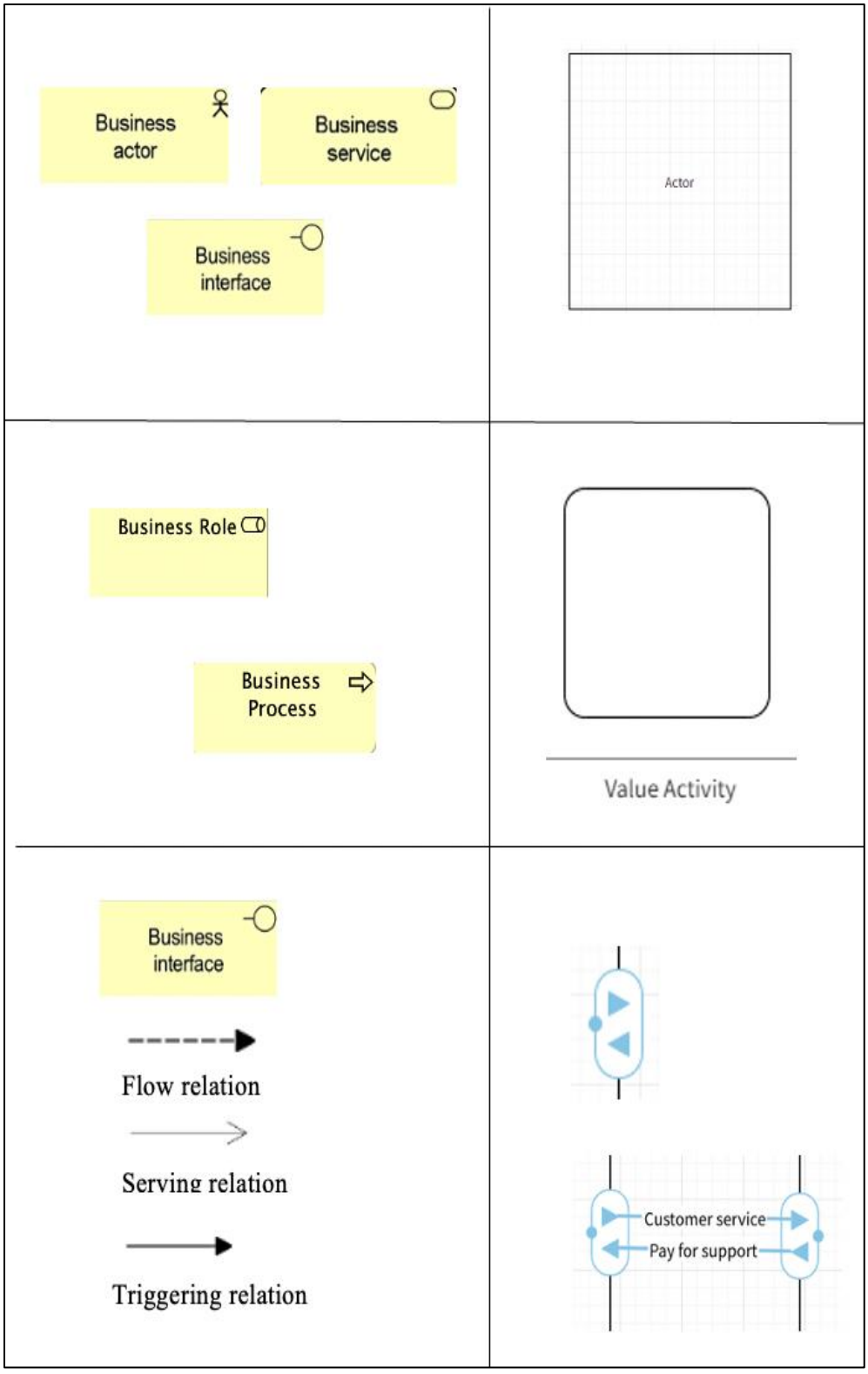

Figure 31: Meta-Model Mapping of ArchiMate to E3

4.6.3 Cost and Revenue Analytics

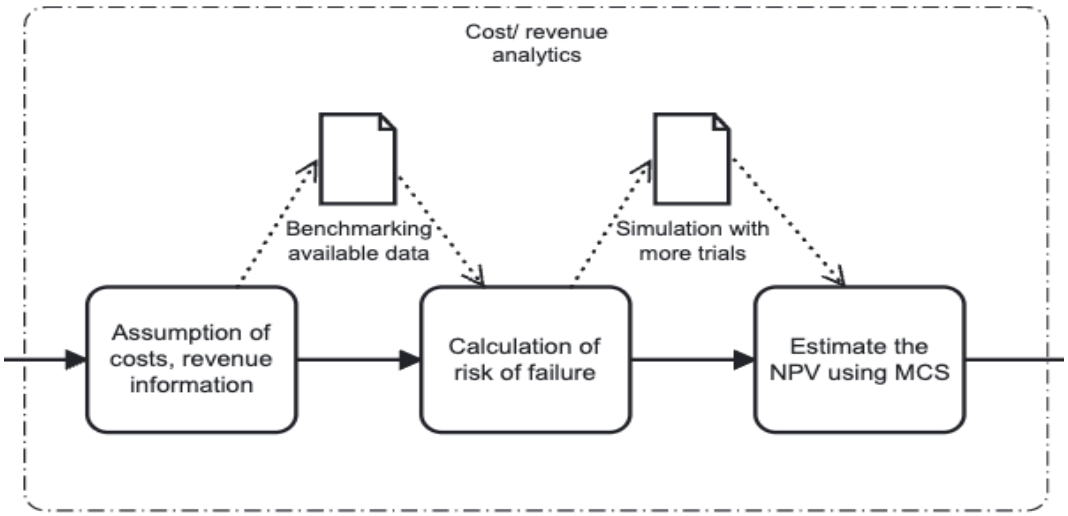

Figure 32: Activities in Step 3 - ArchiSurance Cost and Revenue Analytics

Figure 32 describes the use of available data from literature and assumptions in benchmarking the costs for simulation are executed as activities in the final step. In ArchiSurance, the illustrated example of an IT project is the delivery of customer support service. The costs for providing the customer support were randomised based on the cost of payment for support agents while the support revenue was assumed as revenue in MCS because the service was a paid support. The standard deviations are based on support market best practices. They were randomised as well to maintain the accuracy of the calculation.

The assumptions for customer support at ArchiSurance is given below in the Table 5 distinguishing the costs as expenses and revenue for the value generated by service provided. Here, the monthly costs were first tabled, and total costs were calculated. Using the total cost from this Table, the MCS and NPV will be estimated. In the NPV estimation, yearly costs are calculated as yearly cost is equal to the multiplication of monthly cost with a multiplicative factor of 12.

Table 5: Assumptions of Costs and Revenue – ArchiSurance

Assumptions for Customer Service per Month		
Type of cost	**Indicator**	**Costs ($)**
Variable cost (VC)	Number of customer queries	1250
	Cost to resolve per query	20
	Total cost charged to ArchiSurance	25000
Fixed cost (FC)	Number of licenses used by support team	60
	Cost per license	500
	Total cost	30000
Revenue	Number of customers	70
	Cost charged per customer	1000
	Total cost charged by ArchiSurance to customers	70000

Monte Carlo Simulation - ArchiSurance							
						Trial (x500)	Profits
						1	14827.88
	Revenue	Fixed Cost (FC)	Variable Cost (VC)			2	31858.44
Expected	70000	30000	25000			3	9183.17
Standard Deviation (SD)	9000	2700	6000			4	9858.679
					Profits	5	220.5933
First Simulation	70205.53	33592.61	21785.04	→	14827.88	6	18390.63
						7	-298.673
						8	5198.113
Mean	14836.1					9	19374.76
SD	10741.5					10	20615.42
Min	-17186.5			←		11	14622.75
Max	-17186.5					12	18854.8
						13	26124.91
Risk of loss	8.60%					14	19139.8

Figure 33: MCS in ArchiSurance Case

From the MCS, we find that the ArchiSurance faces a failure of its customer support service at a probability of 8.6% as shown in Fig. 33. The minimum and maximum profits for the estimated standard deviation were calculated. The trials conducted 500 times provided less randomized mean value of $14836 approximately.

The graphical representation as recommended in the solution design as final step, the normal distribution curve is calculated and drawn as shown in Fig. 34. However, the costs were simplified to its tenth value for the normal distribution calculation. The standard deviation against the negative profits were plotted in the normal distribution curve as Y axis against the X axis respectively.

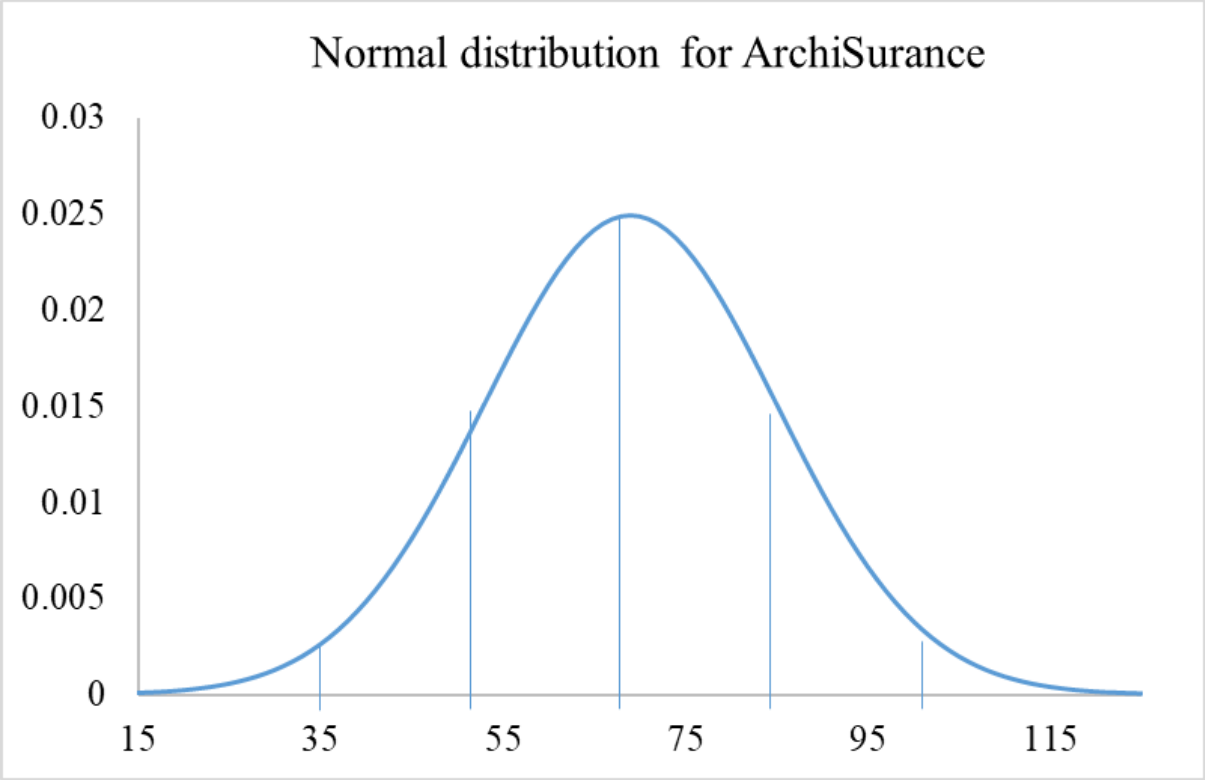

Figure 34: Normal Distribution of ArchiSurance Case

The insights from MCS calculation in the illustration example gave the following insights:

1. An average for 500 trials showed the calculated mean value is accurate loss % and the simulation can be trusted.
2. The number of profits were lesser than the loss on an overall simulation.
3. The what-if analysis estimated outcome accurately for the assumed numerical inputs.
4. The analysis method reveals the likelihood of a failure of a project.

Using the same data points from the Table 5 and Fig. 33, we can calculate the NPV as well for understanding the profitability of customer service after a time duration of 3 years. The estimation is shown in the Table 6. The customer service is assumed to be delivered at a discount rate of 5%. The cash flow after discount has been calculated on a yearly fashion for the NPV to be estimated. Finally, using the NPV formula, the benefit value of the service was calculated.

Table 6: NPV of Customer Service by 3 Years

NPV Estimation (in $)		
Monthly revenue		70000
Annual revenue = Monthly revenue x 12		840000
Discount rate (i)		5%
Investment = Variable Cost + Fixed Cost (per year)		660000
Year	**Cash Flow**	**After Discount (CFn)**
1	840000	800000
2	840000	761905
3	840000	725624
NPV = ∑(CFn / (1 + i)^n) - Investment		
Net Present Value (NPV)		**1627528**

4.7 Conclusion

In the illustrated example, we can also find that the NPV was found to be $1627528 approximately based on the assumption input values given for investments, expenses and revenue of the Customer Support service. The time for the benefit value was 3 years and the same can be leveraged for the Demonstration of the artefact.

In conclusion to this chapter, we find that the solution design proposed and tested on ArchiSurance case reveals the benefit value generated by users of the IT services. The users could be customers, individuals, or organisations. Irrespective of the size of user, the steps in the proposed method estimated value for the benefits. Through this method, the functionality of the solution could be traced using the architectural specification, E3 business value model and the MCS.

By using the proposed method from this chapter, we can demonstrate in Shell context to test the applicability of the artifact. In the next chapter, the artefact will be demonstrated in the same sequential steps as illustrated using ArchiSurance.

