JUNE
2023

# DESIGN AND IMPLEMENTATION OF VELOCITY IN RISK ASSESSMENT WITH ENTERPRISE ARCHITECTURE MODELING

MASTER THESIS

**DEA AMELIA SAVITRI**
MASTERS OF BUSINESS IT
UNIVERSITY OF TWENTE
2527537

**SUPERVISORS**

DR. GAYANE SEDRAKYAN (BMS - UNIVERSITY OF TWENTE)
DR. FAIZA A. BUKHSH (EEMCS - UNIVERSITY OF TWENTE)
LAURENT WILLEMSEN, M.SC., RE (KPMG NETHERLANDS)

# ACKNOWLEDGEMENT

It has been an unforgettable and precious journey to finally complete my master's thesis and graduate from the University of Twente, The Netherlands. The feeling of finishing this journey is bittersweet, as it began not at the start of my master's degree in September 2021, but five years ago when I first dreamed of pursuing my master's degree at this university. This journey has taught me the importance of perseverance and the belief that if we truly desire something and it is good for us, it will come to fruition, inshaAllah.

I would like to express my deepest gratitude to Dr. Gayane Sedrakyan and Dr. Faiza A. Bukhsh, who have been incredibly supportive supervisors throughout my thesis despite the limited time constraints. I am also grateful to Laurent Willemsen, M.Sc., RE, for his continuous support and encouragement during my internship and thesis. To all my colleagues at ITA RNO KPMG, especially Dennis Uttermark, thank you for your assistance and support during my internship. I would also like to thank Jessica, Leanie, Jorgos, and Joeri for the warmth of friendship I experienced at KPMG.

My heartfelt thanks go to my best friends during my time at UT: Tifani, Jesus, Raef, Jeroen, Amy, Danniar, Nikitha, and Donika. You have become my second family away from home, and I treasure the time we spent together. I am also grateful to my Muslimah coffee talk group, including Tifani (again), Ovi, Sabrina, Suhad, Sanae, and others, for being my source of strength and support as a minority in The Netherlands. May Allah SWT reward you all with Jannah.

I want to express my special thanks to my family: Ibu, Ayah, and Evan. You have always been my rock, providing unwavering support and trust. Without you, I would not be where I am today. I have always missed you, and if I could, I would run home just to feel the warmth of your hugs. But despite the distance, you have always managed to show me your love and always give me strength.

To my fiancé, Christian Nanninga, I am grateful for your presence in my life. Your patience, love, and unwavering support have been a constant source of strength. Your amazing qualities never cease to amaze me, and I consider myself fortunate to be with you. I look forward to spending the rest of my life with you, inshaAllah.

Finally, I offer my deepest gratitude to the almighty God, Allah SWT. Without His blessings and barakah, none of this would have been possible. As Danniar also stated in the preface of his EngD paper; "*Lā ḥawla wa- lā quwwata ʾillā bi-llāh,*" which means "*There is no power or strength except through God*".

Enschede, 9 July 2023.

# ABSTRACT

Risk and uncertainty are typically assessed based on the variables of impact and likelihood. However, high-impact, low-likelihood events, such as the COVID-19 pandemic, often lead to oversight of such risks. To address this, the concept of risk velocity, which had been mentioned as early as 2017, has gained renewed attention. Despite its significance, academic research on risk velocity remains limited. In light of this, using a case study approach, the current study applies the Design Science Research Methodology (DSRM) by Wieringa to investigate the implementation of risk velocity within a hospital setting in the Netherlands.

This study proposes a solution in the form of a comprehensive guideline comprising two primary process frameworks: a single-use process framework and an annual & ad hoc process framework. The effectiveness of the proposed guidelines has been validated through structured interviews, demonstrating their usefulness not only for hospitals in the Netherlands but also for other businesses worldwide that possess dedicated risk management departments and embrace a mathematical-based risk culture and calculation approach. These organizations can adopt the proposed guidance to incorporate risk velocity into their risk assessment processes.

The application of ArchiMate, a visualization tool, plays a crucial role in the proposed guidelines. ArchiMate visualizes the organization's main, supporting, and management processes. Additionally, it is utilized to depict the relationship between the timeline of guideline implementation and the guideline processes themselves. This comprehensive approach enhances the understanding and implementation of risk velocity within the risk assessment process, facilitating effective risk management practices.

Overall, this research contributes to filling the gap in academic research on risk velocity, providing a practical and applicable solution in the form of a guideline that can be implemented by organizations, particularly those with a specialized risk management department and a strong emphasis on mathematical-based risk analysis and culture.



**Keywords**

Risk assessment, risk register, velocity of risk, enterprise architecture

# TABLE OF CONTENTS

# CHAPTER 1
# BACKGROUND

## 1.1. Background and Context

As more organizations advance into the business, the more aware of the risks they have become. Risk registration is one of the crucial parts of any organization's operation, for it contains the vitality of important summary information on the risk status of an organization (Hopkin, 2013). Knowing this, a risk register has been included to be implemented within the enterprise architecture of organizations since it is both a driver and enabler of secure, safe, resilient, and reliable behavior and addresses risk areas throughout the enterprise (Harrison, 2018).

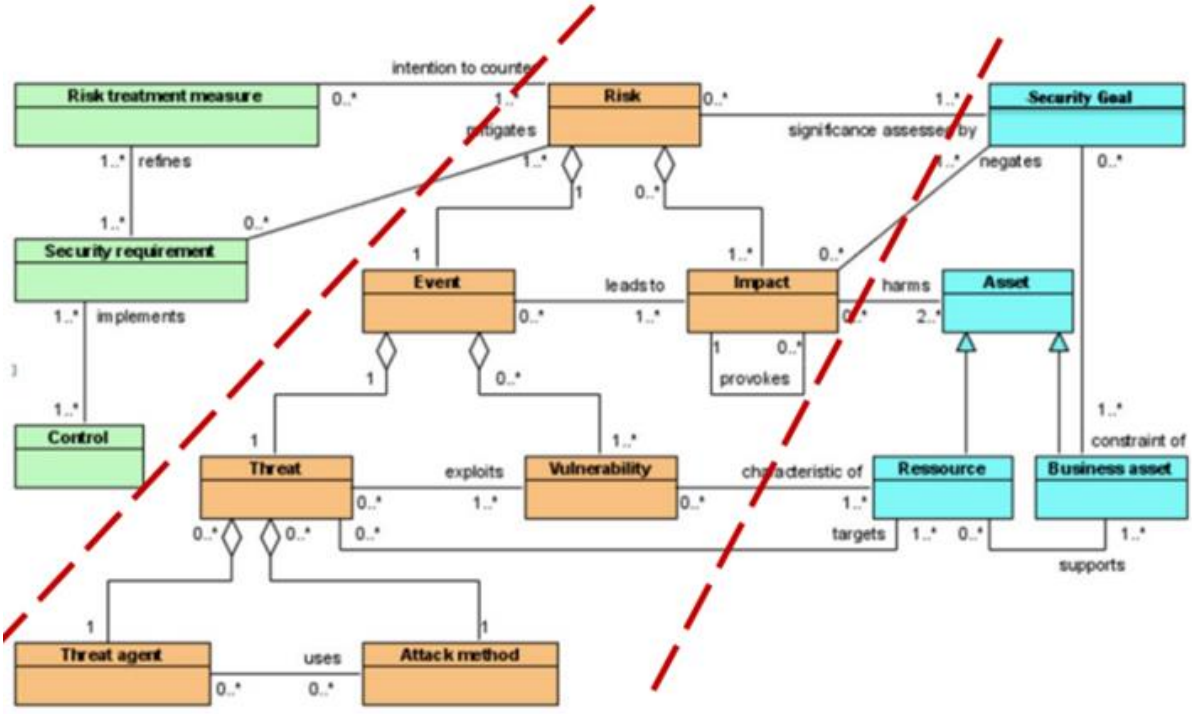



**Figure 1 N. Mayer, "Model-based Management of Information System Security Risk," Ph.D. Dissertation, University of Namur, 2009.**

In the last few decades, risk management professionals have used impact and likelihood as their primary risk assessment drivers. Impact defines the extent to which a risk event might affect an organization, while likelihood represents the possibility that a given event occurs (Curtis, 2012). On the other hand, there is another driver that has emerged as a standard of ERM since 2013, which is called the Velocity of Risk (VoR) (COSO, 2013).

Velocity in risk itself is described as how fast the impact of one risk hits an organization. While most risk analyses use impact and likelihood as their variables to make prioritization the risk, the velocity of risk (VoR) could also be an essential variable to consider in the analysis, specifically in times of the COVID-19 pandemic or any pandemic in general. In hindsight, adding velocity should be able to help organization owners to better understand the risk and prioritize the controls depending on how fast the risk hits and the organization's ability to function normally again.

The outbreak of the COVID-19 pandemic has brought unprecedented challenges to businesses worldwide. The pandemic has highlighted the importance of considering the velocity of risks in enterprise risk management. As organizations face threats similar to the pandemic, which possess high velocity and impact with low likelihood, incorporating these variables into risk management strategies could enable organizations to prepare for and manage such risks more effectively. This would allow organizations to retain business operations, prevent financial losses, and mitigate reputational risks.

The COVID-19 pandemic has demonstrated the importance of understanding the velocity of risks, which refers to the speed at which a risk can manifest, and its impact materializes. In the case of the pandemic, its velocity was particularly high, and the impact was felt almost immediately. Many businesses were unprepared for the rapid spread of the virus and the resulting lockdowns, which caused significant disruptions to their operations.

During the ongoing COVID-19 pandemic, hospitals have encountered significant challenges due to the impact of the virus on both patients and healthcare personnel. Given the airborne nature of the disease, doctors and nurses who directly interact with patients face an increased risk of infection. Consequently, not only departments directly involved in patient care but also the overall management process of the hospital has been adversely affected. Swift adjustments had to be made, including implementing lockdown measures and transitioning staff to remote work, often with limited preparation and readiness for remote operations. As a result, organizations need to incorporate velocity as a variable in their enterprise risk management frameworks to anticipate better, prepare for, and manage high-velocity risks.

The preliminary qualitative assessment, conducted through interviews with senior consultants from KPMG, has provided insights into the risk registration practices of their clients. As KPMG consultants closely collaborate with clients and review their documents for audit purposes, they also request the submission of risk assessment documents from their clients. It was observed that most clients do not currently include velocity as a component in their risk registration process. This finding highlights a gap in the current risk management practices of organizations, indicating that there is a need for greater awareness and understanding of the importance of these variables in managing risks effectively. The lack of consideration of velocity in risk registration processes may lead to inadequate risk assessment, leaving organizations vulnerable to high-velocity risks that can cause significant disruptions to their operations. As such, incorporating velocity as the key variable in enterprise risk management frameworks is critical to ensure that organizations can manage risks effectively and mitigate the impact of adverse events.

Moreover, it is observed that velocity has not been commonly incorporated into enterprise architecture frameworks academically. This implies that there is limited academic research on integrating velocity into enterprise architecture frameworks, indicating a need for further research in this area. Incorporating velocity into enterprise architecture frameworks would enable organizations to consider the speed at which risks can manifest and their potential impact, facilitating more effective risk management. The lack of academic research on incorporating velocity into enterprise architecture frameworks also presents an opportunity for future research to bridge this gap and develop new frameworks incorporating velocity as a key variable in risk management.