5. Demonstration of Artefact

In this chapter, the demonstration of designed artefact was implemented in Shell use case. The steps as shown design of artefact chapter where the testing on ArchiSurance example shed light on the benefit value, will be followed in this chapter. In this phase, the Shell use case testing has been the major contribution that would also serve for novel contribution.

The experiments executed to approach the answers to research questions are discussed in this section. During the design phase of the artefact, the relevant stakeholders were interviewed and consulted to validate the artefact and build observations, findings, and insights to answer the research questions.

As defined in scope, the IT solutions of Shell IT Service Management (ITSM) were considered under the concept of "Solution as a service" to NOVs. The experiments were executed in three different stages as discussed further.

5.1 Target Architecture

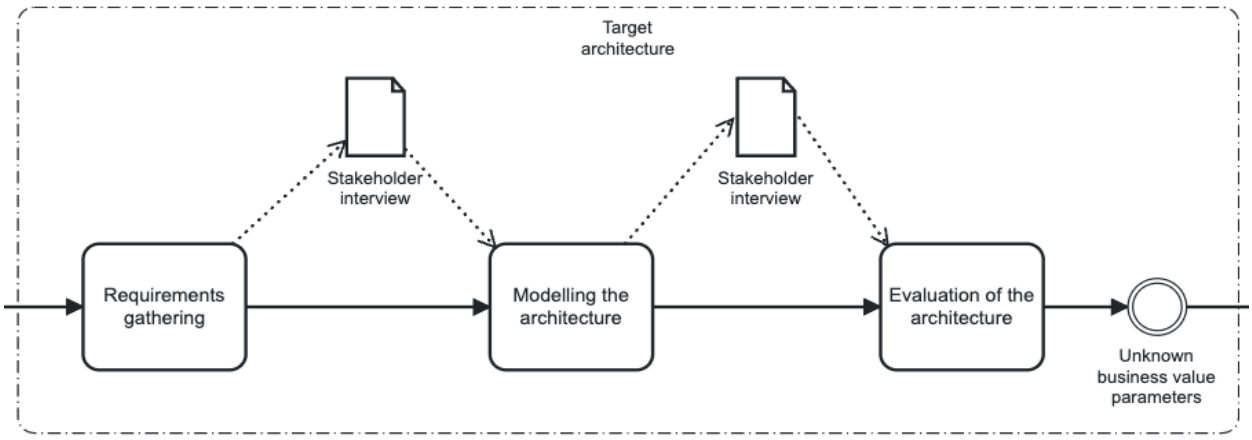

Figure 35: Activities in Step 1 - Shell Case Target Architecture

Architectural specification of Shell ITSM was initiated based on the stakeholder interview with the architecture teams, the enterprise architecture was observed to contribute significantly to the optimization of business processes as shown in Fig. 35. The key elements for the identified viewpoint were observed to sketch their respective advantages.

Firstly, Fig. 36 explains about the advantages identified for using the motivation viewpoint to specify the requirements, goals, drivers, and stakeholders functionally and non-functionally involved in the benefit value estimation method. Based on the identified advantages as in the figure of previous section, the motivation viewpoint from TOGAF standards was replicated in Shell use case.

The relevance of stakeholders was designed based on their role and work at Shell. The architecture specification, for instance, was validated based on the relevance of the thesis topic and information gathered from the literature study. The models were drafted and exposed to the architects internally. From the design context, the design testing was performed in the validation phase of design artefact.

The motivation viewpoint describes the stakeholders that the project served for achieving the purpose of designing a cost performance analysis method to estimate the IT consumption in business ecosystems. The viewpoint was created using the TOGAF standards in ArchiMate to sustain the simplification of the purpose achieved.

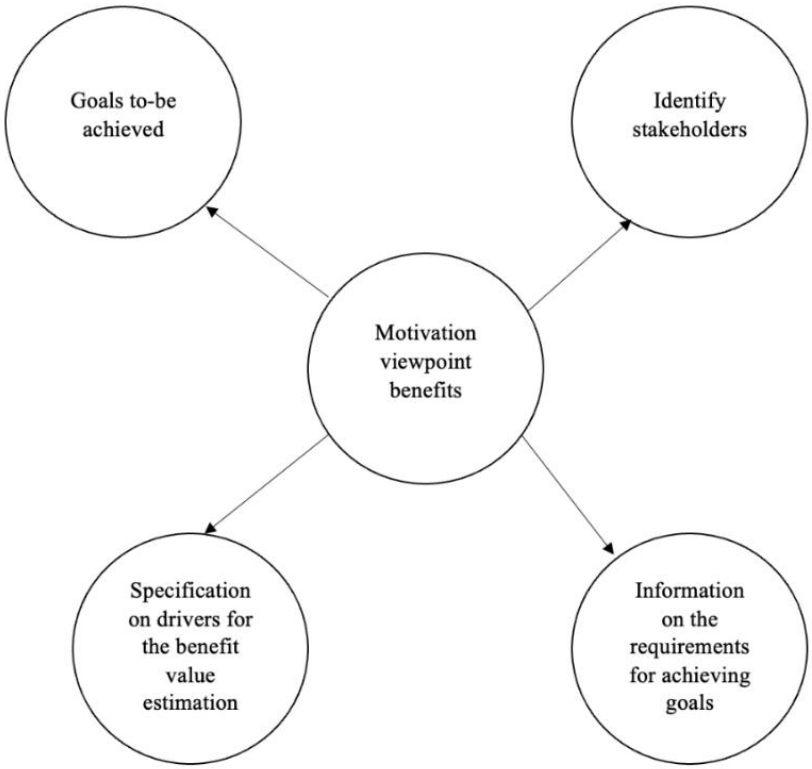

Figure 36: Advantages of Motivation Viewpoint

In Fig. 37, all the requirements contribute positively and influence equally the realization of the goals identified. The translation of the industry standard best practices from Shell, the motivation viewpoint focused on the overarching relations with the Shell IT with its drivers.

The influencing relations in the ArchiMate conveyed the positive input from requirements and goals towards the drivers identified. There was no direct relation but each of the components in the motivation viewpoint aggregated to collectively influence the drivers of the method.

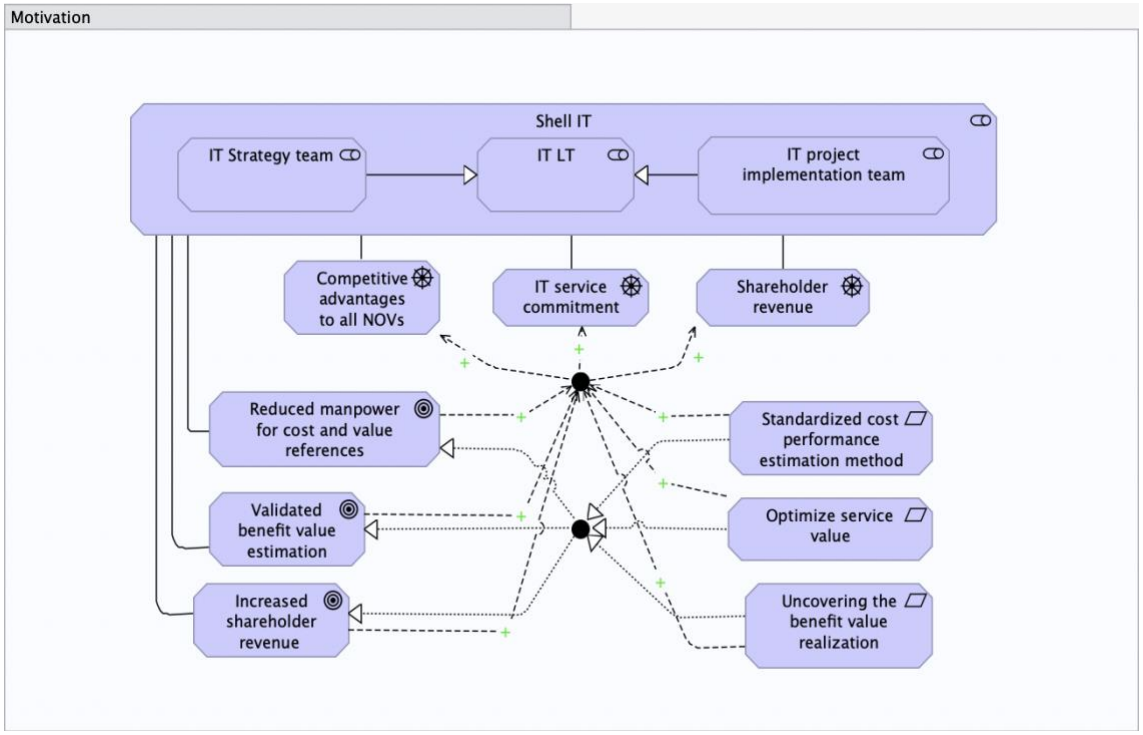

Figure 37: Motivation Viewpoint for Benefit Value Estimation

Both the goals and requirements were responsible for positively influencing the drivers such as providing “competitive advantages to all NOVs”, “IT service commitment” and “Shareholder revenue” equally. The drivers were designed based on the literature study and background on the NOVs that method to estimate benefit value contributed to dedicating required Shell IT services that improved the NOV IT performance and henceforth the cash flow from operations.

The cash flow due to performance had been estimated to be significant when the NOVs function efficiently. The cash flow directly represents the shareholder revenue from NOVs as Shell customers. The mapped stakeholders served by the drivers were members of Shell IT LT (Leadership Team) realized by the IT project implementation team and the IT strategy team under

Shell IT. The method designed was projected to be used by Shell IT in implementing any Shell IT solutions for NOVs.

In Fig. 38, the conceptual depiction of the Shell IT service subscription by the NOVs is the simplified version of how application services are deployed. We used the network topology concept on the hub & spoke to match the model of NOVs as consumers of Shell IT solutions from a central hub. Hub & spoke is a method to describe a central hub of service provider platform that is the hub and the consumers represented as the end users through a spoke. However, the operated ventures also operate similarly to the Shell IT solution deployment, and the same mechanism of publisher subscriber facilitates the applications to be utilized.

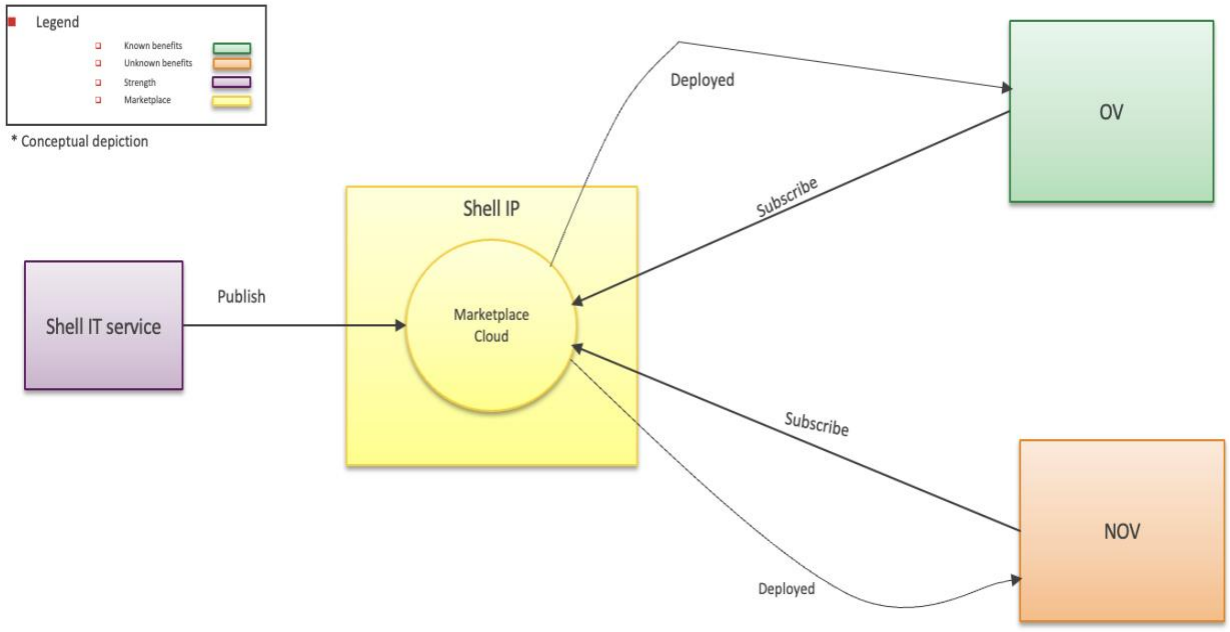

Figure 38: Conceptual Depiction of Shell IT Service Subscription

The Fig. 39 translates simplified conceptual model to the simplified TOGAF framework as per enterprise architecture representation. Following step 1 from the illustration of designed artefact, the architectures are modelled in the Shell case.

To understand the process of IT solution delivery for NOVs, the implementation and deployment viewpoint was modelled. In this viewpoint, we see that Shell IT solutions are developed by the research and development services that transfer application to cloud server that is governed by multiple parties helping Shell to protect the Shell Intellectual Property (IP).

The positive influence is modelled from marketplace transfer interface to cloud server technology as there is a consistent achievement perceived in the cloud for every IT solution that had been transferred and published.

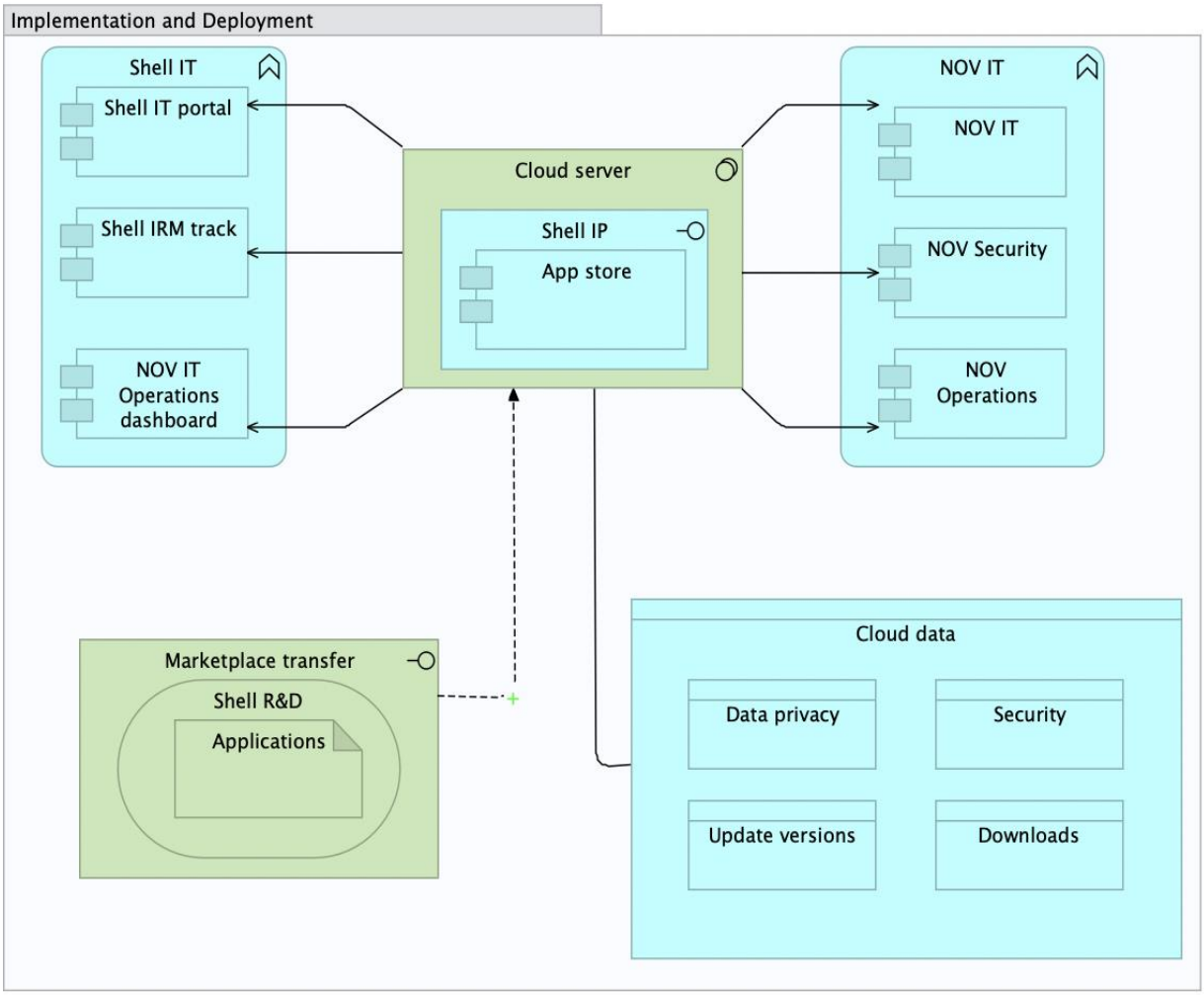

Figure 39: TOGAF with Hub & Spoke Topology

From the cloud server, the application functions such as the NOV IT and Shell IT were served from the cloud on the applications subscribed. The application functions were modelled as NOV IT and Shell IT because they are automated operations that receive the service from Appstore. The data governed around the deployment were identified to be data privacy, security, number of downloads, and updated version history as best practices from my research.

The representation of IT solutions delivered to NOVs mandated meaningful interpretation of how IT services were realized internally in Shell and for NOVs. The service realization viewpoint provided how the IT solutions were delivered within Shell IT functions and helped to map the entire flow of IT solution steps taken from technology to applications to business layers.

In this viewpoint, we also mapped where the solution of this thesis could help Shell. The validation of cost-benefit analysis was indicated as the thesis solution proposed to the created model. The application service modelled validates the existing service provided by the project management team by including a service that serves as project management application services. The proposed service uses of E3 value proposition model that aggregates both architectural elements and a probabilistic analysis to estimate the profit or loss percentage of IT solution deployments.

In Fig. 40, the actors such as the Product Manager, Shell IDT Manager, and the IT Manager at NOV were modelled to indicate the responsibilities in business layers. The service for preparing an investment was found to be triggered by the Shell IDT Manager as per the request raised by IT Manager at NOV respectively. The Product Managers own the Shell Project Management business services as they translate customer requirements to understandable IT terms internally.

However, the investment to implement an IT solution is driven by the entire process of three stages. The three stages were identification of the cost of IT services, Estimating the benefits of consuming an IT solution, and finally calculating an NPV quantitative monetary figure for the IT solution. The benefits of IT solutions and their values were benchmarked with the internal information from their operated ventures that could not share values.

The parameters considered in NPV estimation were found to be currently unvalidated. In the application layer, the project management application service contained application components such as the solution itself along with the tool estimating the cost-benefit analysis.

After the approval, the service is then pushed to the private area network of the NOV directly using the cloud server as shown earlier in Fig. 39 on the implementation and deployment viewpoint. The governance of the entire process was tracked through the NPV estimation & project delivery interface.

The core business processes modelled in the viewpoint were fundamentally required to be translated to the business value model in the E3. The core business processes from service realization viewpoint were selected because they discuss in depth on the relevance of value exchange interface between Shell IT and its customer i.e., NOV in this case. We will investigate the E3 model and how the elements from ArchiMate were mapped to the E3 business value proposition context in the upcoming steps.

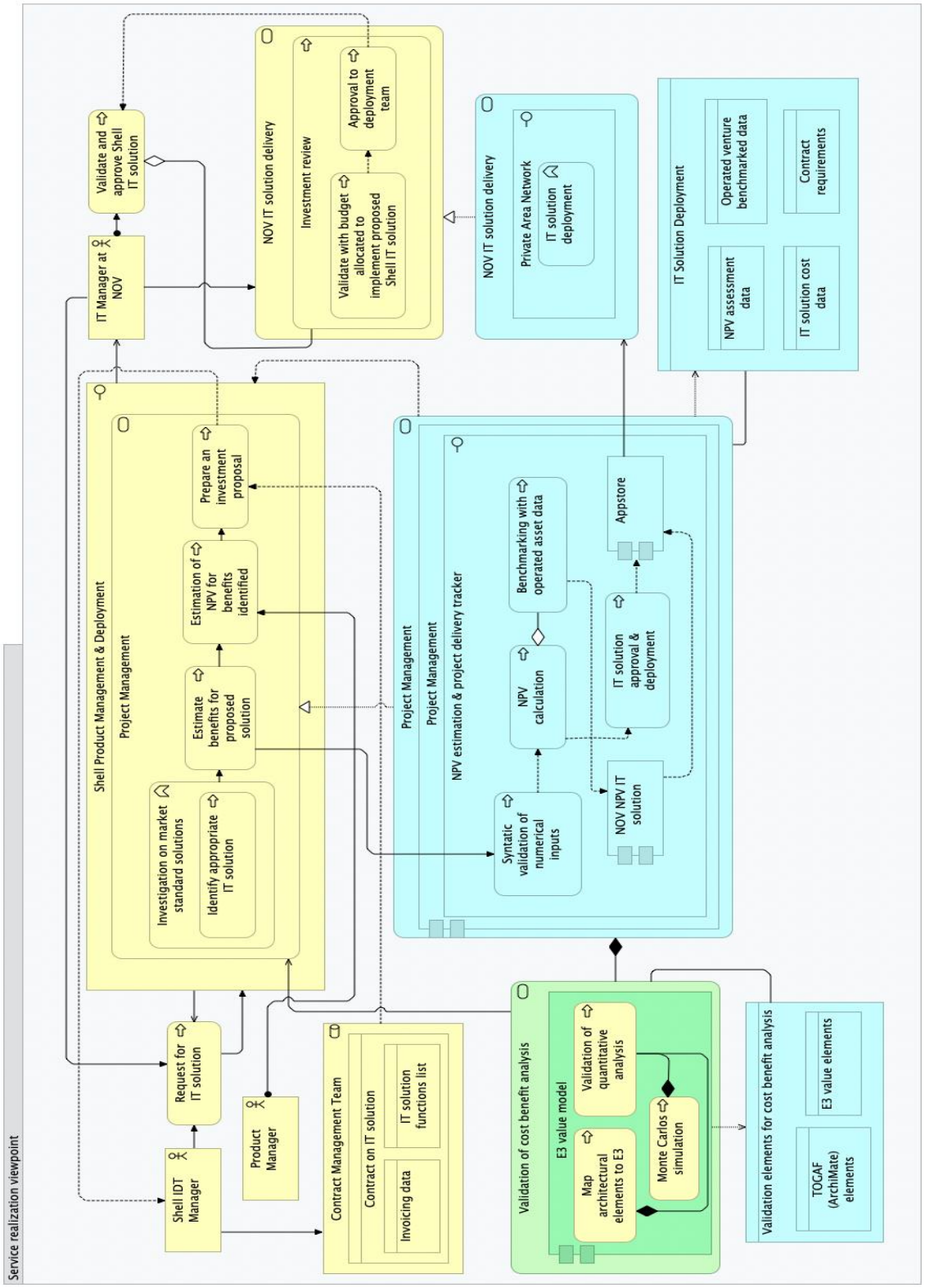

Figure 40: Service Realization of IT Consumptions

5.2 Target Business Model

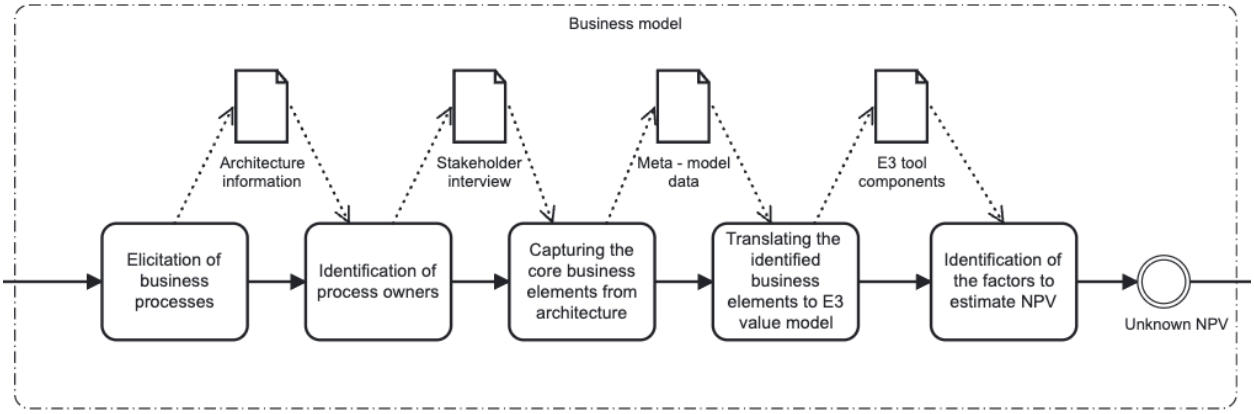

Figure 41: Activities in Step 2 - Shell Case Target Business Model

As illustrated in step 2 of ArchiSurance, the unidirectional mapping from ArchiSurance architecture modelling to the E3 business model is implemented in the Shell use case. In this step, as shown in Fig. 41, the activities to obtain the factors responsible for an NPV calculation and business value proposition are written.

Figure 42 represents the core fundamental business elements from underlying business process that transforms an IT solution from Shell to its NOV ecosystem. In the same figure, the E3 model was defined based on the relevance of elements available in the tool to that of the identified business processes.

The direct translation in an element-to-element fashion was not feasible as some of the elements from ArchiMate were grouped together to signify its E3 value model elements. In similar fashion, we can find that the actors in ArchiMate were grouped as Market segments in E3. The value exchanges for Shell IT to its business ecosystems are two folded starting from Shell IT to the cloud governed by Shell and its partners while the next exchange was between the market cloud to NOVs.

The elements such as customer needs and Shell IT features were obtained from NOV IT managers, Product Managers all serving for the same purpose and hence modelled as an actor “IT Manager”. The value exchange from Shell to the cloud was found to be governed through Shell IP.

The publisher-subscriber process of IT solutions in IT service delivery were applied in the Shell, C3AI cloud Appstore market segment. In this market segment, while selection is made the factors for estimating the NPV were displayed as given in the Fig. 43.

The factors influencing NPV were the following:

1. Size of IT solution,
2. Interest % to be induced,
3. Investments,
4. Expenses.

These components are then mapped to assess the value of IT solutions using the NPV estimation. In the NPV estimation, the parameters as illustrated in ArchiSurance example, the revenue, fixed and variable costs will be calculated in MCS. Here, the size of solution is 1, as we are estimating for only one of such solution. The interest percentages are also not considered as Shell provides at a not for profit but for efficiency building interests for their NOVs. We will look into the assessment of cost and revenues in the final step.