The COVID-19 pandemic has had a profound impact on hospitals, affecting various aspects of their operations and interactions (Rosenfeld, 2021). This includes both the interactions between staff and patients within the hospital as well as the internal interactions among different departments and functions, such as finance, human resources, and internal audit. Hospitals have been compelled to navigate significant changes amidst the pandemic, grappling with challenges such as the surge in patient numbers while experiencing a reduction in available staff due to individuals contracting the virus. During this time, hospitals have had to

contend with the symptoms of this highly infectious virus without the availability of a cure. Additionally, supporting and managerial functions within hospitals have been required to adapt to remote work arrangements, often without sufficient IT infrastructure.

The rapid and widespread nature of the pandemic has caught businesses off guard, including hospitals, leaving them with little time to prepare for the ensuing challenges. Given the extensive impact on hospitals and the urgency to address the associated risks, the research focus of this study is centered on the velocity of risk in the risk assessment process within the hospital context. Understanding and effectively managing the velocity of risk is crucial in the healthcare sector, where the dynamics and consequences of risks are amplified during times of crisis and uncertainty. By examining the risk assessment process in hospitals, including the incorporation of the velocity of risk, this research aims to contribute to the knowledge and practices of risk management in the healthcare domain, specifically the hospital.

Mapping ISSRM onto ArchiMate

| ISSRM Concept | EAM Concept | Mapping |
|---|---|---|
| Business Asset | Business Process | Generalisation |
| Business Asset | Business Object | Generalisation |
| Business Asset | Business Actor | Generalisation |
| Business Asset | Business Role | Generalisation |
| IS Asset | Application Component | Generalisation |
| IS Asset | System Software | Generalisation |
| IS Asset | Node | Generalisation |
| IS Asset | Device | Generalisation |
| IS Asset | Network | Generalisation |
| Security Objective | Driver | Specialisation |

| ISSRM Concept | EAM Concept | Mapping |
|---|---|---|
| Risk | Assessment | Specialisation |
| Event | Assessment | Specialisation |
| Impact | Assessment | Specialisation |
| Threat | Assessment | Specialisation |
| Vulnerability | Assessment | Specialisation |
| Risk Treatment | Goal | Specialisation |
| Security Requirement | Requirement | Specialisation |
| Control | Core Element | Specialisation |

**FIGURE 2 MAPPING ISSRM INTO ARCHIMATE - M.E. IACOB, "EA & RISK, SECURITY, AND RESILIENCE," ENTERPRISE ARCHITECTURE LECTURE SLIDES**

Based on this initial observation, this thesis will be a research to capture and analyze velocity as part of the risk registration process using ArchiMate. This framework will be a pilot project to also highlight the importance of having velocity analysis within the risk register process in an organization using COVID-19 as an example.

## 1.2. PROBLEM STATEMENT

A systematic literature review has been conducted and revealed a lack of literature on the topic of the velocity of risk in enterprise architecture. While there is an extensive body of research on resilience related to risk assessment, enterprise architecture, and emergencies, the topic of the velocity of risk has not been previously explored in the context of enterprise architecture. While some literature on the velocity of risk in the context of COVID-19 exists, it is relatively limited. The lack of literature in this area represents an opportunity for future research to explore the relationship between the velocity of risk and enterprise architecture and to develop new risk assessment methods specifically for emergencies in organizations. In order to address the main research question of this paper comprehensively, further extensive research is required, as the existing literature does not provide sufficient information pertaining to the analysis and visualization of velocity in risk assessment methods specifically for emergency response. It is important to

acknowledge that relying solely on literature research will not be adequate for conducting this thesis. Therefore, a case study approach is deemed necessary to effectively answer the research question.

The case study provides the practical implications for the field of Enterprise Architecture (EA) and risk management through valuable insights into the development of resilient systems capable of adapting and recovering swiftly in the face of unexpected disruptions. This research will contribute to the advancement of knowledge and understanding in these domains through the examination real-world scenarios and the analysis of velocity application in risk assessment within an emergency response context.

## 1.3. OBJECTIVES AND RESEARCH QUESTIONS

This section is essential to the thesis as it presents the key goals and objectives of the study. The research questions are formulated in this section to guide the research, and the objectives are developed to provide a clear picture of what the study wants to achieve. The research questions aim to gain a more focus research, while the objectives assist on the goals to be achieved by the research questions. The study can be carried out in a more planned and organized manner, improving the accuracy and dependability of the results by answering the research questions.

**Main Research Question:**

*How can velocity be captured and analyzed in ArchiMate enterprise architecture models to create a risk assessment model in a hospital?*

**Sub-Research Questions:**

To facilitate the comprehensive exploration of the main research questions, a set of carefully crafted questions has been devised to guide and contribute to the investigation. In order to enhance the structure of the sub-research questions, they have been categorized into four distinct parts, namely literature research, case study, solution design, and solution implementation.

For the literature research phase (1), the following question has been formulated to guide the inquiry process and inform the subsequent stages:

1.1 - WHAT IS THE STATE-OF-ART ON VELOCITY IN THE RISK ASSESSMENT PROCESS?

The objective of this sub-research question is to gain an understanding of the current state-of-the-art regarding the embodiment of velocity in the risk assessment process. The specific objective is to identify existing literature, frameworks, and methodologies that address these two concepts in the context of risk assessment.

Organizations can better prepare themselves to identify and manage risks that may have a high velocity or require a resilient response by understanding the state-of-the-art on these concepts.

In summary, the objective of this sub-research question is to identify the current understanding and practices related to velocity in risk assessment processes, which can be used to inform the development of effective risk management strategies.

A set of questions has been defined to assist the researcher in comprehending the challenges and complexities associated with risk assessment in a hospital setting. These questions serve as a guide to explore the key aspects related to the risk assessment process in a hospital context.

### 2.1 - What are the key challenges that hospitals came across during their risk assessment process?

The objective of this sub-research question is to identify the main issue(s) encountered by the hospital during the risk assessment process. This can be accomplished through various methods, such as conducting interviews with key personnel involved in the risk assessment process, reviewing relevant documentation, and observing the risk assessment process. This way, the researcher can design and develop a solution to address the issue(s) and improve the risk assessment process by having in-depth understanding of the main issue(s). The solution can be in the form of guidance or a tool that can be used to help hospital personnel better identify, analyze, and mitigate risks.

### 2.2 – What are the steps in the risk assessment process in a hospital?

The objective of this sub-research question is to gain an understanding of the current risk assessment process steps implemented in the hospital. The acquired information will be utilized to develop a suitable solution to improve the risk assessment process. This question also aims to identify the existence and the type of risk assessment documents used in the hospital to ensure that the developed solution is aligned with the specific types of risk assessment being used. The researcher can identify any inefficiencies or gaps in the process and develop a solution that addresses these issues while aligning with the hospital's current risk assessment practices once having a good understanding on the current risk assessment process.

### 2.3 – What are the elements used in a hospital risk assessment?

The objective of this sub-research question is to gain an understanding of the current risk assessment practices in the hospital and the variables and elements that are used to quantify the risk. The aim is to identify if the hospital has incorporated any additional variables beyond the traditional impact and likelihood measures to assess its risks. This information is crucial in developing a risk assessment model using ArchiMate enterprise architecture that can capture and analyze velocity in the hospital's risk assessment process. The results of this research can also help identify any gaps in the hospital's risk assessment practices and provide suggestions for improvements or modifications to their current process.

To aid in the development of solutions to address the challenges identified in the hospital's risk assessment process, a set of questions has been formulated. These questions are designed to guide the researcher in exploring potential strategies and approaches to effectively mitigate the identified challenges.

### 3.1 – How and to what extent can risk assessment be captured by enterprise architecture models such as ArchiMate?

The objective of this sub-research question is to investigate the benefits of using ArchiMate enterprise architecture models in visualizing a risk assessment model for a hospital. The sub-research question aims to identify the strengths and weaknesses of ArchiMate models as compared to other models in terms of visualizing and communicating risk assessment information. It also aims to contribute to developing a risk assessment model that is easily understood and effectively communicated to stakeholders within a hospital setting.

### 3.2 – What are the key components of the guidance for capturing and analyzing velocity in ArchiMate enterprise architecture models for risk assessment in a hospital?

The objective of this sub-research question is to provide guidance on incorporating velocity into risk assessment using the ArchiMate model. This research question aims to understand how the ArchiMate model can be used to capture and analyze velocity in risk assessment, as well as to identify any challenges that may arise when incorporating these concepts into the model. The findings from this research question will be used to develop guidelines and recommendations for risk assessment using the ArchiMate model focusing on capturing and analyzing velocity.

The guidance that will be developed from the findings of this sub-research question will serve as a framework for incorporating velocity into risk assessment in a hospital setting using the ArchiMate model. This guidance will be based on the best practices and insights gathered from the previous sub-research questions and will aim to provide practical, actionable recommendations for healthcare professionals looking to improve their risk assessment processes.

In order to facilitate a methodical and thorough validation of the proposed solution in this research, a set of structured questions has been formulated. These questions are intended to guide the validation process and ensure a systematic and comprehensive assessment of the proposed solution's effectiveness and suitability.

### 4.1 – What are the steps for the hospital to implement velocity in its risk assessment process?

The sub-research question aims to provide a practical and actionable plan for the hospital to successfully adopt the proposed risk assessment guidance that incorporates velocity using ArchiMate enterprise architecture models. This will ensure that the hospital is able to manage its risks and improve its overall resilience effectively.

### 4.2 – What are the limitations and potential drawbacks of using an ArchiMate enterprise architecture model to capture and analyze velocity in a hospital, and how can they be addressed?

The objective of this sub-research question is to identify any potential limitations that may surface during the implementation of the proposed guidance on incorporating velocity into risk assessment using ArchiMate enterprise architecture models in a hospital. Having to understand the limitation, the research can provide insights into how to address these limitations to ensure the successful implementation of the proposed guidance.

The limitations may come from factors such as lack of resources (e.g., budget, staff, time), resistance to change, technical limitations, or other organizational challenges. Having to understand the limitation will allow the research to suggest ways to address the challenges as well as to increase the chances of success in implementing the guidance. The proposed solutions can be tailored to the specific context of the hospital and can help overcome the limitations that may arise during the implementation process.

### 4.3 – What is the feedback of hospital stakeholders (such as risk managers, IT professionals, and hospital administrators) on the proposed risk assessment model that incorporates velocity using ArchiMate models?

The objective of this sub-research question is to obtain feedback from stakeholders in the hospital regarding the proposed guidance on the velocity embedment into risk assessment using the ArchiMate model. The goal is to extract insights into how the stakeholders perceive the proposed guidance, identify any challenges that they might encountered during implementation, and provide suggestions for guideline improvement.

The researcher will conduct interviews with stakeholders, such as risk managers, enterprise architects, IT professionals, and other relevant staff in the hospital in order to achieve the objective. The interview questions has the purpose to gather feedback on the proposed guidance, such as whether the guidance is clear and easy to follow, whether it addresses the identified issues and challenges, and whether it can be implemented within the hospital's existing processes and procedures.

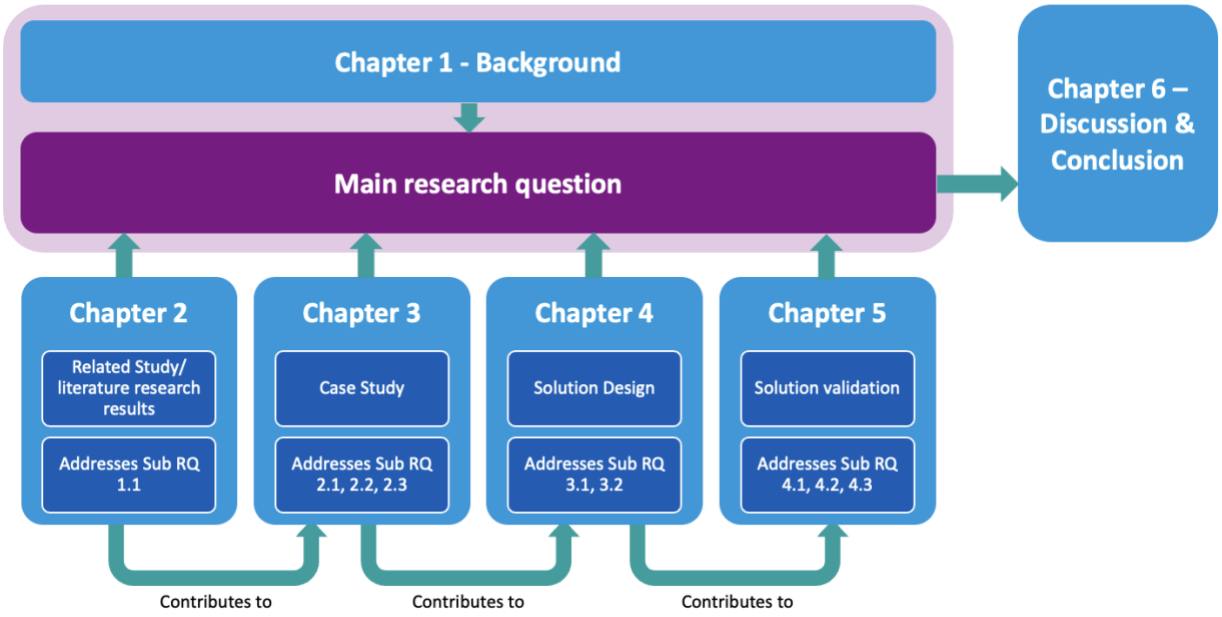



FIGURE 3 RESEARCH STRUCTURE

Figure 3 provides a comprehensive illustration of the interrelationships between chapters, sub-research questions, and their contributions to other research questions and the main research question. This research structure visualization serves to elaborate the interconnectedness and mutual influence of the various components within the research framework. Figure 3 facilitates a clearer understanding of how the sub-research questions synergistically contribute to the overall investigation and aid in addressing the main research question through the structure mapping visualization.

## 1.4. SIGNIFICANCE OF THE STUDY

This thesis is unique in that it addresses an area of enterprise risk management that has received limited attention in academic research. By exploring how velocity can be incorporated into ArchiMate enterprise architecture models for risk assessment in emergency response scenarios, this thesis offers a valuable contribution to the academic study of enterprise risk management.

In addition to its academic value, this thesis offers practical guidance for professionals involved in enterprise risk management. By providing detailed insights into how velocity can be incorporated into ArchiMate enterprise architecture models for risk assessment, this thesis can serve as a useful resource for professionals looking to implement this approach within their organizations.

Overall, this thesis offers a unique and valuable perspective on how velocity can be captured and analyzed in ArchiMate enterprise architecture models to create a risk assessment method in emergency response. By expanding the body of knowledge in this area and offering practical guidance for professionals, this thesis has the potential to contribute to the field of enterprise risk management significantly.

## 1.5. RESEARCH APPROACH

This sub-section discusses the research approach adopted for this study, which was adapted from Design Research Science Methodology by Wieringa (2014). Before presenting the rationale for this choice, this section will highlight the distinct characteristics of Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) and Wieringa (2014) methods.

The Design Science methodology by Peffers is primarily concerned with creating and evaluating innovative artifacts, such as new software systems, to address specific problems in a particular context. The methodology is typically structured in a series of iterative cycles that involve defining the problem, designing a solution, building the artifact, and evaluating its effectiveness, as presented in Figure 4. Design Science aims to produce knowledge through the creation of innovative solutions that can be applied to real-world problems.

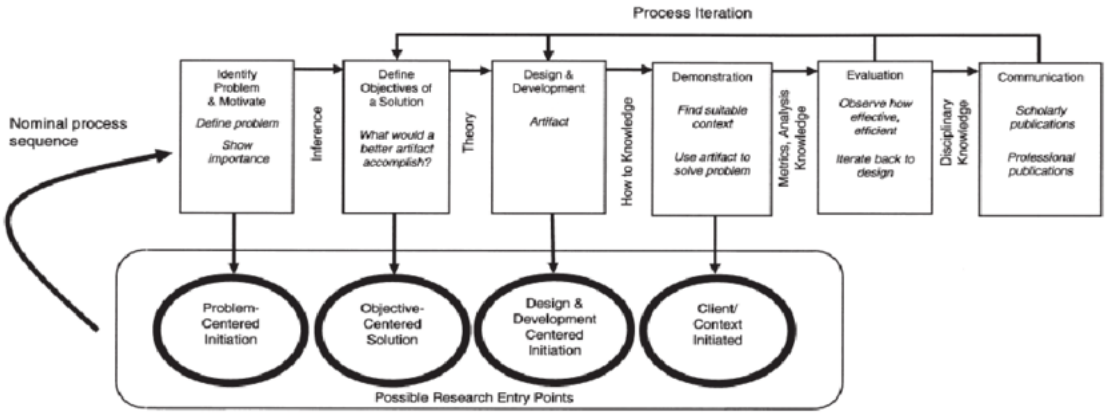



**FIGURE 4 DESIGN SCIENCE METHODOLOGY, PEFFERS (2007)**

In contrast, Wieringa's Science Methodology (2014) is concerned with developing and testing theories that explain phenomena in the information systems field. This methodology involves generating hypotheses based on existing theories or observations, collecting empirical data to test those hypotheses, and using the results to develop and refine the theory. The emphasis is on understanding and explaining the underlying principles behind the phenomena being studied.

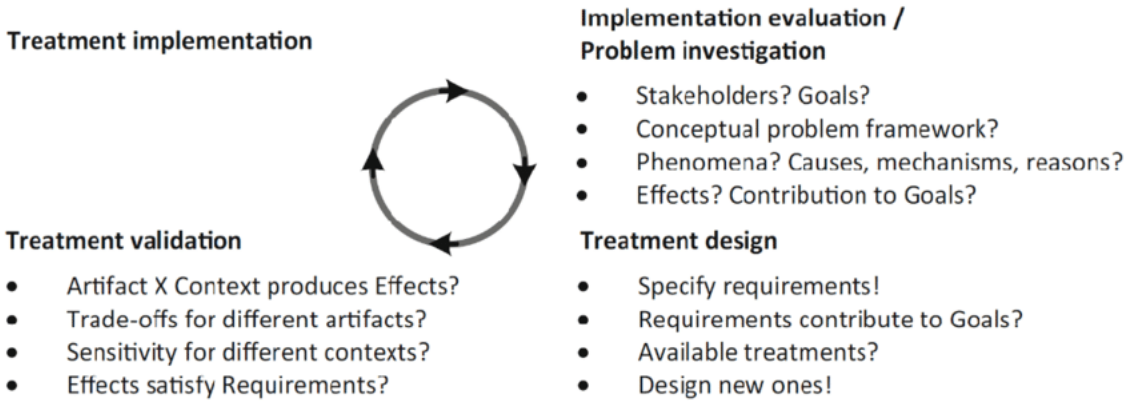



**FIGURE 5 DESIGN SCIENCE RESEARCH METHODOLOGY (DSRM) BY WIERINGA (2014)**

Previous research studies have mentioned the concept of velocity in risk assessment. However, they lack sufficient information regarding its implementation. Hence, the primary objective of this research is to investigate whether implementing the velocity of risk as one of the risk score variables could potentially address the issues companies face in their risk assessment process. This will be accomplished through the application of Wieringa's Science Methodology, including the problem investigation, solution design, and solution validation phases, as presented in Figure 5. While Peffer's approach could also be utilized, due to time constraints, an iterative process between the steps may not be feasible. It is worth noting that this research is not intended to introduce a novel concept but rather to implement an already established variable in the context of risk assessment.

For the present study, the chosen research design is the case study approach. This choice is justified by several reasons. Firstly, the case study design allows for a detailed and in-depth examination of real-life cases within the organization under investigation. Given that many organizations tend to keep their risk assessment documents and processes confidential, it would be difficult to attain the research objectives without adopting the case study approach. Additionally, this research design would enable the identification of whether the organization under study shares similar issues faced by other organizations in their risk assessment process. This would provide a broader perspective on the issues encountered in the industry and the potential benefits of incorporating velocity as a variable in the risk assessment process.

In line with the research design chosen for this study, which is a case study approach, the data collection method that will be employed is a series of interviews. As indicated by Cresswell (2014), interviews can provide in-depth and detailed data about participants' experiences, perspectives, and attitudes, which are particularly useful in qualitative research. However, due to the time-consuming nature of interviews, the case study will be limited to one hospital to allow for an in-depth analysis of their risk assessment process. Interviews will be conducted in two phases of the research, namely the problem investigation and solution validation phases. This approach will enable the researcher to gather relevant information about the risk assessment process in the hospital and also to validate the proposed solution.

ArchiMate has been selected as one of the modeling techniques employed to visualize the business and risk assessment processes. This choice is attributed to ArchiMate's extensive range of notations, surpassing those offered by other techniques such as BPMN, UML, or ERD. ArchiMate adopts a multi-layered

approach in its visualization, allowing for the depiction of correlations among various elements across different layers. Despite their connection to elements from different layers, ArchiMate facilitates the visualization of these relationships. The elements in ArchiMate are organized into six layers, namely strategy, business, application, technology, physical, and implementation & migration. Furthermore, the elements within each layer can be further classified into different aspects, including passive structure, behavior, active structure, and motivation, as portrayed in Figure 6. This categorization framework within ArchiMate enables a comprehensive and structured representation of the interconnected components within the visualization process.