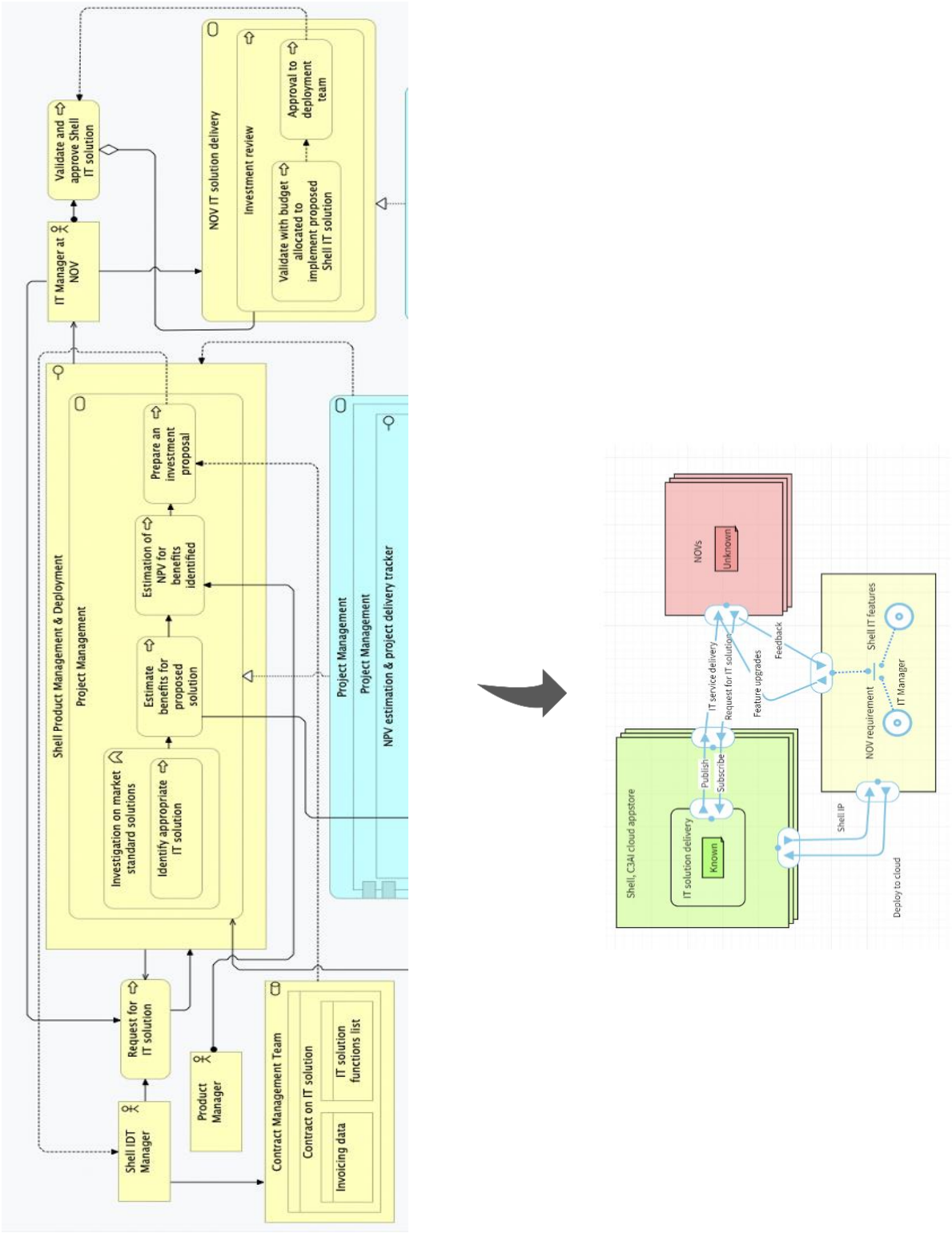

Figure 42: Mapping Elements from TOGAF to E3

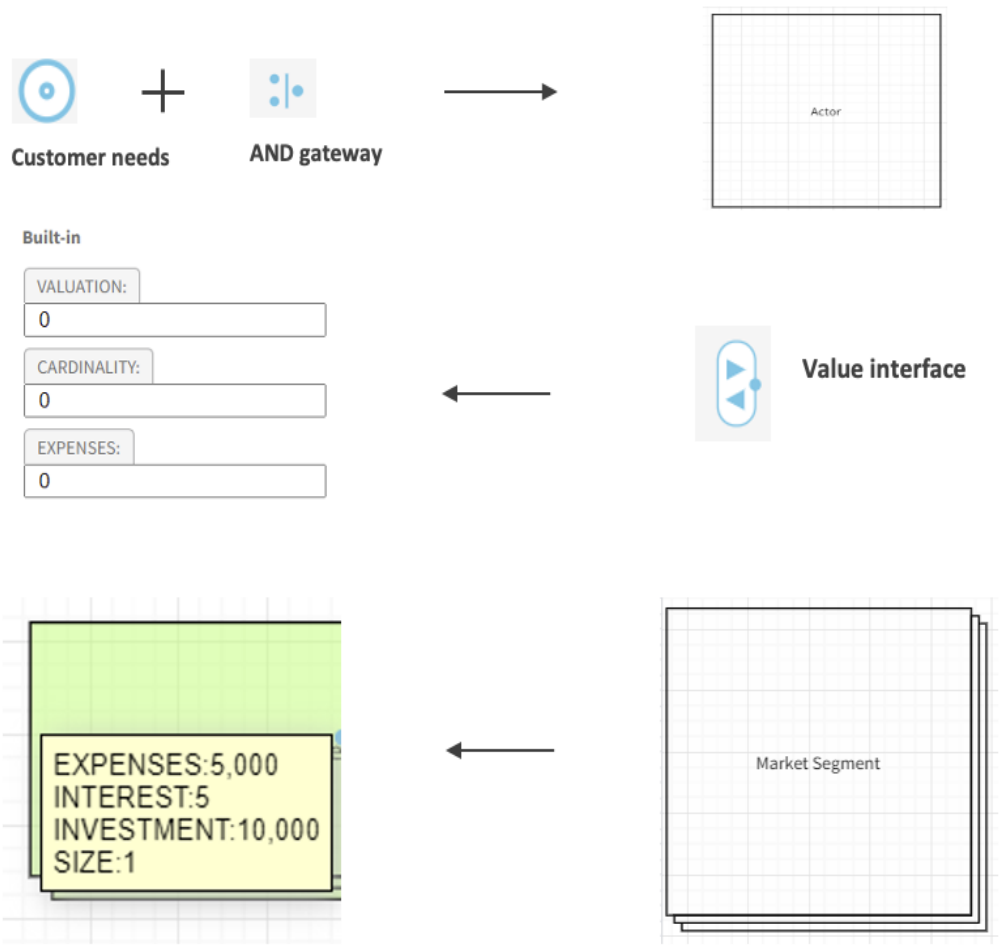

Figure 43: Contributing Factors in E3 Model

The model still lacked an explanation of the factors responsible for the E3 business value model. This was addressed by exploring the parameters window where the components were shown as given in Fig. 43. The components were then listed to be validated with the IDTMs on a real-time IT solution provided to NOVs.

Internally, the expenses were perceived as any cost relating to the cost of deployment of IT solutions whereas the investment costs were the costs to research and develop IT solutions. Figure 44 displays the meta-model mapping from ArchiMate to E3 in Shell use case. The Shell use case was also found to be unidirectional mapping due to grouping of architectural elements to only relevant E3 components.

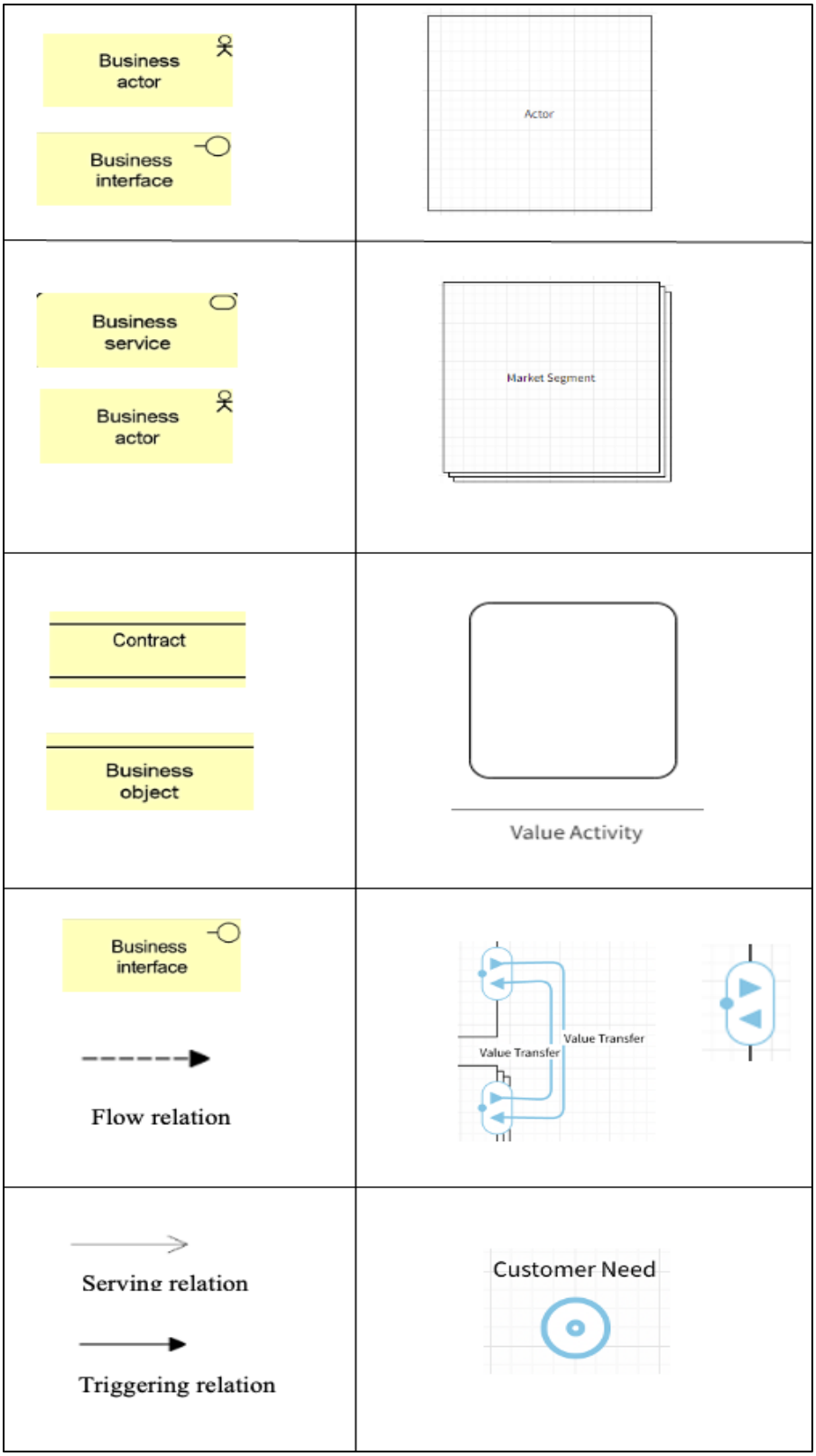

Figure 44: Meta-Model Mapping of E3 and ArchiMate

5.3 Cost and Revenue Analytics

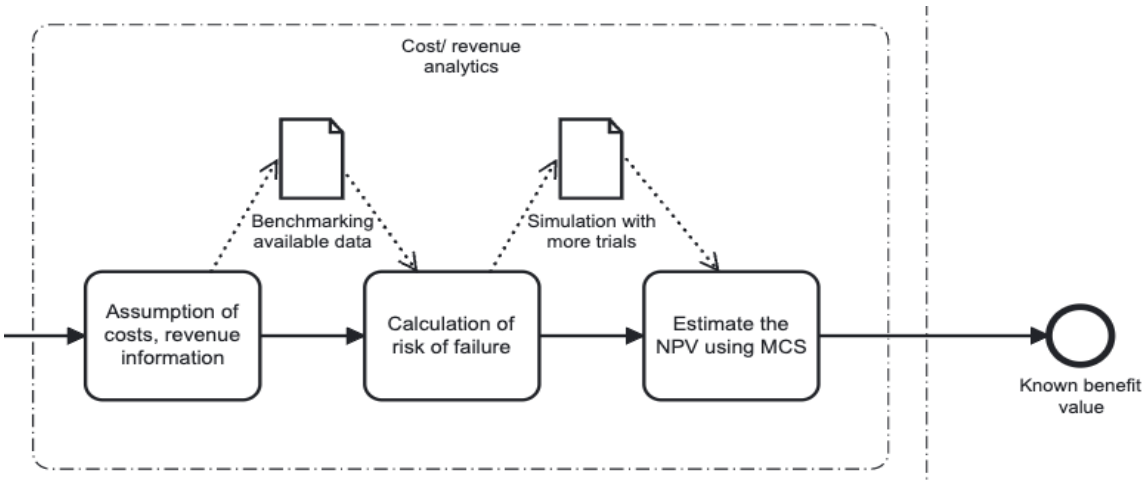

Figure 45: Activities in Step 3 - Shell Cost and Revenue Analytics

In the final step, as shown in Fig. 45, the activities of referring to the benchmarking data and simulation has been carried out to finally obtain the NPV as the benefit value for IT solution provided. The MCS was executed with the MS Teams deployment at Small and Medium scale Enterprise (SME) customer organisation. The SME was assumed based on its size and IT solution requirement like that of an NOV. Hence, the NOV IT solution i.e., the MS Teams deployment has been estimated for its NPV value through MCS. The dollar value figures are randomised appropriately to a real time application at an LNG asset as shown in Fig. 46. In this use case, the what-if analysis has been performed as introduced in the solution design.