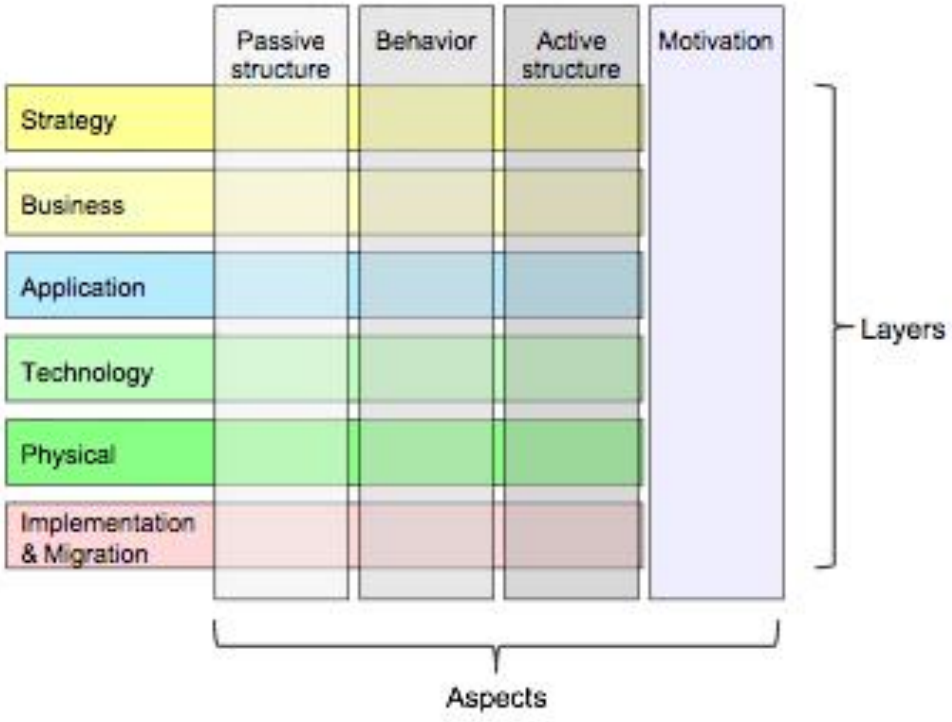



**FIGURE 6 ARCHIMATE LAYERS AND ASPECTS (GROUP, 2023)**

## 1.6. PROBLEM INVESTIGATION PHASE

This subsection discusses the first phase of Wieringa's design science methodology, the problem investigation phase. According to Wieringa's Design Science Research Methodology (DSRM), the problem investigation phase is the first phase of the research process. This phase aims to identify the problem that the research seeks to solve.

The problem investigation phase is critical in DSRM, as it lays the foundation for the subsequent phases of the research. By identifying the problem and analyzing its causes and requirements, the researcher can develop an effective solution that meets the needs of the stakeholders.

The participants of this study, as previously discussed, are KPMG clients, specifically hospital clients. KPMG is a global professional firm that provides Audit, Tax, and Advisory services and is one of the big

four accounting organizations, along with Ernst & Young (EY), Deloitte, and PricewaterhouseCoopers (PWC). The healthcare industry was selected for this research, and interviews will be conducted with hospital clients during the problem investigation phase. The objective of this phase is to identify the issues faced by the hospital in its risk assessment process. Through the interviews, the researcher aims to gain insights into the hospital's risk assessment practices, identify any weaknesses or inefficiencies in the process, and understand how velocity could be used to improve the process. The findings from this phase will inform the subsequent phases of the research, namely the solution design and solution validation phases.

## 1.7. Solution Design Phase

The solution design phase is the second phase of the Design Science Research Methodology (DSRM) by Wieringa (2014). In this phase, the researcher formulates a solution to the problem identified in the problem investigation phase. The researcher utilizes the results of the problem investigation phase and creates a design of the solution. The solution design is based on the requirements and constraints gathered during the problem investigation phase. The solution design must also follow the design principles established by Wieringa (2014), which are relevance, novelty, utility, and feasibility. The solution design is then evaluated in the next phase, the solution validation phase.

The solution design phase of Wieringa's DSRM is the stage where the researcher designs and creates a solution or solution to the identified problem. The steps involved in this phase are specifying requirements, determining how these requirements contribute to the goals, exploring available solutions, and designing new solutions if necessary.

The first step in the solution design phase is specifying requirements. This involves defining the necessary features or characteristics that the solution must have in order to address the identified problem. These requirements should be specific, measurable, achievable, relevant, and time-bound (SMART).

The next step is determining how these requirements contribute to the goals. In this step, the researcher must analyze the requirements and identify how they will help achieve the desired goals. This step ensures that the proposed solution is aligned with the research objectives and will ultimately provide a solution to the identified problem.

The third step is exploring available solutions. The researcher must identify any existing solutions that address the identified problem and evaluate their effectiveness. This step may involve a review of the literature, as well as consulting with experts or practitioners in the field. In this step, discussions will be conducted with risk professionals specializing in internal and external audit, both within the Netherlands and internationally. The purpose of these interactions is to gain a deeper understanding and relevance in relation to the implementation of the proposed solution, while also serving as a source of inspiration for its development (Eisenhardt & Graebner, 2007). The discussions will span a structured period of three months, with the specific topics to be covered depending on their relevance and the outcomes of the interviews conducted during the problem investigation phase.

The discussions will involve the participation of the following professionals:

- Assistant Manager of the Risk Department at Deloitte Indonesia
- Head of the Internal Audit Department at Astra International Indonesia

- IT Audit Manager at KPMG Netherlands
- IT Audit Senior Consultant at KPMG Netherlands

Through the engagement with professionals from different organizations and backgrounds, both within and outside of the Netherlands, these discussions serve to gather valuable insights and perspectives. This will contribute to a more comprehensive understanding of the proposed solution and facilitate its further development and refinement.

Designing a new solution will be the final step in the solution design phase. If no existing solution is suitable for addressing the identified problem, the researcher requires to design a new solution. This includes developing a new solution that fulfill the specified requirements and contributes to achieving the desired outcomes. The new solution must be rigorously tested and evaluated to ensure its effectiveness in addressing the identified problem.

In this phase, the researcher will set the requirements for the solution in accordance with the findings from the previous phase, especially from the conducted interviews. These requirements will be analyzed to determine on how they will contribute to achieving the research goal, hence proving if the implementation of velocity could help solve the problems faced by companies in their risk assessment process.

The researcher will find available solutions that could potentially overcome the issues encountered by the selected study case, which in this case, is the hospital once the requirements are established. The solution may be in the forms of frameworks, matrices, or guidelines that have been implemented by other organizations to address similar problems. Afterwards. the researcher will develop a comprehensive list of these solutions, outlining their pros and cons.

In case no existing solution to be found effective in addressing the issues, the researcher will propose a new solution according to the identified requirements. The final deliverables in this phase will be a set of guidelines designed for hospitals and potentially other organizations in the Netherlands to embed velocity into their risk assessment process. The researcher will also utilize ArchiMate to visualize the process of the risk assessment process by different stakeholders leading to a higher quality of deliverables.

In summary, solution design phase is a crucial step in the DSRM as it aims to create a solution that can address the identified problem in the most effective and efficient way possible. The phase ensures that the requirements of the solution are well-defined and aligned with the research goal while also exploring all available solutions and designing a new solution if necessary.

## 1.8. Solution Validation Phase

Solution validation is the last phase in the DSRM by Wieringa. This phase aims to validate the effectiveness of the designed solution or solution to solve the identified problem. The validation is done by evaluating the solution against the requirements defined in the Solution Design phase.

The Solution Validation phase involves four main steps. The first step is to evaluate the effectiveness of the designed solution or solution based on the predefined criteria in the requirements. This evaluation includes testing and validating the designed solution with real-world data and scenarios to ensure its efficiency in solving the problem.

The second step is to evaluate the impact of the designed solution on the organization or system. This includes analyzing the effect of the solution on the stakeholders, processes, and resources involved. The aim of this step is to ensure that the solution is sustainable and has a minimal negative impact on the system.

The third step is to evaluate the quality acceptance of the solution. This involves testing the ease of use of the solution by the stakeholders and users involved in the system. The aim of this step is to ensure that the solution is user-friendly and can be adopted by the organization without significant difficulties.

The final step is to validate the solution against the performance indicators defined in the requirements. The performance indicators are used to measure the success of the solution in achieving the goals and objectives defined in the problem statement. The validation is done by comparing the actual performance of the solution with the predefined performance indicators.

Once the solution validation is completed, the researcher can evaluate the overall effectiveness of the designed solution and make recommendations for further improvements or modifications. The deliverables in this phase are a validated solution or solution, along with a report documenting the validation process and the results obtained.

In the solution validation phase of the DSRM by Wieringa, the aim is to validate the developed solution by testing it in a real-world environment. The deliverables developed in the solution design phase will be implemented in the case study organization, which in this research is the hospital. The validation process will involve two parts, internal and external validation.

Internal validation will involve stakeholders from the first hospital being interviewed in the problem investigation phase. The purpose of this validation process is to investigate whether the implementation of the developed solution is useful for the organization to mitigate or solve the issues they have with their risk assessment process. This will provide insight into the effectiveness of the developed solution and whether it is applicable within the context of the organization.

External validation will involve interviewing stakeholders from other organizations, such as other hospitals or organizations outside of the Netherlands. The purpose of this validation process is to investigate whether the developed solution is generic enough to be implemented outside of the case study organization. This will provide insight into the potential applicability of the developed solution in other contexts.

To ensure consistency in the data collected from the validation process, a structured interview will be used. A list of questions will be sent to the interviewees before the interview process. There are a set of answers being prepared, and the interviewees can explain their reasoning behind choosing every answer if they wish. This approach will allow the researcher to extract the same responses from different interviewees coming from different organizations.

Finally, the results of the interviews will be analyzed further for evaluation according to DSRM by Wieringa. This will involve analyzing the data collected from the interviews to assess the effectiveness and applicability of the developed solution. The findings of the validation process will be used to refine the developed solution further and to identify any areas for improvement.

# CHAPTER 2
## RELATED STUDIES

## 2.1. Related Studies

An overview of current research in risk assessment and enterprise architecture is given in this chapter. The use of velocity in risk assessment and enterprise design, which was discovered through a separate, systematic literature review document, is the particular focus of this chapter. Velocity is a term used to describe both the rate of risk events and the response time. This chapter aims to point out the gaps and restrictions in the current body of knowledge and propose prospective areas for further study.

There are numerous sections in the chapter. The first section briefly introduces enterprise architecture and risk assessment, emphasizing their significance in guaranteeing an organization's success. In the second portion, the idea of velocity is introduced and discussed with risk assessment and enterprise architecture, as well as its significance in the current, quickly evolving corporate world. The final section examines the research on applying velocity to risk assessment and enterprise design, highlighting current trends, knowledge gaps, and research constraints. The chapter ends with an overview of the significant discoveries and suggestions for additional study.

This chapter will answer the following sub-research question: **1.1 - What is the state-of-art on velocity in the risk assessment process?**

## 2.2. Overview of Risk Assessment and Enterprise Architecture

Risk is a concept that has been defined differently by various scholars and standardization bodies. Rosa (1998) defines risk as a situation or event where something of human value, including humans themselves, has been put at stake and where the outcome is uncertain. ISO (2002) defines risk as a combination of the probability and scope of the consequences. IRGC (2005) defines risk as an uncertain consequence of an event or activity related to something of human value. Campbell (2006) states that risk is equal to expected damage. Finally, ISO (2009) defines risk as the effect of uncertainty on objectives.

The various definitions of risk highlight the importance of uncertainty and the potential for negative outcomes that can impact something of value to humans. The definitions also stress the need to consider the likelihood and potential consequences of uncertain events. These definitions can serve as a foundation for understanding and managing risk in various domains, including health and safety, finance, and project management. By considering these definitions, risk managers can better identify, assess, and mitigate risks to protect human value and achieve their objectives.

Risk assessment is a crucial process in risk management that involves identifying, analyzing, and evaluating the potential risks that an organization may face. Tzanakakis (2021)posits that risk assessment is composed of three main components, namely risk identification, risk analysis, and risk evaluation. Risk identification is the process of identifying all possible risks that an organization may face. It involves identifying the sources of the risks, the events that may trigger them, and the potential consequences of the risks. Risk analysis, on the other hand, involves analyzing the identified risks to determine the likelihood and severity of the consequences. This is done by considering the probability of the risk occurring and the potential impact of the risk. Finally, risk evaluation involves determining the acceptability of the risks and the most appropriate response to the risks.

According to Manzano et al. (2020), risk assessment is a critical component of an overall risk management strategy. It involves introducing control measures to eliminate or reduce any potential risk-related consequences. After identifying the potential risks an organization may face, the next step is to analyze and

evaluate them. This allows organizations to develop appropriate control measures to address the identified risks. These control measures can range from eliminating the risk entirely, reducing the likelihood or impact of the risk, or accepting the risk.

Based on the literature reviewed regarding the risk velocity within the quantitative and qualitative analysis, in addition to impact and likelihood, several emerging variables can be used to calculate the risk score, as portrayed in Table 1. Visibility is an example of a variable used to identify fraud or risk before a company can respond and prevent damage to its reputation (Grove & Clouse, 2020). A good example of visibility is the risk of a cybersecurity attack on a company, which the number of similar risk occurrences in social media can quantify. These additional variables demonstrate the need for a more comprehensive approach to risk management that goes beyond the traditional impact and likelihood assessment.

**TABLE 1 MEASUREMENT UNITS OF RISK VARIABLE**

| No. | Variable Name | Unit | Description |
|---|---|---|---|
| 1. | Impact | amount of financial loss | The impact is measured by the financial consequences of the risk to the organization. |
| 2. | Likelihood | # of probability | The likelihood is determined by the number of times a similar risk has occurred in the past, or the probability of risk will occur (if it has never occurred before). |
| 3. | Velocity | time | Velocity refers to the time it takes for a risk to materialize and cause harm to the organization. |
| 4. | Visibility | # of occurrence | Visibility is assessed by the number of times similar risks have been reported on the internet or social media. |

Examples of each variable are presented in Figure 7, while the example of visibility does not exist within the current literature study documents. All of these definitions of variables may vary depending on the organization's scale and conditions.

| Impact Scale | | |
|---|---|---|
| Rating | Description | Definition |
| 5 | Very High | Impact on net income by more than 2 millions |
| 4 | High | Impact on net income by between 1 and 2 millions |
| 3 | Moderate | Impact on net income of between 500,000 and 1 million |
| 2 | Low | Impact on net income of between 100,000 and 500,000 |
| 1 | Very Low | Impact on net income of less than 100,000 |

| Likelihood Scale | | |
|---|---|---|
| Rating | Description | Definition |
| 5 | Very High | Probability of the event occurring once within a three-year period is >50% |
| 4 | High | Probability of the event occurring once within a three-year period is 30 to 50% |
| 3 | Moderate | Probability of the event occurring once within a three-year period is 15 to 30% |
| 2 | Low | Probability of the event occurring once within a three-year period is 5 to 15% |
| 1 | Very Low | Probability of the event occurring once within a three-year period is <5% |

| Velocity Scale | | |
|---|---|---|
| Rating | Description | Definition |
| 5 | Very High | Very rapid onset, little or no warning, instantaneous, days |
| 4 | High | Onset occurs in a matter of days to a few weeks |
| 3 | Medium | Onset occurs in a matter of several months |
| 2 | Low | Onset occurs in a matter of one year |
| 1 | Very Low | Very slow onset, occurs over 3 years or more |

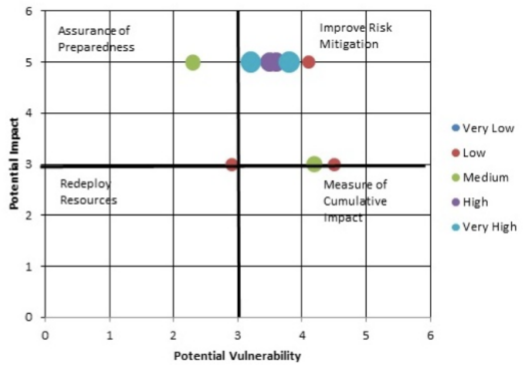



**FIGURE 7 IMPACT, LIKELIHOOD, AND VELOCITY SCALE WITH A MARCI RISK MATRIX (CHAPARRO, 2014).**

Enterprise Architecture (EA) is a discipline that has gained significant attention in recent years due to its ability to facilitate business transformation and improve overall organizational performance. According to Jonkers et al. (2006), EA is defined as a "coherent whole of principles, methods, and models that are used in the design and realization of the enterprise's organizational structure, business processes, information systems, and infrastructure." This definition highlights the importance of EA in ensuring that various components of an organization work together cohesively to achieve business goals.

On the other hand, Foorthuis, Steenbergen, Brinkkemper, and Bruls (2016) describe EA more from a process-based angle, defining it as "a set of high-level views and norms that guide the coherent design and implementation of processes, organizational structures, information provision and technology within an organization." This definition emphasizes the role of EA in providing guidance for the design and implementation of various components of an organization.

Overall, both definitions emphasize the importance of EA in ensuring the alignment between an organization's various components and its overall business objectives. EA provides a holistic approach to organizational design and ensures that all aspects of the organization are optimized to achieve maximum efficiency and effectiveness. It is an essential tool for organizations seeking to improve their business processes, information systems, and overall infrastructure.

The relationship between risk assessment and enterprise architecture has been extensively explored in the literature. Various management aspects, such as operations, financial, quality, human resources, project, investment, and human resources management, have been recognized as essential components of an

organization (Aldea, Vaicekauskaite, Daneva, & Piest, 2021). To address risks in these aspects, risk assessment methods that involve architecture models have been developed. One such method involves using EA frameworks, such as The Open Group Architecture Framework (TOGAF), as well as ArchiMate, to provide a structured approach to identifying and analyzing risks within an organization. Furthermore, risk assessment is a crucial element in the EA resilience by design method, where it is incorporated as one of the five essential steps (Jedynak & Bąk, 2021).

## 2.3. The Concept of Velocity in Risk Assessment

Drawing from the analysis of seven papers for the velocity of risk assessment from the literature review that has been conducted, the concept of velocity of risk has been found to be delineated into three distinct categories. Predominantly, the literature describes the velocity of risk as the temporal dimension of the duration during which a risk manifests its impacts on an organization (Alfandi, 2015). Additionally, two studies delineate the velocity of risk as the pace at which a risk event occurs without specifically highlighting its impact and the time required to take corrective measures (Chaparro, 2014). Furthermore, a single study depicts the risk velocity as the span of the risk time (Carroll, ARM, CPHRM, Charney, & ... 2020).

The following table elaborates on how the literature describes the definition, objective, and how to quantify risk velocity.

**Table 2 Definition, Objective, Scale, and Calculation of Risk Velocity in Literature**

| | |
|---|---|
| Definition | - How long until the company experiences some type of impact? (Levine, 2013)<br>- Rate of movement of risk from where we stand today to either the cause of a risk event (time to cause/ TTC) or its impact (time to impact/ TTI). (Chaparro, 2014)<br>- Time for risk to manifest itself. The time that passes between the occurrence of an event and the point at which the company first feels its effects. (Alfandi, 2015)<br>- Time lag originates in the gap between risk occurrence and the following impact of it. (Stanislav, 2016)<br>- The pace at which a certain risk or event causes the devaluation of an asset. (AlAli, 2020)<br>- The speed of action or of an event occurring, the time in which you have to take action, realize the outcome of a risk occurring, or the duration of the event. (Carroll et al., 2020)<br>- The speed with which a particular risk occurs or the time it would take for the risk to impact the company. (Grove & Clouse, 2020) |
| Objective | - Highlight exposure to risks and define the time to react should the particular risk begin to manifest. (Levine, 2013)<br>- various attributes of risk can be reflected in the risk quantification and management prioritization. Also, the incorporation of the velocity of risk in the assessment of risk events helps to improve the risk prioritization process |

| | |
|---|---|
| | and subsequent development of adequate response planning. (Alfandi, 2015)<br>- Aimed to give organizations an understanding of appropriate moments to risk responding. (Stanislav, 2016)<br>- To manage risk (Naviza, Sehgal, Cherrington, & Mehdipour, 2021)<br>- provide precision and relevance to risk assessments. (R, Kattumannil, & ... 2022) |
| Scale | - Defined on a scale of 5, ranging from very high to very low. Very high means very rapid onset with little to no warning, and very low is defined as very slow onset and occurs every three years or more. (Suresh, Sanders, & Braunscheidel, 2020)<br>- Defined on a scale of 5, ranging from very high to very low. Very high means very rapid onset, in a matter of <1 month, and very low means very slow onset, occurs over six months or more. (Alfandi, 2015) |
| Presentation/ Calculation | - Presented in the 3D model as a z-axis beside probability (x-axis) and impact (y-axis) (Chaparro, 2014)<br>- Risk = (probability x impact) + velocity (Alfandi, 2015)<br>- Risk = Likelihood + velocity x impact (Carroll et al., 2020) |

## 2.4. State of the Art in Velocity of Risk Assessment

The velocity of risk goal has two primary functions when used in risk analysis. To prioritize risks, it is first utilized to assess the accuracy and significance of each risk (R et al., 2022). The second and more crucial step is the velocity of risk, which defines an adequate response time for the detected danger (Levine, 2013). Organizations can better grasp the urgency and potential impact of different risks by including risk velocity in risk analysis. This will enable them to allocate resources and plan appropriately to reduce or respond to the risks.

A scale with five distinct levels, from very high to very low, is frequently used to quantify risk velocity. According to two sources that were looked at, this category is based on how quickly the risk manifests itself at each level. According to one body of research, "very high" refers to a danger that manifests itself exceptionally quickly and with little to no notice, and "very low" refers to a risk that manifests itself every three years or more and manifests itself very gradually (Suresh et al., 2020). According to other research, "very high" refers to a risk that manifests quickly in less than a month, while "very low" refers to a risk that manifests gradually over at least six months (Alfandi, 2015).

## 2.5. Velocity in Enterprise Architecture

The connection between risk and enterprise architecture has been widely recognized as an essential component of various management aspects, such as operations, financial, quality, human resources, project, investment, and human resources management (Aldea et al., 2021). Additionally, the integration of risk assessment is a crucial element in the EA resilience by design method, where it is incorporated as one of the five essential steps (Jedynak & Bąk, 2021). Based on the results of this literature review, it is apparent that the number of scholarly publications on risk management in the context of enterprise architecture is insufficient, given the significance of this subject within organizations.

In conclusion, to answer the previously stated sub-research question **What is the state-of-art on velocity in the risk assessment process?** The literature review revealed a lack of literature on the velocity of risk in enterprise architecture. While there is an extensive body of research on resilience related to risk assessment, enterprise architecture, and emergency situations, the velocity of risk has not been previously explored in the context of enterprise architecture. While some literature on the velocity of risk in the context of COVID-19 exists, it is relatively limited.

However, the few studies that did examine velocity usually recommend that businesses include velocity as a major consideration in their risk-assessment procedures, along with factors like likelihood and impact. When discussing risk management, the term "velocity" refers to the rate or speed at which a risk can materialize and have a negative impact on a company. One study emphasized the significance of considering velocity when discussing cyber security threats because these risks can spread and inflict damage at a rate that is frequently significantly faster than other types of risks. Another study stressed the necessity of real-time monitoring and response capabilities for firms to quickly address hazards. The overall findings of velocity in risk assessment indicate that businesses shouldn't ignore this crucial element in their risk assessment strategies, even though the research on velocity in relation to EA is still in its early stages. Organizations can better predict and react to risks that have the potential to materialize fast and cause considerable damage by incorporating velocity into their risk assessment processes.