The costs were randomized based on expert opinions from research of Microsoft and tacit knowledge at Shell. The simulation was inspired by what-if analysis referred from open forums.

During the demonstration of MCS in the proposed method, the profits were found to be negative, indicating a loss that could incur if such a deployment is taken place. The numbers in the figure were assumed and estimated in dollars ($) to simplify the calculations. The assumptions for MS teams IT solution from Shell IDT to NOV is given in the Table 7. The dollars indicated in this table serve as input for MCS and finally the NPV calculation. The step is same as the illustration in ArchiSurance case.

Table 7: Assumptions of Cost and Revenue - Shell IT Solution

Assumptions for MS Teams as Shell IT Service per Month		
Type of cost	**Indicator**	**Costs ($)**
Variable cost (VC)	Number of deployment requests	500
	Cost to develop, run and maintain in server	2000
	Total cost incurred	1000000
Fixed cost (FC)	Number of MS Teams licenses	3000
	Cost per MS Teams license	300
	Total cost incurred	900000
Revenue	Number of NOVs	80
	Cost charged per NOV	25000
	Total revenue generated	2000000

Monte Carlo - MS Teams							
						Trial (x500)	**Profits**
						1	50178.47406
	Revenue	Fixed Cost (FC	Variable Cost (VC)			2	15792.47844
Expected	2000000	900000	1000000			3	238782.8562
Standard Deviation (SD	100000	10000	30000			4	78346.0546
					Profits	5	228070.0715
First Simulation	1942940.1	892216.1651	1000545.421	→	50178.47	6	28382.41237
						7	20277.04064
						8	208057.1639
Mean	99525.907					9	132331.4558
SD	102735.26					10	66132.6214
Min	-183341.6					11	138940.4411
Max	527808.07					12	28888.97058
						13	172638.3153
Risk of loss	17.40%					14	4762.03597

Figure 46: Monte Carlo Simulation for MS Teams

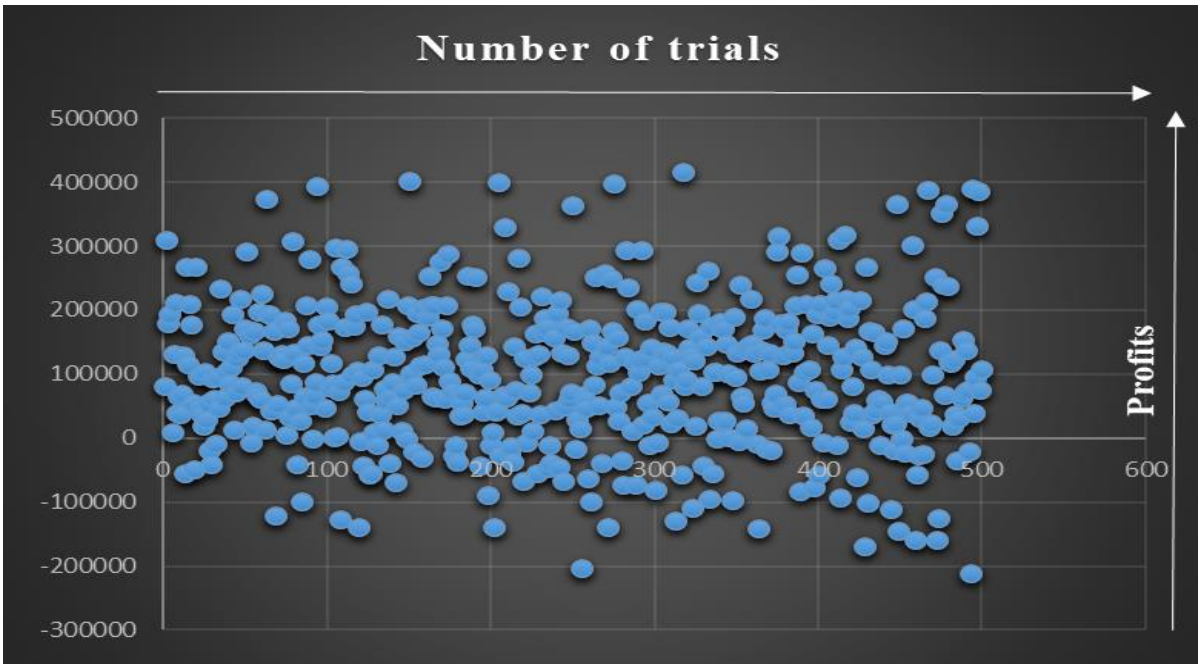

Figure 47: Scatter Plot of MCS

As shown above, in Fig. 47, the scatter plot was drawn to show trials vs. profits. The selection of scatter plot was based on the use case and the values from the trials were not sequential or linear. The uncertain profits were found to be easily interpreted using a scatter plot. The plot also depicts the range of minimum and maximum values for the respective trials.

As the last step of demonstration of the artefact, the simulation concluded without a normal distribution curve due to the large standard deviations assumed for revenue, fixed and variable costs. To test the eligibility of MCS, the interview questions for used as documented in the appendix as guiding principles. However, with the approximate assumptions as given in Table 7, the final step output to calculate the NPV was performed. The calculations are shown in the Table 8 below. The case study at Shell was assumed at the discount rate of 10% with the calculation towards end of 3 years revenue. Here, for the assumed dollar values, we find that the NPV after three years of utilising the MS teams was $ 36,884,448, approximately 36.9 million dollars.

Table 8: NPV of MS Teams Deployment

NPV Estimation (in $)		
Monthly revenue		2000000
Annual revenue = Monthly revenue x 12		24000000
Discount rate (i)		10%
Investment = Variable Cost + Fixed Cost (per year)		22800000
Year	**Cash Flow**	**Discount factor (CFn)**
1	24000000	21818182
2	24000000	19834711
3	24000000	18031555
NPV = ∑(CFn / (1 + i)^n) - Investment		
Net Present Value (NPV)		**36884448**

5.4 Conclusion

The benefits value for the MS teams at NOVs as a Shell IT service was determined and demonstrated using the steps defined in the proposed method. The method was found to estimate the value of the service at the end of three years to clearly specify prospect of using the service. The steps of the method were analysed based on the assumptions considered at each step.

The novel contribution is to reveal how IT services are implemented in NOVs, adding literature to identified research gap by mapping the architectural single directional translation to business value proposition such as the E3. The usefulness of the designed artefact will then be evaluated by interviewing stakeholders from relevant departments as explained in next chapter.

The stakeholders in Shell were then interviewed to validate the proposed method and key opinions were observed. The final output from the proposed method is the final NPV to estimate the benefit value of an IT solution. The observations are tabled and discussed in the next chapter.

6. Evaluation of Proposed Method

In this chapter, the benefits identified from the stakeholder interviews were classified and evaluated based on their performance expectancy, effort expectancy, and social influence. The facilitating conditions were descoped as irrelevant for LNG IT team to utilise the proposed method.

6.1 Validation Phase

The context for testing the artefact is to connect the multiple stakeholders under the standardized framework in the process of alignment. The scope was to test six different LNG assets on their performance from an IT perspective.

The preliminary testing opened doors for architecture specification of NOV IT consumptions and the processes involved to trace the IT capabilities of NOVs consumed in the business ecosystem. The dashboard only revealed how the information is tracked.

However, the dashboard that was proposed conveyed neither the cost value of the IT services and capabilities consumed nor the benefit estimates as the NOVs benefit value generation is non-mandatory information to be shared with Shell. Hence, from the entire research in thesis, the findings indicated to design of a method to estimate the cost performance.

The following observations were noted during the interview:

1. The architecture conveyed the business processes meaningfully.
2. We can use the business functions and roles from Shell IT to model architecture specifications for every IT solution deployment to simplify the processes involved.
3. Using the parameters obtained from the MCS, we could potentially open new dialog and insights on understanding the probability of failure on a particular IT solution investment.
4. Internally, Shell uses market research driven configurations that assists their NPV estimation and simulates differently the parameter on overall success and failure percentages that is restricted to business stakeholders.
5. The internal success and failure estimation simulation mirrors to MCS, however, the tool predicts the probability based on efficiency gains unlike revenue generated for produced service. There are scenarios where MCS is a perfect match, but they depend on only those IT solutions where Shell and NOVs function as producer-consumer relation for new services offered.
6. The question of designating the stakeholder to take charge must be debated for further simplification of internal business processes.

The indicators of the method were found to be constantly refreshed based on the market insights from energy industry consortiums. From the observation of the parameters and inputs from the product managers who govern the tool, some of the indicators were defined in simple terms. The actual vs planned project cost was mapped to the investment costs to develop and deploy IT solution. The project costs are mapped to expenses incurred in developing, run, and maintaining the IT solution whereas the deployment costs were investment cost directly.

The project's planned and actual benefits were indicated in monetary value to show the benefit value for the functionality of applications. The benefits were qualitatively estimated to identify how the business customers would use the product. The benefits were then given a monetary value in dollars. These values were considered then for the total NPV estimation of the project.

6.2 Analysis on the Evaluation of Proposed Method

The gender and age were eliminated based on the irrelevance to the topic contributing no value towards decision making. The experience and voluntariness of use were found to be of relevance because they directly impacted the decisions taken for utilisation of the designed artefact (Venkatesh et. al, 2003) as in Fig. 48.

The UTAUT model was identified as the desired method of evaluation because of the identified parameters such as performance expectancy, effort expectancy and social influence.

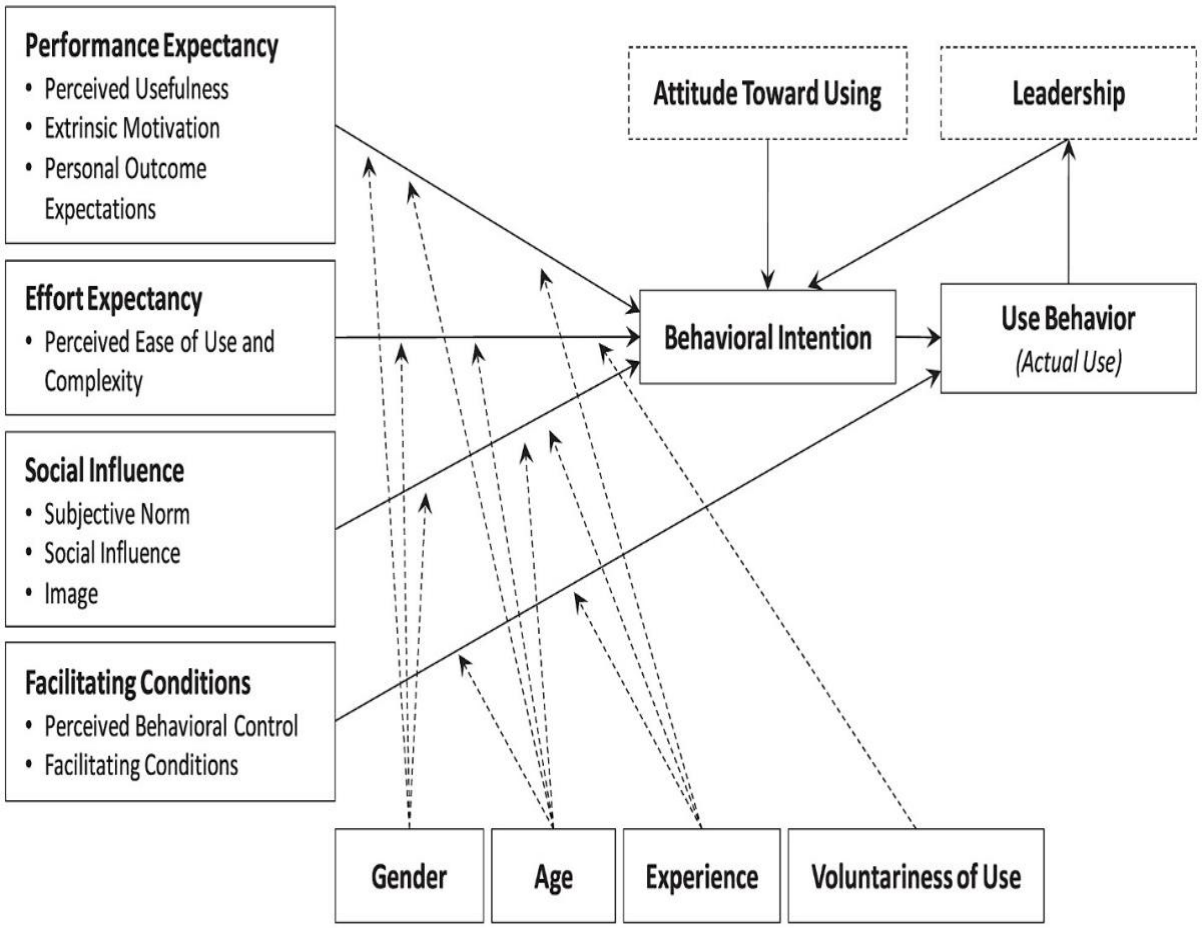

Figure 48: UTAUT model (Venkatesh et. al, 2003)

The responses to key questions from the questionnaire were documented and scored accordingly to the Likert scale (Joshi et. al, 2015) as given in the Appendix 2.3. The score ratings were then consumed for calculating the user acceptance of the proposed method in the parameters of Performance expectancy, effort expectancy and social influence. The complete scoring is shown in the Table Fig. 49.

The questions as given in the appendix were answered and classified as positive and negative opinions. Once, they were categorized, we scored the responses for average. It was found that on an overall perspective, the proposed method was accepted. The business roles of interviewed stakeholders were Architects, Economists, IDTMs, IDT Advisors, and PMs at Shell. Their experience in the respective roles at Shell were based on the knowledge base and expertise on the work domain and leaders working in the corresponding steps of methodology.

6.3 Conclusion

In conclusion to this chapter, the proposed method was found to be acceptable based on the user acceptance testing of IT. The average score indicated that the proposed method was found to be solving the estimation of benefit value on Shell IT services. The viewpoints were found to be acceptable to architecturally visualise the services deployed to NOVs. The visualisation also helps in architectural analysis among the architects to create roadmaps seamlessly as shown in Q I. C. of appendix 2.3.

Similarly, the business value proposition mapped from the architecture was found to positively influence IDT team to understand the benefits behind the functionality of applications dedicated and their respective value exchange points as given in Q II. B. of appendix 2.3.

Finally, the MCS was not completely agreeable for predicting the probability of success or failure as there were few negative opinions on the method as documented in Q III. C. of appendix 2.3. The NPV method as obtained from the literature study was already implemented as best practice at Shell and henceforth widely accepted as given in Q IV. B of appendix 2.3.

Though there were few recommendations on automations, it was overall a positive user acceptance towards the proposed method as recommendation as documented in Q V. A. in appendix 2.3. However, the areas of improvement in the steps of proposed method were documented as limitations. The areas of improvement also are components for future scope of research as discussed in the next chapter.

No.	Parameter	Explanation	Discovered benefits	Statement	Score based on Stakeholder responses											
					A	B	C	D	E	F	G	H	I	J	K	Mean
1	Performance Expectancy (PE)	The extent to which stakeholder believes that using the system would assist them perform better at work	Transparency in costs and value generated	Does the business model translate the context of benefit value estimation for IT consumption?	4	2	4	3	2	5	5	4	2	4	3	3.4
			Uncover hidden costs	Would you recommend this method of simulation with 500 trials for probabilities a valid benefit value estimation technique?	4	4	4	3	4	1	1	2	3	1	3	
			Towards better data driven decisions	To what extent would you consider the use of NPV estimation to determine the benefit value of IT consumptions?	5	5	4	5	4	4	3	4	3	2	4	
2	Effort Expectancy (EE)	The degree of ease to which the system can be used	Simplification of core business processes on benefit value estimation	Do you find architectural specification as a best practice for benefit value estimation of IT solutions?	3	3	5	3	4	4	3	2	5	2	4	3.5
3	Social Influence (SI)	The degree to which a stakeholder believes that significant stakeholders say they should utilize the new method.	Reduced manpower for cost reference	Would you recommend estimating benefit value using the combination of these steps?	4	5	4	4	5	3	2	1	4	2	1	3.2
Net mean score for the proposed method																**3.3**

Figure 49: Assessing Responses in UTAUT Framework

7. Conclusion and Discussions

In this final chapter, the recommendations were described and discussed to answer the research questions categorically. Following that, future scope has been prescribed based on limitations of this project and potentially research areas for future.

7.1 Recommendations to Shell IDT

The thesis assignment execution provided insightful recommendations for Shell IT. Shell IT could consider the following key recommendations, also shown in Fig. 17, identified to structurally estimate the benefit value of Shell IT services consumed by their customers i.e., the NOVs:

1. An architectural specification to identify the NOVs and their consumption overview of Shell IT services to reduce workforce and time for understanding the IT solution deployment and business processes involved.

2. Use of value propositions, such as the E3 used in this thesis, for each IT solution per asset to track their benefits and factors responsible for estimation of the benefit value and successfully trace the profitability of an IT solution with a +/-ve NPV.

3. Execute Monte Carlo simulation to determine the probability failure of a project before an IT solution is planned for an NOV. These IT solutions should be focused on a new service production for business ecosystems while improving the efficiency. In efficiency gain-based IT solutions, we find that the NPV estimation reveals the value for the defined duration of time. MCS is not applicable where parameters are found to be uncertain especially in the NOV use case. However, the use of standard deviation provides space to expand the accuracy of costs better.

With the proposed method in practice, Shell's high-level design while providing IT services to its NOV business customers would be in 4 stages where unknown benefit value could be uncovered as shown in Fig. 50.

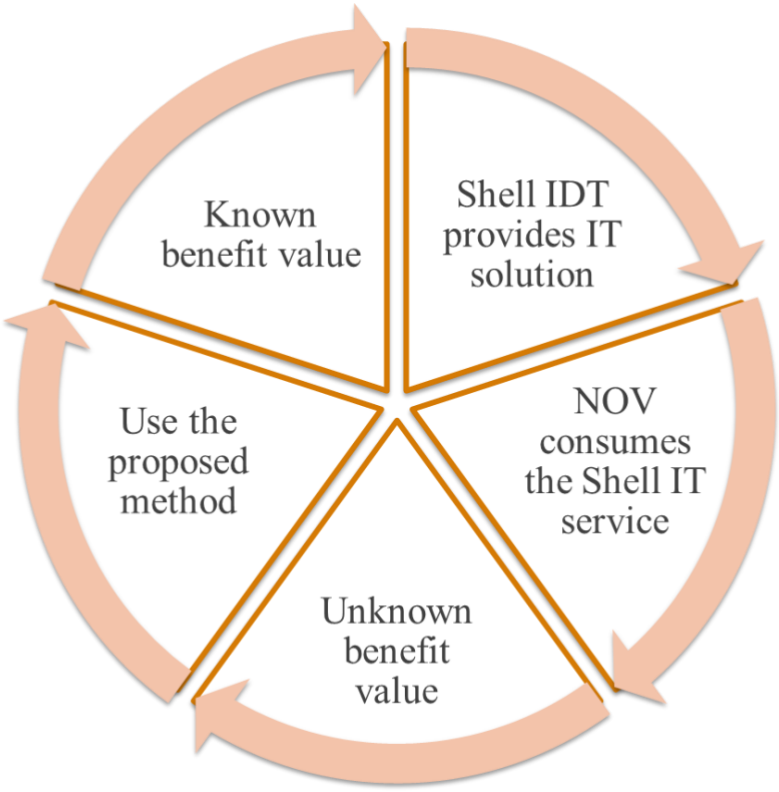

Figure 50: Final High-Level Design

The following points of discussion would answer the research questions formulated in this thesis as written below:

1. **RQ1:** What are the available methods for estimating the value of IT services in business ecosystems with central control?

   Answer to RQ1: The available methods for estimating value were:
   a. Creation of architecture using TOGAF standards.
   b. Value proposition techniques using E3.
   c. Probability of failure by implementing a Monte Carlo Simulation.

2. **RQ2:** How do we specify an architecture of the IT service consumption?

   Answer: The viewpoints to be used for architecture specification are:
   a. Implementation and deployment,
   b. Service realization

3. **RQ3:** How does the functionality of IT solutions provided generate the high-level benefits?

   Answer: Benefit identification of IT solutions and mapping monetary values to the benefits as expenses and investment provides insights on the costs and benefit values using E3 value proposition model.

   Mapping of how IT solutions are deployed from architecture to business value proposition helps to identify the high-level benefits for the functionality of IT solution. The **meta model** mapping is key element to match different frameworks accurately. The functionality benefits of IT solutions were already estimated in the current method in terms of its monetary values.

4. **RQ4:** How can we trace the performance gains of NOVs to IT consumption capabilities?

   Answer: The performance gains of NOVs to consumption capabilities could be answered using the Monte Carlos simulation through the calculation on probabilities of failure on the IT solution. The performance gains are tabulated based on the NPV calculation for the estimation usage duration.

Thereby, the answers to research questions show a method contributes to achieving the research goal combined by three steps involved to design a quantitative cost performance analysis of IT consumptions in business ecosystems.

7.2 Contributions

7.2.1 Contribution to Theory

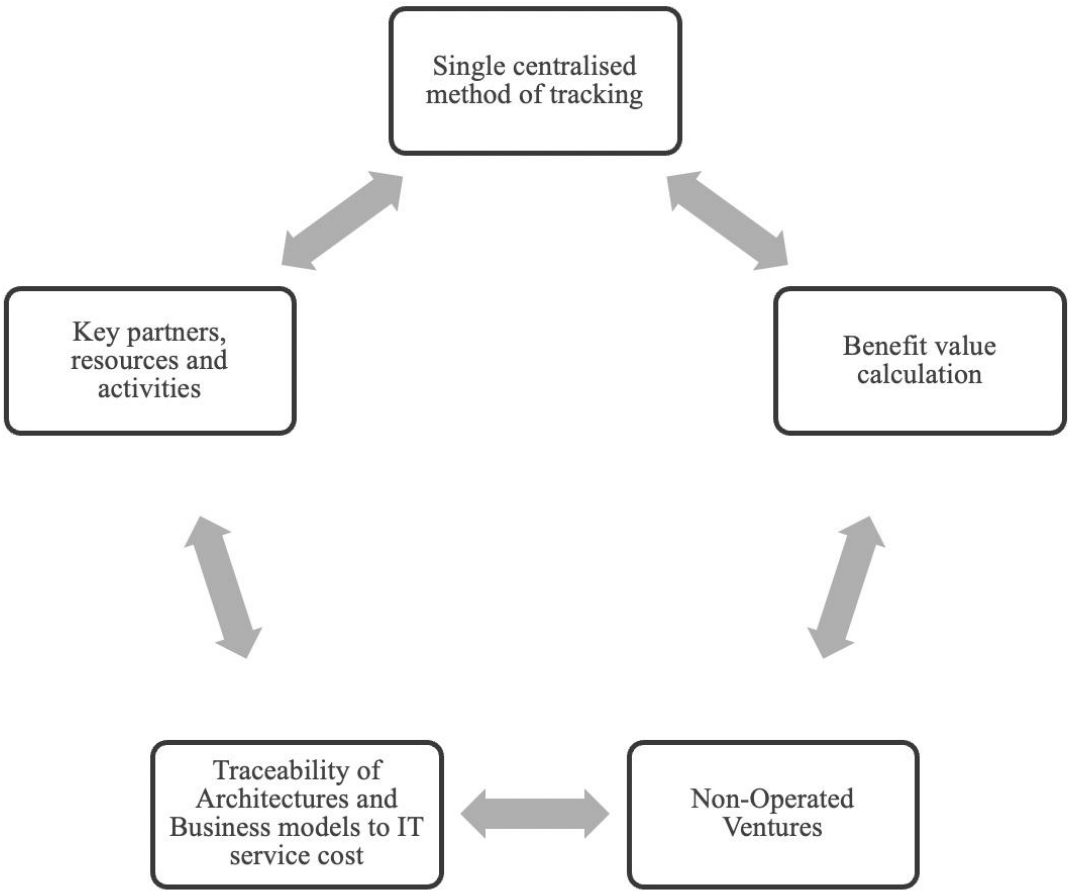

Figure 51: Novel contribution to Theory

In theoretical context, the methodology proposed solves the purpose of estimating the unknown benefit value in NOV business domain. The contributions towards theory are the following:

1. Enriched literature on the NOVs
2. Single source of truth to uncover the value of IT services provided
3. Cost analysis is performed with the information on cost incurring business functions, roles from architectural specification
4. Identification of involved key partners in the business ecosystem, their resources and activities involving the IT service delivery.

7.2.2 Contribution to Practice

In practical application of Shell IDT, the proposed method is found to be useful as a solution design step in their investment proposal documentation. However, there are few limitations while using MCS for a determining the probability of failure of Shell IT projects. The MCS is currently not automated to calculate the required NPV.

The tested and proposed methodology has been proven and accepted by the IDT LNG team at Shell as best practices to uncover the benefit value of Shell IT services. However, the method does not directly reveal true value generation that NOVs generate at their end.

The limitation is to understand the unknown data points that requires deeper exploratory validation for dollar assumptions. There was a missing explanation on the correlation between consequences for the same assumptions and data points. The NPV estimation through MCS could further be broadened for a normal distribution curve. The limitations and future scope are further discussed in the final section.

7.3 Discussion

We find that the elements from all the three steps of the designed artefact contributes for a valid benefit value estimation step as shown in Fig. 52. These valid steps are responsible for the final NPV calculation.

The elements from architecture, business models and the cost analysis show the clear roadmap of how the IT services are provided from one organisation to another. Each element of the introduced steps has equal weightage towards the final NPV calculation and therefore it is mandatory to utilise the components without the compromise at each stage.