The lack of literature in this area represents an opportunity for future research to explore the relationship between the velocity of risk and enterprise architecture and to develop new risk assessment methods specifically for emergencies in organizations.

# CHAPTER 3

# PROBLEM INVESTIGATION (CASE STUDY)

## 3.1. Case Study

This chapter's objective is to offer a case study that was undertaken with one of the largest hospitals in the Netherlands, a KPMG client. The case study is an important part of this research because it offers a practical setting for examining the problems with the velocity of risk in the hospital's risk assessment procedure.

The problem investigation stage of this study, which involved a thorough interview with the hospital's risk management staff, is described in this chapter. This interview aims to determine the hospital's problems with its risk assessment procedure and how the speed of risk affects the process' efficacy. This research intends to offer advice for hospitals and other organizations in the Netherlands to enhance their risk assessment process by embracing the notion of velocity of risk by examining the data from this case study. In the following stages of this research, the findings of this case study will also be used to confirm the efficacy of the suggested guidelines.

In addition to the objectives outlined above, this chapter makes use of the following queries to help readers understand the difficulties and complexities involved with risk assessment in a hospital setting:

**What are the key challenges that hospitals came across during their risk assessment process?**

**What are the steps in the risk assessment process in a hospital?**

**What are the elements used in a hospital risk assessment?**

## 3.2. Case Study Overview

With more than 227,000 experts collaborating to provide value in 146 countries, KPMG is a global network of professional businesses offering Audit, Tax, and Advisory services. One of the KPMG member firms in the Netherlands is KPMG Netherlands, a professional service provider that provides a broad range of services, such as audit, tax, and consulting services, to a variety of clients there. The company works in many different industries, including healthcare, financial services, public administration, energy and natural resources, and many more. KPMG Netherlands is dedicated to offering top-notch services and cutting-edge solutions that assist its clients in achieving their business goals and building lasting value (KPMG, 2023).

With a broad clientele across numerous industries, including healthcare, KPMG Netherlands is a top provider of professional services in the Netherlands. KPMG works with organizations as a consulting firm to offer cutting-edge solutions to difficult business problems. Hospitals, which have special issues in relation to risk management and enterprise architecture, are among its clients in the healthcare sector. This study focuses on a large hospital in the Netherlands that is one of KPMG's clients in order to look into the problems they have with their risk assessment process and how enterprise architecture may be used to enhance their risk management procedures.

The name of the hospital cannot be revealed in this study to protect the privacy and confidentiality of the facility under inquiry. The hospital is one of the biggest in the Netherlands, and it is connected to a public university that has a specific research department, so it's crucial to remember that. This hospital has a sizable workforce of more than 12,000 workers and is a level 1 trauma center. The hospital has enlisted KPMG's assistance in resolving a few problems with its risk assessment procedure. The goal of this study is to examine the hospital's risk assessment procedure and find any potential problems or shortfalls that may be fixed using enterprise architecture and risk management principles.

## 3.3. Problem Investigation Phase

This chapter's subchapter gives a thorough overview of how the research's problem inquiry phase was carried out. This phase's main goal is to compile data on the risk assessment procedure in the Netherlands' chosen hospital.

To achieve this aim, a semi-structured interview was conducted with the risk manager of the hospital. However, before proceeding with the interview, a feasibility analysis was conducted to ensure that the hospital had sufficient data for the research. Short interviews were conducted with KPMG staff, and the IT audit division was approached for recommendations. As they were not in charge of reviewing their clients' risk assessment files, they recommended financial auditors.

Four financial auditors were approached, and one client was identified for the research. Three confidential risk assessment files from different periods were obtained, which provided insight into the hospital's risk assessment templates.

With the necessary information, the hospital was chosen as the case study for this research. An email was sent to their risk manager seeking permission to participate in the research, and the request was granted.

Based on the purpose of the interview, a list of questions was drafted to cover the following:

1. Process of risk assessment within the organization,
2. identification of issues within the process, and
3. the extent of the interviewee's knowledge about the velocity of risk.

Appendix 1 covers the interview questions in more detail. A semi-structured interview with the hospital's risk manager was done in order to look into the issue of risk assessment within a level 1 trauma hospital in the Netherlands. Before the interview, a list of questions covering the primary topics of interest, such as the risk assessment method, issue identification within the process, and the level of the interviewee's knowledge of the velocity of risk, was developed. In order to make the interview process easier, the questions were divided into five categories.

1. **Introduction of the company:** Understanding the hospital's primary procedure and stakeholders is the goal of the first category of questions. This included inquiries regarding the organizational structure, goals, and principal parties participating in the risk assessment process of the hospital. The interviewer could better grasp how the risk assessment process fits into the hospital's overall operations by being familiar with the hospital's overall structure and procedures.
2. **Knowing the process:** The second group of inquiries centered on knowing how the hospital's risk assessment procedure is carried out. This includes inquiries regarding the risk assessment tools and procedures, the stakeholders' roles and duties, and the frequency of risk assessments. The interviewer could find any probable flaws or problems in the hospital's risk assessment procedure by comprehending the procedure.
3. **Risk appetite in the company:** The final group of questions tries to comprehend stakeholder communication and the significance of risk assessment inside the hospital. Questions were asked regarding the risk manager's responsibility for informing other stakeholders of the risk assessment results and how those results are applied to the decision-making process. The interviewer could

find potential holes or problems in the hospital's risk communication strategy by comprehending the communication process.

4. **Challenge:** The hospital had difficulty conducting risk assessments, which was the emphasis of the fourth group of inquiries. They inquired about any restrictions or limitations that might affect the risk assessment procedure and any data gathering or analysis difficulties. The interviewer could learn more about potential areas for development in the hospital's risk assessment procedure by recognizing these difficulties.
5. **Velocity of risk:** The last group of inquiries sought to ascertain the risk manager's perspective and familiarity with risk velocity. Questions were asked regarding the risk manager's comprehension of how risk might fluctuate over time and the hospital's readiness to respond to changes in risk. The interviewer could better comprehend the hospital's overall risk management plan by understanding the risk manager's perspective on risk velocity.

In summary, the semi-structured interview with the hospital's risk manager aimed to provide a comprehensive understanding of the hospital's risk assessment process, identify any potential gaps or issues, and gain insight into the hospital's overall risk management strategy. The interview questions were carefully crafted and categorized to ensure that all key areas of interest were covered, providing valuable insights into the hospital's approach to risk assessment and management.

## 3.4. Interview Results

Based on the interview performed with the risk manager, the following answers are extracted. Detailed answers are available in Appendix 2.

1. **Introduction of the company:**
   The interview results suggested that there is no patent information about the main business process in the hospital, but the interviewee informed that the hospital's main processes revolve around providing care for patients, including intensive care, surgeries, diagnostic processes such as blood and CT scans, as well as operational departments, such as the emergency room. Difficulty in defining the main processes within the hospital is also one of the issues faced by the risk manager, which will be elaborated on in the challenge, section 4 of the interview.

   The main risks related to strategic risk were identified as a lack of staff (nurses and other support staff) in terms of both quantity and quality, which the job market or diseases could influence. Other risks mentioned included electricity and utilities (energy, water), IT issues (monitoring in intensive care and patient data monitoring), and continuity of medical devices such as MRI scans and facilities.

   Given that the hospital is a first-line trauma hospital in the Netherlands, there are many stakeholders involved, including both internal and external stakeholders. Internal stakeholders include doctors (in 50 departments), the board of directors, and department directors, while external stakeholders include patients, health insurance providers, and safety organizations.

   In summary, the hospital's main processes were identified as providing care for patients, including intensive care, surgeries, diagnostic processes, and operational departments. Finally, the identified

risks mainly revolve around staff shortages, utilities, IT issues, and medical device continuity, with many stakeholders from both internal and external being involved in the risks.

2. **Knowing the process:**
   Based on the interview, it was found that the hospital has two kinds of risk assessments which are the strategic risk assessment and the prospective risk assessment (in Dutch, Prospectieve Risico-Inventarisatie/ PRI). Strategic risk assessment mainly focuses on enterprise-level risks, while PRI focuses more on the well-being of the patients' (Veiligheidsprogramma, 2012). It was explained that the strategic risk assessment process consists of five steps which are identification, analysis, prioritization, control, and evaluation. The process starts with identifying the risks based on the hospital's annual goals, then analyzing and prioritizing them by calculating their impact and likelihood. The risk assessment is then controlled and evaluated, and it is continuously updated annually to ensure that it is in line with the latest best practices and company goals.


**FIGURE 8 RISK MANAGEMENT PROCESS IN THE CASE STUDY**

The risk assessment process within the hospital is based on the bowtie method. This method defines the possible risks in the middle part, with the right and left sides representing the impact and root cause, respectively. Moreover, the impact and likelihood are also considered mandatory elements for prioritizing the risks, particularly for PRI, which will be explained further in the next section of the interview (risk appetite in the company). The hospital ensures that the risk assessment process is continuously updated to the changing environment and risks by conducting the process annually.

3. **Risk appetite in the company:**

Based on the interview results, there are differences between strategic risk assessment and Prospective Risk Assessment (PRI) in terms of risk assessment appetite. The hospital has a strategic risk assessment process that prioritizes risks based on which objective of the hospital's strategy will accept the least deviation. This is a departure from the previous approach of prioritizing based on probability and impact. The strategic risk assessment process involves brainstorming with several representatives for each strategic objective, and the responsible managing directors and the Board of Directors review the outcome of the brainstorms.

On the other hand, the PRI process is focused on the well-being of patients, and it prioritizes risks based on probability and impact. The main employees responsible for or part of the process are involved in the PRI process. This differs from the strategic risk assessment process, which involves representatives from several departments and is reviewed by higher management.

4. **Challenges:**

Risk managers face several challenges in the risk assessment process within the hospital. One of the significant challenges is the impact of external events on the hospital, such as the Ukraine conflict, Brexit, and the COVID-19 pandemic, which have had a massive impact on the organization in the last five years. These unexpected situations can significantly affect the organization's ability to deliver services and achieve its strategic objectives. Five years ago, the pandemic risk was not considered, and this has revealed a significant gap in the hospital's risk management approach.

Another challenge risk managers face is the complexity of defining the main (core and supporting) processes within the hospital. The hospital has numerous dependencies between its core and supporting processes, such as IT systems, making it challenging to define its main business processes. Specifically, defining IT processes is a challenge due to the high number of information systems used.

In addition, some risks may appear quickly, and the hospital may be insufficiently prepared due to a lack of attention. Although the hospital can react quickly to risks, its size requires an appropriate approach, similar to a large company. Calamities such as earthquakes can impact the hospital, including building damage and a large influx of patients. These risks require a comprehensive risk management approach to ensure the hospital is prepared to mitigate their impact.

5. **Velocity of risk:**

The risk manager attempted to categorize the top risks faced by the hospital into different levels of velocity. According to the risk manager's classification, the risk of lack of staff and capacity has a low velocity, indicating that it is a slowly developing risk that can be mitigated over a longer period. The risk of concentration of cure was categorized as having a medium velocity, indicating that it is a risk that may develop at a moderate pace, requiring some immediate attention. The financial risk also has a medium velocity, indicating that it is a risk that may take some time to develop but could have a significant impact on the hospital's financial stability. Finally, the risk associated with the

operating and control model was classified as having a low velocity, indicating that it is a risk that can be addressed over a longer period.