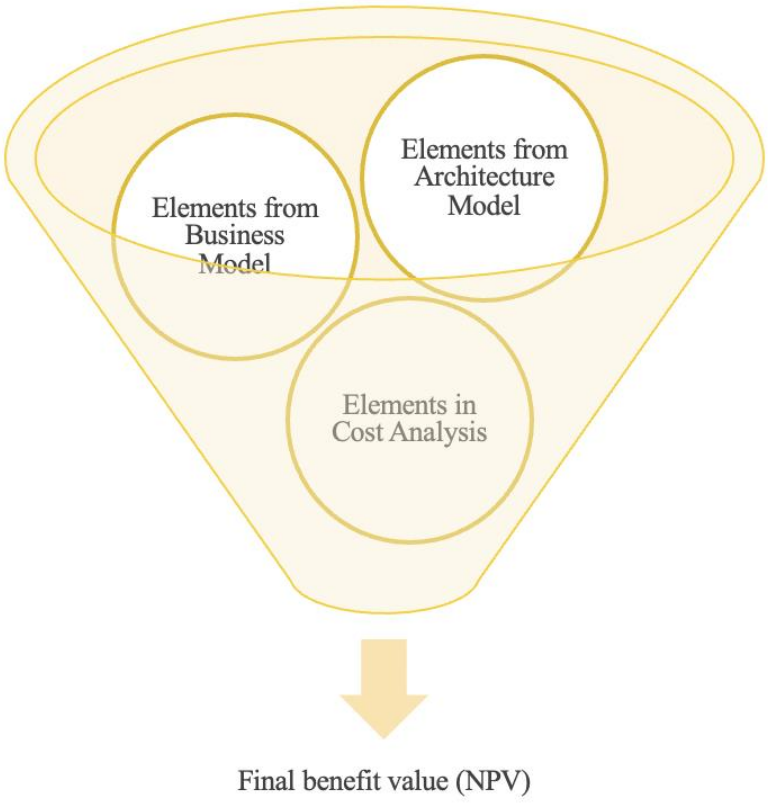

Figure 52: Overview of the NPV Estimation

However, to understand the dependency of the architecture model and business model for the final cost analysis, we need to map the cost handling processes and sections at every stage. Figure 53 depicts the overview costs attached to each factor obtained from the elements of architectures and business models. The end users or customers of the solution provided are shown in architectures that helps us to identify where the value exchange occurs. They are indicated in $ (dollars) beside the elements that contributes for the cost analysis. These are elements that contributes for Investments and Revenue for NPV calculation.

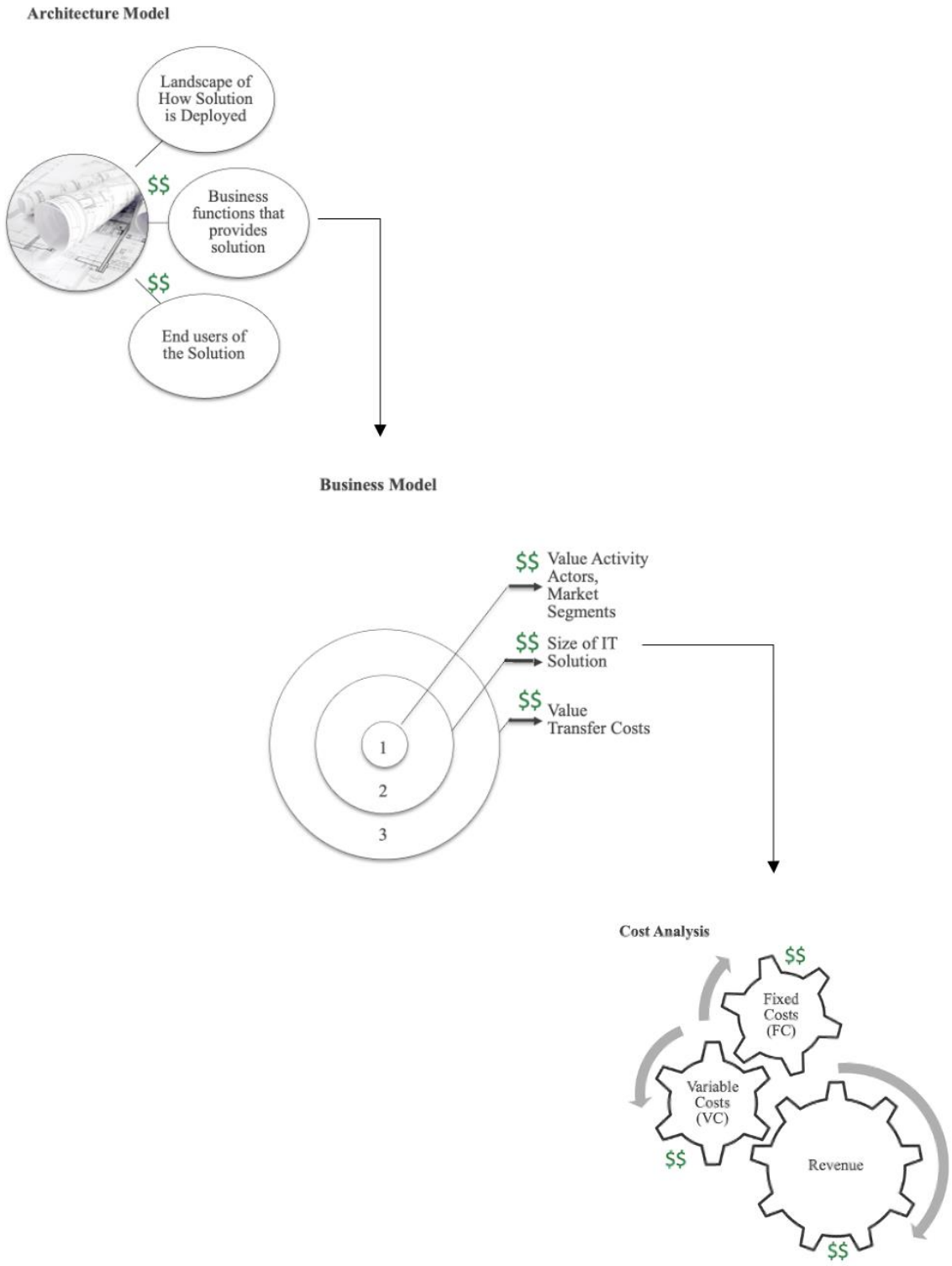

Figure 53: Dependency of Cost Analysis on Architecture and Business Models

Furthermore, the direct and simplified relation between the architecture model and the cost analysis is shown in Fig. 54. It clearly specifies the value exchange business process and application components contributing for fixed, variable costs and revenue in the cost analysis.

From the architecture, the stakeholders such as business actors and market segment for solutions, the processes responsible for deployment of a solution and the value exchange interface are shown. Finally, the NPV is calculated to estimate the benefit value of the solution provided.

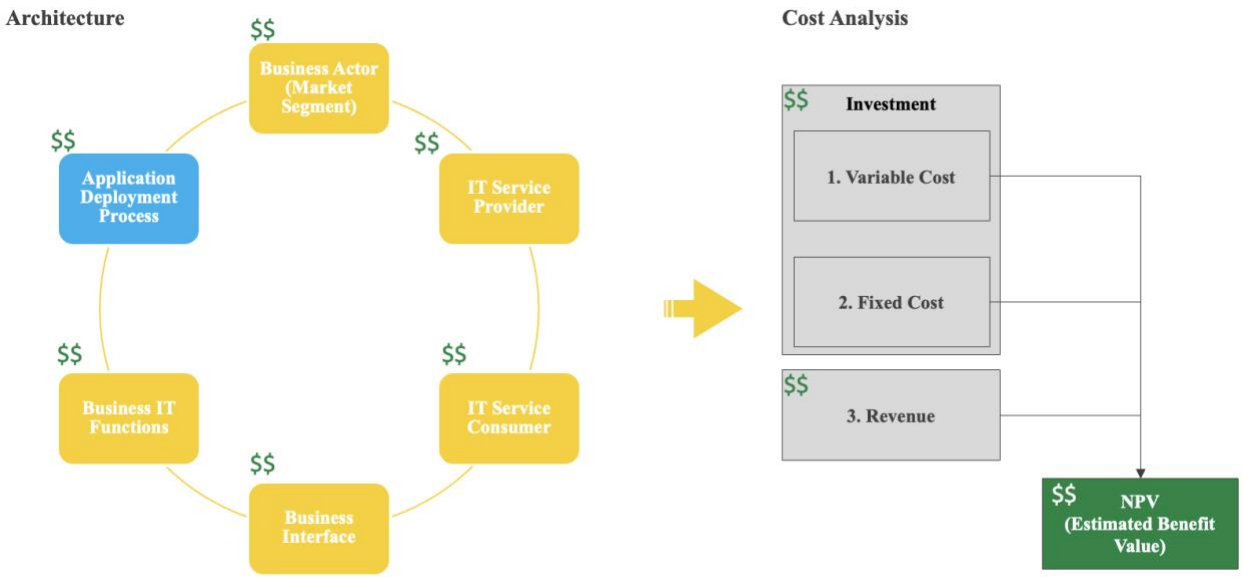

Figure 54: Contribution from Architecture elements to Cost Analysis

7.4 Future Scope & Limitations

The limitations to this assignment were based on majorly the assumptions identified. We assumed that the same parameters considered for the experiments would be applicable to every IT solution deployment to Shell's customers in NOV space. Though the user acceptance testing indicates vested interest in utilisation of such a design to uncover benefit value, there are missing parameters such as predicting the accuracy of value itself. This could be taken up in the future scope of the assignment. Currently, this aspect while implemented in Shell context was not solved as it only helped in validation of existing high level design as well as the link between the architectures and business models.

However, the research could expand further to areas that helps Shell IT to differentiate between each IT solution, NOVs and the respective resources required for deployment of an IT solution. The method could also implement the use of estimation techniques that incorporates correlation between consequences to better explain the narrative on costs and values estimated meaningfully. To target the probability of success and failure, a method to incorporate uncertainties in MCS could provide better insights for Shell IDT. Using such a sophisticated research, Shell IT could appropriately request for architecture specifications, business value propositions and allocate IT resources to determine the automated calculation of NPVs.

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Appendix

A.1 Reflection

The final project began with understanding what the business represents in the current energy transition progress. It encompassed the implementation of the environmental requirement while also aiming to achieve shareholder commitments.

I comprehended the business goals, organizational goals, team goals, topic goals, and finally the thesis assignment topic through iterations of project planning principles and a series of validations through discussions, interviews, and academic research papers. Though it was a hassle to align with the academic learnings to organizational work nature, with time and continual feedback mechanism, I picked up the sense of common ground to comply with both stakeholder expectations and scientific approach.

The challenge was committing to the timeframe of project planning, as some of the time estimates were breached. The reason was due to the implementation of designed mitigation strategies developed. The immense support from mentors and supervisors guided me to shape the final deliverable. Finally, complying with the anonymity requirements from the organization turned out easy as I followed the guidelines stipulated internally. I tested my learnings from Enterprise architecture and Design Science Research Methodology (DSRM) courses and respective core learning concepts to set the direction of research.

A.2 Time Planning, Questionnaire, and Reference

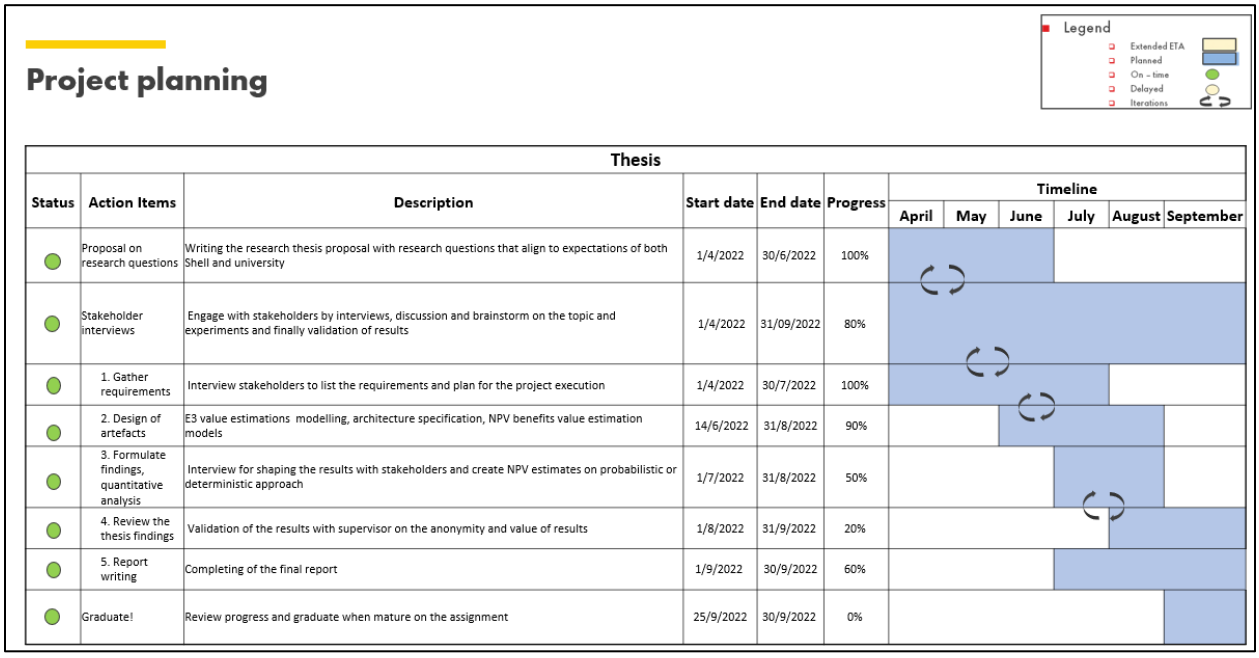
In this appendix section, the time planning for the thesis assignment uses the principles of project planning in a combination of both agile and waterfall techniques.

A.2.1 Time Planning

Project Management using the Gantt Charts to showcase the Milestones for 6 months of thesis assignment. In iterations and based on the follow-up meetings with supervisors and mentor both at the company and at the university, there were multiple versions designed for the time planning to accommodate unforeseen changes.