Classifying risks into different velocity levels provides useful insights into how the hospital can prioritize its risk management efforts. By focusing on risks with higher velocities, the hospital can proactively take steps to prevent or mitigate the impact of these risks before they become too severe. On the other hand, risks with lower velocities can be addressed over a longer period, allowing the hospital to allocate its resources effectively.

It should be noted that categorizing risks into different velocity levels is not an exact science and might be subjective. However, it can give a valuable framework for risk managers to prioritize risks and allocate resources efficiently. Overall, the risk manager's attempt to categorize the hospital's key hazards into various velocity levels is a helpful start toward successful risk management.

The results from the interview can help in answering the following sub-research questions:

**What are the key challenges that hospitals came across during their risk assessment process?**

Several issues with the hospital's risk assessment procedure were highlighted during the interview with the risk manager. They are divided into two categories: external issues and internal issues.

One of the hospital's external challenges was the Ukraine conflict, which produced substantial geopolitical uncertainty in the region. The conflict directly influenced the hospital's supply chain because part of the medical supplies was imported from Ukraine. Aside from the Ukraine conflict, Brexit and COVID-19 pandemic also impacted the hospital's risk assessment procedure. These unforeseen circumstances necessitated a quick response from the hospital's risk management team.

Internal challenges experienced by the hospital, on the other hand, were related to the complexity of defining the main and supporting processes within the institution. There were several dependencies between the main and supporting processes, like IT systems. This made identifying the primary business operations that needed to be prioritized in the risk assessment process difficult.

Furthermore, the hospital confronted the problem of some dangers emerging quickly and the hospital being unprepared to deal with them. This was mostly due to the hospital's size, which necessitated a strategy akin to that of a huge corporation.

**What are the steps in the risk assessment process in a hospital?**

There are two types of risk assessment in the hospital, namely strategic risk assessment and prospective risk assessment, with the details portrayed in Table 3. The risk assessment process for both types of assessments consist of five generic steps.

1. The first step is to identify possible risks, which is performed by correlating the risks based on the hospital's annual goals.
2. The second step involves analyzing the likelihood of the risk occurring, determining its root cause, and assessing its possible impact.

3. The third step is prioritization, which involves ranking risks based on their score. For PRI, impact and likelihood are used as criteria for prioritization, while the company's objective is used for strategic risk assessment.
4. The fourth step involves implementing controls that have been defined to mitigate or solve the risk.
5. The final step is evaluation, which entails monitoring the risk and updating the risk assessment process annually to ensure that it is in line with the latest best practices and company goals.

**TABLE 3 STRATEGIC AND PROSPECTIVE RISK ASSESSMENT IN THE HOSPITAL**

| Topic | Strategic Risk Assessment | Prospective Risk Assessment (PRI) |
|---|---|---|
| Scope | Enterprise-level risks | Patients care |
| Department | Risk management | Crisis organization |
| Prioritization | Based on the company's objective | Based on likelihood and impact calculation |
| Stakeholders Involvement | Brainstorms are done with several representatives for each objective of the hospital's strategy. The outcome is then discussed and reviewed by the responsible managing directors and the Board of Directors. | Main employees, i.e., doctors, IT, and nurses, who are responsible or who are part of the process. |

**What are the elements used in a hospital risk assessment?**

In the hospital risk assessment template, the main elements used are as follows:

1. Risk events: This refers to the potential events or situations that may lead to negative outcomes for the hospital.
2. Root cause: This element is used to identify the underlying factors or reasons that may lead to the occurrence of a risk.
3. Impact: This element is used to assess the potential consequences or effects of a risk on the hospital, including its patients, staff, and operations.
4. Likelihood: This element is used to estimate the probability of a risk occurring based on past events or available data.
5. Control/solution plan: This element refers to the measures or actions that can be taken to mitigate or manage the identified risks, including the strategies to be implemented, responsible parties, and timelines for completion.

By utilizing these elements, the hospital risk assessment template can help the hospital to identify, evaluate, and manage risks effectively in order to minimize negative impacts and ensure the safety and well-being of its patients and staff.

# CHAPTER 4

# SOLUTION DESIGN

In the Design Science Research Methodology (DSRM), the solution design phase is a crucial step in addressing the problem identified in the problem analysis phase. This phase aims to develop a solution that effectively and efficiently solves the identified problem. In order to achieve this goal, the solution design phase must follow a structured process that considers the specific requirements and constraints of the problem. This chapter will present the solution design phase of the DSRM, which includes the steps of formulating design requirements, creating design alternatives, and selecting a preferred design. The chapter will also discuss the importance of evaluating the design solution to ensure its effectiveness and usability.

Apart from the aforementioned points, a set of questions has been formulated to assist in the development of solutions to tackle the challenges identified in the hospital's risk assessment process:

**How and to what extent can risk assessment be captured by enterprise architecture models such as ArchiMate?**

**What are the key components of the guidance for capturing and analyzing velocity in ArchiMate enterprise architecture models for risk assessment in a hospital?**

## 4.1. Requirements

Based on the insights gathered from the previous chapter, it is important to identify and document the specific requirements that the proposed solution must fulfill. In the context of the hospital risk management case study, the key requirements include the need for a risk assessment process that consists of both strategic and prospective risk assessments. The strategic risk assessment must define and prioritize risks based on the organization's objectives, while the risk prioritization must be based on impact and likelihood scores. These requirements form the basis for the development of the proposed solution, which must address the identified issues while meeting the specific requirements of the hospital risk management process.

## 4.2. Solution Design

The proposed solution design follows the Wieringa Design Science Research Methodology (DSRM) framework. This ensures that the design is relevant to the previously defined requirements. The solution incorporates the differentiation between strategic and prospective risk assessment processes to address specific organizational needs.

Wieringa's DSRM emphasizes the novelty of the proposed solution, indicating that it brings innovative elements to the field of risk assessment. To ensure the usability of the solution, extensive research was conducted, including a thorough analysis of current available guidance and frameworks. Additionally, interviews with risk practitioners from various businesses and organizations were conducted to gather insights and incorporate practical perspectives into the solution design.

The insights gained from discussions with risk professionals, internal audit, and external audit professionals are summarized in Table 4 below. These discussions took place in the form of non-structured interviews, conducted during the solution design phase of the thesis. The insights obtained from the discussions have been incorporated into the proposed solution and are presented in the subchapters of the solution design chapter, since discussions with key informants are considered valuable for developing in-depth understanding of complex process and for generating insights (Eisenhardt & Graebner, 2007).

**TABLE 4 DISCUSSION RESULTS WITH RISK & AUDIT PRACTITIONERS**

| No. | Participants | Discussion Points |
|---|---|---|
| 1. | Risk Department Assistant Manager Deloitte Indonesia | - The individual responsible for conducting risk assessment should be the owner of the respective business process.<br>- Visualizing both core and support processes is crucial in the risk assessment process.<br>- The utilization of a 5x5 matrix is recommended for assessing risk variables.<br>- The implementation of the new framework should be carried out in a phased approach.<br>- Risk assessment cycle is performed annually. |
| 2. | Internal Audit Manager Astra International Indonesia | - There is a need for research to be conducted to ensure that organizations remain updated with current risk trends and developments.<br>- Risk assessment process need to be updated as regularly as possible. However, the assessment of overall risk events needs to be performed annually.<br>- The utilization of a 5x5 matrix for assessing risk variables should be considered. |
| 3. | IT Audit Manager & Senior Consultants KPMG Netherlands | - It is imperative to conduct validations of the proposed solution with other businesses to ensure its applicability and effectiveness.<br>- Clients of KPMG usually perform their risk assessment process once every year.<br>- The participants helped by reviewing on the overall proposed solutions. |

Feasibility was a critical consideration during the development of the solution. A timeline of implementation was created to estimate the time required to implement the solution in an organization. This provides organizations using the guidance with a clear understanding of the implementation process.

The framework consists of two main process frameworks, as depicted in Figure 9. The first framework is a single-use process framework, followed by an annual and ad hoc process framework. Both frameworks are iterative, drawing inspiration from the continuous improvement process of PDCA (Plan, Do, Check, Act) and the project management principles outlined in the PMBOK (Project Management Book of Knowledge).

The renowned COSO ERM framework and ISO 31000 standard played a significant role in inspiring the development of this framework. Specifically, the concept of establishing a foundation before initiating the annual iterative process of risk assessment at the enterprise level is derived from these frameworks.

Addressing the issue raised in the previous interview regarding the lack of formal visualization of business processes, the importance of business processes as the basis for risk event definition is highlighted in ISO 31000. Similarly, the COSO ERM framework emphasizes the significance of establishing a foundation, including defining business processes, to ensure the completeness of risk assessment. Consequently, business process visualization has been incorporated into the single-use process framework of this guidance, utilizing ArchiMate as the primary tool for visualizing enterprise-level business process architecture.

In this study, the proposed solution is presented in the form of two frameworks, namely the single-use process framework and the annual & ad-hoc process framework, as portrayed in Figure 6. The single-use process framework aims to address two major issues identified in the hospital's current risk assessment process.

- Firstly, the main and supporting business processes have not been defined.
- Secondly, there is no connection between the strategic and prospective risk assessment processes.

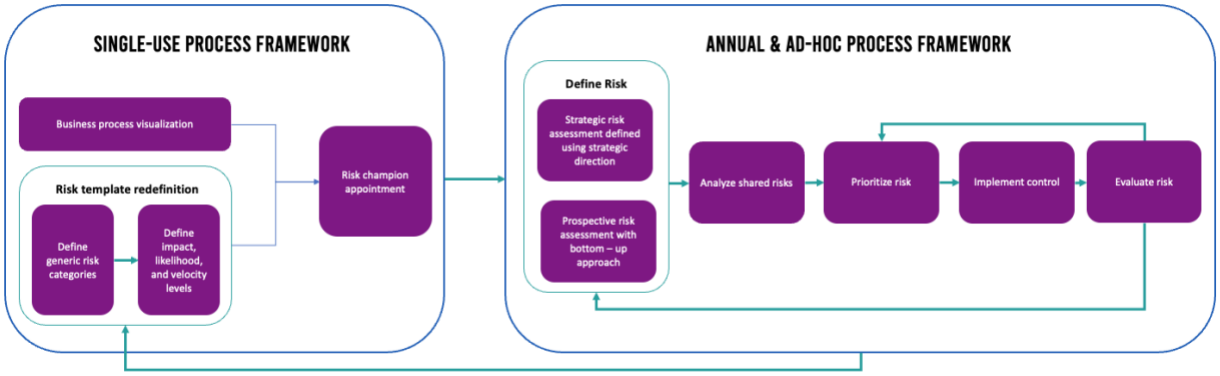



**FIGURE 9 HOSPITAL RISK ASSESSMENT GUIDANCE**

The single-use process framework is designed to enable the hospital to conduct a smoother annual risk assessment process, ensuring a more complete and reliable risk assessment. The single-use process framework consists of four processes:

- Business process visualization,
- Risk template redefinition, which consists of defining the levels of impact, likelihood, and velocity, as well as defining generic risk categories, and
- Appointment of risk champions.

The single-use process framework will enable the organization to conduct a smoother annual risk assessment process, where there will be an assurance of a more complete and reliable risk (Fraser, 2014).