As part of the thesis journey, I learned to improve my project planning techniques. Using such techniques learnt, I drafted the agile way of working for my sub-tasks along with the main waterfall principle on main tasks. It involved iterative validations at each stage of my findings to progress meaningfully towards the next tasks that was formulated to execute the thesis.

Figure 55 and Figure 56 shows the time planning was formulated for the execution of thesis assignment at Shell.



Thesis						
Status	Action Items	Description	Start date	End date	Progress	Timeline (April, May, June, July, August, September)
	Proposal on research questions	Writing the research thesis proposal with research questions that align to expectations of both Shell and university	1/4/2022	30/6/2022	100%	
	Stakeholder interviews	Engage with stakeholders by interviews, discussion and brainstorm on the topic and experiments and finally validation of results	1/4/2022	31/09/2022	80%	
	1. Gather requirements	Interview stakeholders to list the requirements and plan for the project execution	1/4/2022	30/7/2022	100%	
	2. Design of artefacts	E3 value estimations modelling, architecture specification, NPV benefits value estimation models	14/6/2022	31/8/2022	90%	
	3. Formulate findings, quantitative analysis	Interview for shaping the results with stakeholders and create NPV estimates on probabilistic or deterministic approach	1/7/2022	31/8/2022	50%	
	4. Review the thesis findings	Validation of the results with supervisor on the anonymity and value of results	1/8/2022	31/9/2022	20%	
	5. Report writing	Completing of the final report	1/9/2022	30/9/2022	60%	
	Graduate!	Review progress and graduate when mature on the assignment	25/9/2022	30/9/2022	0%	

Figure 55: Project Planning - Thesis Assignment

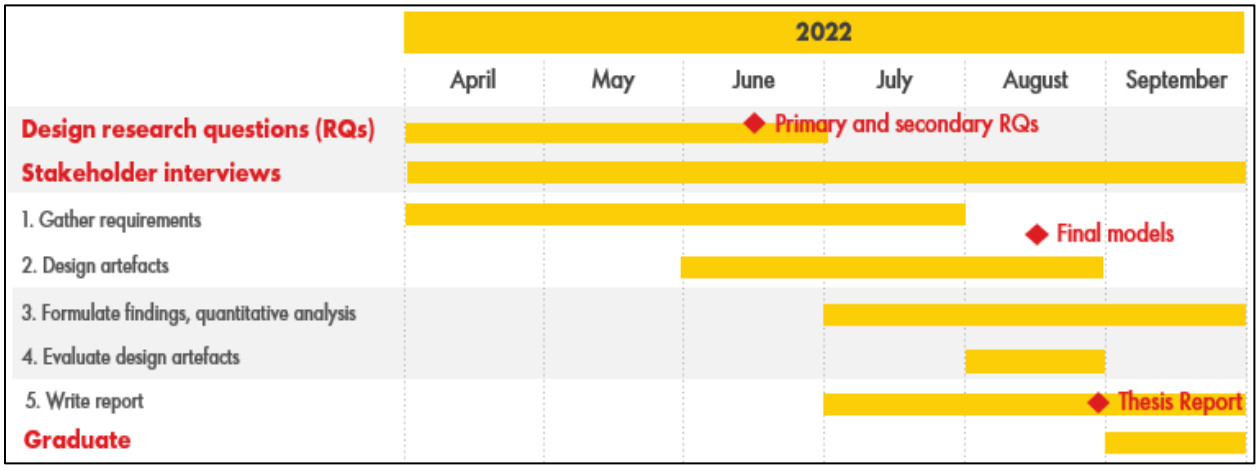


Figure 56: Project Planning in Shell

A.2.2 Questionnaire (Guiding Principle)

To gather requirements and understand the problem description at each pocket of the business stakeholders related to the issue of benefit value estimation, the questionnaire below was formulated, and the stakeholders were interviewed.

I. NOV performance areas of interest
   a. When it comes to NOV performance, what are the areas of interest for you?
II. Metrics that cover these areas
   a. What are the relevant metrics that will measure the status of each area that you recommended?
III. Data sources
   a. Are the KPIs being tracked right now?
   b. If yes, which are their data sources and how can I obtain the data?
IV. Proposed stakeholder interest
   a. How do we quantify the IT cost-value with the investments and expenses of these NOVs? If not, how about operated ventures?
   b. What are the factors that you consider for achieving strategic business-IT alignment with NOVs? Are there goals that conflict with your stakeholders (NOVs & Internally)?
   c. What are the strengths and weaknesses of the current method of estimation? What are the new opportunities that could be unveiled with a value model? Are there threats in the current method? (SWOT analysis)
   d. Is there a current system in place to predict the value that works? If so, what is the motivation (drivers) behind the current model?
V. Architecture
   a. Is the drafted ArchiMate model narrating the data flow points accurately?
   b. Do we have any missing elements for the model?
   c. Do you see any constraints in achieving the data flow?

As part of the validation of the results, the second set of interview questions as below was drafted to confirm findings from the experiments and henceforth the quantitative method that was created.

I. Architecture specification
   a. Is the service realization viewpoint describing an overall perspective of how IT solutions are developed?
   b. Does the hub & spoke network architecture provide the narrative on how IT solutions are implemented and deployed from Shell IT to NOVs?
   c. Do you find the architectural specification as a best practice for benefit value estimation of IT solutions?
II. Mapping architecture elements to the E3 value model
   a. Are the elements shown in the business model matching to existing best practice of Shell?

b. Does the business model translate the context of benefit value estimation for IT consumption?
c. Are the value interfaces mapped appropriately?
d. Has there been an architectural translation to value proposition models done before?
e. Do you currently have a value proposition framework to understand IT solution benefits for NOVs?

III. Probabilistic analysis
a. Is the probability of loss a relevant indicator to be measured in an investment proposal for an IT solution?
b. Is this method currently utilized for the estimation of the loss percentage of a particular IT solution investment?
c. Would you recommend this method of simulation with 500 trials for probabilities a valid benefit value estimation technique?

IV. NPV estimation
a. Do you agree to utilize the NPV estimation to predict the benefit value of IT solutions?
b. To what extent would you consider the use of NPV estimation to determine the benefit value of IT consumptions?

V. The overall method of benefit value estimation
a. Would you recommend estimating benefit value using the combination of these steps?
b. Are there missing elements that could be added to the current method from the proposed design solution?

A.2.3 Evaluation of Responses

Below are the tabulations of responses and their respective scores given based on Likert scale (Joshi et. al, 2015).

Q I. C. Do you find the architectural specification as a best practice for benefit value estimation of IT solutions?

Table 9: Assessment of Responses for Q I. C.

Stakeholder	Interview Question	Score value	Opinion	
			Negative	Positive
A	I. C	3		It is indeed a relevant component for initiation of discussions.
B		3		The architectural analysis provides overall perspective on the deployment methods.
C		5		Fundamentals are clear when we see from architectures.
D		3		Provides an academic lens of looking at IT solution deployment
E		4		Agreed, it is in fact a followed best practice here. The viewpoints differ but resonates to research findings.
F		4		This mandates for efforts and raises questions to designate a resource to commit for architectures. However, it would add value for high value demanding projects.
G		3		Architectures with cost figures would provide more value to the method.
H		2	Unsure of directly quantifiable benefit value using architectural specification.	
I		5		Any viewpoint from TOGAF is the first step for simplification of IT.
J		2	We have different viewpoints to analyze IT solution deployments. Research viewpoints adds different perspective but not applicable for all solutions.	
K		4		Viewpoints are clear. However, some of the elements proposed could be modified from Shell lens of every solution. A thought for future scope "How could we make this sustainable?".

Q II. B. Does the business model translate the context of benefit value estimation for IT consumption?

Table 10: Assessment of Responses for Q II. B.

Stakeholder	Question	Score	Opinion	
			Negative	Positive
A	II. B	4		Business value propositions gives better storytelling to our IDT customers.
B		2	E3 is relatively a new concept of viewing business value exchanges between one organization to another.	
C		4		Interesting view of business models translated from architecture elements.
D		3		Within the proposed business model, are there possibilities to also perform value estimations directly?
E		2	Are there integration features to directly import from business model to other systems?	
F		5		The business model reflects how Shell IT would perceive certain IT solution deployments globally. Actors, roles and requirements modelled in such a simplified model gives precision.
G		5		Clear depiction of value exchange from Shell IT to NOVs and the marketplace Appstore.
H		4		The factors responsible for the value estimation provides additional inputs for stakeholder to be made aware of internal IT solution and their customers.
I		2	Internal business model for certain IT solutions don't necessarily follow the same path of value exchanges. There may be other reasons for solutions offered.	
J		4		New perspectives for validation of internal business models are always welcomed. E3 helps us to reflect on how we need to perceive our future projects.
K		3		The translation of elements from ArchiMate to business models gave ideas to identify roles and actors where we estimate benefits to be achieved.

Q III. C. Would you recommend this method of simulation with 500 trials for probabilities a valid benefit value estimation technique?

Table 11: Assessment of Responses for Q III. C.

Stakeholder	Question	Score	Opinion	
			Negative	Positive
A	III. C	4		The steps in proposed method would assist in uncovering the benefit value.
B		4		There may occur social influences where the model is seen as exhausting on resources available.
C		4		The value addition of this method could possibly be perceived as non-functional as this creates awareness on areas to be investigated more than benefit value numbers directly.
D		3		Most of them yes, because we do that already and having different perspectives to same context would help in brainstorming better.
E		4		These methods would naturally validate our current way of working.
F		1	The concept of probability of loss or profit can be slightly mirrored to probability of success or failure in projects. However, they don't mean the same idea because success or failure depicts the benefit value on uncertain parameters whereas MCS appears to have certain events and costs completely known.	
G		1	NOVs don't share the revenue, fixed and variable costs as they are customers. Replicating MCS on uncertainties demand for correlation between consequences is not possible. MCS lacks the capability of consequence analysis.	
H		2	Estimation of a profit/ loss is applicable for project initiation but not completely aligned for benefit value in NOVs.	
I		3		We could incorporate MCS in project investment proposals, however, it wouldn't provide complete story on benefit value.
J		1	Current model has sophisticated explanations on several parameters as compared to MCS.	
K		3		A what-if analysis is relatively an aggregated concept for several trials and assumptions in costs. In NOV use case, the financial benefits could be better recognized using MCS.

Q IV. B. To what extent would you consider the use of NPV estimation to determine the benefit value of IT consumptions?

Table 12: Assessment of Responses for Q IV. B.

Stakeholder	Question	Score	Opinion	
			Negative	Positive
A	IV. B	5		NPV has always been the core element for benefit value estimations.
B		5		The NPV estimation has often been used to assess whether we should do certain projects or not. The method and its components are constantly checked with the research field.
C		4		NPV method has quantitative value drivers, helps to determine whether the delivery leads to measurable value/higher profit.
D		5		An example in NPV estimation parameters is increased production, improved reliability, less downtime, lower cost, quicker fulfillment and related.
E		4		The method is existing and satisfactorily used for benefit value estimation for future years. Validation from research literature confirms that we are working in the right direction.
F		4		Baseline of NPV is to first create both pre- & post- reviews to develop, deploy, run and maintain an IT solution.
G		3		Currently yes. Are there automation functionalities with NPV estimation?
H		4		In all projects, the NPV components are first checked for its relevance and later applied for overall perspective.
I		3		NPV estimated are slowly becoming silos in different pockets of the same organization. Interoperability is a new definition that could be explored in NPV.
J		2	NPV has been existing for quite some time. Are we looking for new estimation techniques so that we get automated entries?	
K		4		From architecture perspective, we recommend start with NPV and then prepare documentation for IT solution project.

Q V. A. Would you recommend estimating benefit value using the combination of these steps?

Table 13: Assessment of Responses for Q V. A.

Stakeholder	Question	Score	Opinion	
			Negative	Positive
A	V. A	4		Elements in the method overall is a good recommendation to the existing ways of working.
B		5		We can implement the E3 specially to test out different perspectives of business value exchanges. The overall method validates existing methods.
C		4		Hub & Spoke is a new lens of viewing IT solution deployment and implementation in the architecture domain. The complete method could compensate for the gaps that we may encounter in the IT solution delivery.
D		4		The method provides clear indication of the research world and helps us to validate the existing internal methods of estimations.
E		5		Best practices revealed how Shell IT could focus on industrial best practice for application of quantitative estimation techniques.
F		3		Agree that some elements resonate with the existing models, however, completely disagree use of MCS as MCS would undermine the correlation of consequence element in storytelling.

G		2	The proposed estimation method if included in our current ways of working would demand for more resources and costs mapped to them. We have to investigate if the method is truly valuable in terms of efforts.	
H		1	Social influences could be seen in terms of efforts and commitment required to run and maintain the proposed method.	
I		4		We can use the method to simplify IT processes and reveal the underlying principles of IT operations with the NOVs.
J		2	Automation would be helpful for future scope on all the components as that simplifies efforts and time taken to complete the task.	
K		1	Architecturally, the proposed method would be a cost burden in terms of efforts and time for the quantum of IT solutions deployed to NOVs. Maybe an automated derivative of all the steps in proposed method would facilitate seamless functioning for Shell IT.	

A.2.4 Reference Style

Section 9.35 of the **APA** Publication Manual states that is acceptable to use either the default display setting (blue hyperlinks) or plain text (without underlining) when formatting DOIs and URLs in reference lists.