In the annual and ad-hoc process framework, the hospital risk assessment process was designed based on the current method utilized. This framework follows the generic 5-step risk assessment process of defining, analyzing, prioritizing, implementing controls, and evaluating the risk (Fraser, 2014). The main difference is observed in the analysis process, where both strategic and prospective risk managers share their risk assessment results from the define phase to identify risks that complement each other's document. This shared risk is then evaluated and prioritized to ensure the hospital's overall risk profile is accurately represented. The annual and ad-hoc process framework serves as a continuous improvement process to identify and address new risks that emerge over time.

### *4.2.1. SINGLE-USE PROCESS FRAMEWORK*

Fraser contends that a framework must be established before beginning the annual risk assessment process to provide a more prosperous and efficient assessment. A systematic method for detecting, evaluating, prioritizing, and controlling risks is provided by frameworks. They create a common approach that all

parties adhere to, guaranteeing the consistency and thoroughness of the risk assessment process. Frameworks ensure that risks are recognized and assessed in the context of the organization's mission and goals, which helps to connect risk management with the hospital's strategic objectives.

Professionals in risk and auditing who were interviewed for this study advise using frameworks in risk management. For instance, the COSO framework offers a thorough internal control structure, including risk assessment. Any company can use the risk management framework provided by the ISO 31000 standard. The NIST Cybersecurity Framework provides a risk-based strategy for managing cybersecurity risks. This framework is specifically created as a simplified version for enterprises to integrate velocity as another component in their risk assessment process, using these frameworks as a basis and qualitative research with risk professionals.

The suggested framework for risk assessment can be used by organizations other than hospitals that must incorporate risk assessments of operational and strategic risks. However, it is crucial to have a clear definition of the primary and supporting business processes, as well as each of their goals, to guarantee that all significant risks are recognized and evaluated. With this method, the business may thoroughly understand its whole risk profile and use that understanding to guide its risk management decisions. Therefore, businesses must consider implementing this framework to increase their risk management capabilities and risk assessment process.

In this section, we'll go over how to apply business process visualization to firms dealing with problems akin to those in the study case. The purpose of this advice is to assist firms in adequately defining and visualizing their business processes. However, this advice can be used as a foundation for firms who have already defined and illustrated their business processes to analyze or enhance their current business process architecture. It is simpler to see possible dangers and increase process efficiency by visualizing the business process. Literature like Jacka and Keller's (2009) emphasis on visualizing company processes for spotting possible inefficiencies and raising customer satisfaction lends credence to this strategy.

In his article, Myers (2022) explains that regardless of an organization's size, there are only 4-8 core processes or "value chains." These core processes have strategic importance and a major impact on the organization's success. They are essentially operational and do not manage or provide internal services. If performed well, they enable excellent service delivery; however, if they are ineffective, inefficient, or not managed, they could pose a major strategic weakness. These characteristics of core processes are also highlighted in Harmon (2002) as portrayed in Figure 11. These processes are visualized under a different name by Weske (2007) in Figure 10. Defining main and supporting business processes and their objectives ensures that no important risk is left undefined and allows organizations to have an integrated risk assessment between operational and strategic risks while analyzing their current business process.

In his article on business process classification, Winton Myers also identified the presence of supporting and management processes in organizations, in addition to core processes. Supporting processes are designed to assist core processes in delivering value by providing resources and infrastructure. The characteristics of supporting processes are, they add value to internal customers but not directly to external customers, often cross-functional boundaries, and are associated with functional areas of the organization.

Supporting processes can be critical and strategic to the organization as they affect the ability to execute core processes effectively. On the other hand, management processes ensure that core and supporting

processes run smoothly. These processes do not add direct value to customers and are usually internal, but they are necessary for the organization to operate efficiently. Understanding the different types of business processes can help organizations evaluate and improve their process structures.


**FIGURE 10 LEVELS OF BUSINESS PROCESSES - "BUSINESS PROCESS MANAGEMENT: CONCEPTS, LANGUAGES, ARCHITECTURES" BY MATHIAS WESKE**

In the field of business process visualization, primitive visualization tools that visualize departments of an organization instead of the business process itself are often used, which are commonly referred to as organization charts. However, according to audit and risk professionals, business processes are best visualized in an organization's standard operating procedure documents, which specifically define the standard process, subprocess, and activity within an organization. The correlation between core business processes (value chain), business processes, subprocesses, tasks, and activities can be visualized using

various tools such as flowcharts, BPMN, swim lanes, and value stream maps, depending on the organization's needs.

In contrast, Archimate has a unique perspective and is specifically designed to be used in the framework presented in this study case. This tool enables the hospital to map different views of not only the process but also the goals, constraints, stakeholders, and detailed IT systems connected to the process, making it a valuable asset in answering the issues identified in the study case.

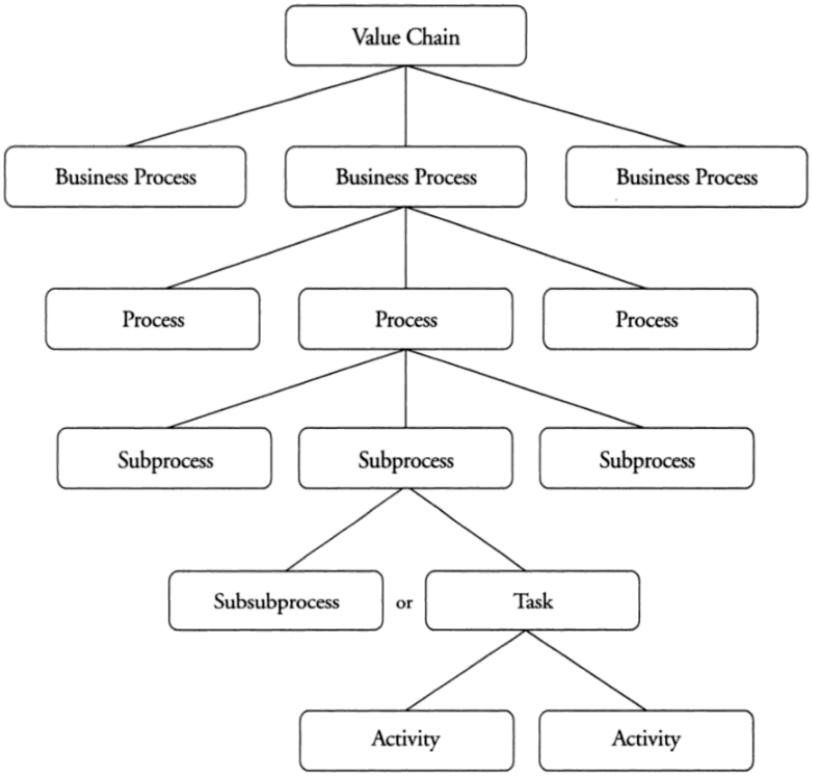



**FIGURE 11 GENERIC HIERARCHY OF PROCESSES (HARMON, 2002)**

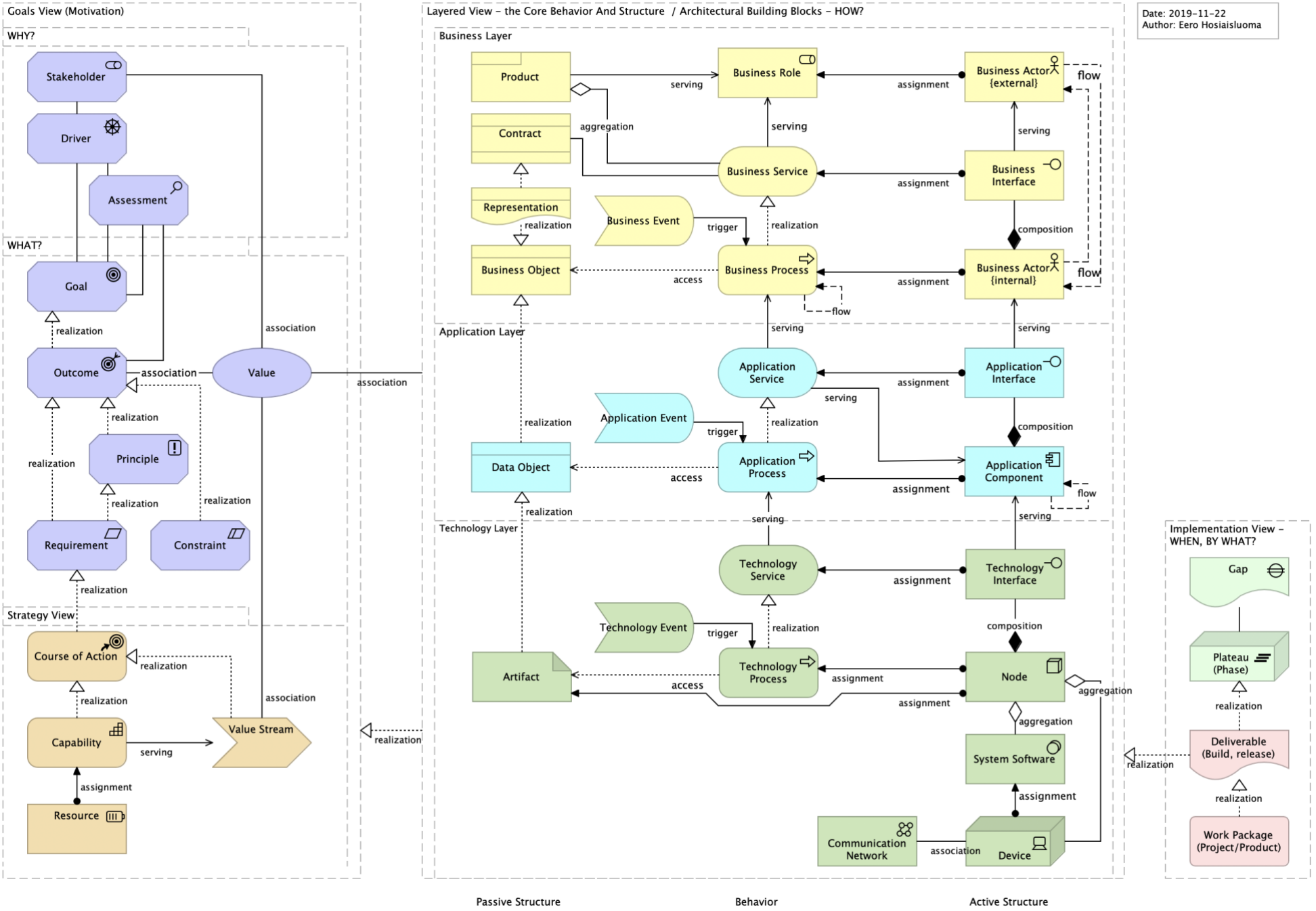



FIGURE 12 ARCHIMATE METAMODEL (HOSIAISLUOMA, 2021)

In utilizing ArchiMate, organizations can gain a comprehensive understanding of the interconnection between various aspects of their processes and monitor their relationships. In the case of hospitals, this tool enables them to map out the correlation between the hospital's strategic objectives and operational or patient care processes. The conceptual view of the utilization of ArchiMate is demonstrated in Figure 12, which portrays the ArchiMate metamodel (Hosiaisluoma, 2021). This metamodel includes various components, such as the business layer, application layer, and technology layer, which serve to define the different aspects of the organization's architecture. The utilization of ArchiMate in this framework can help organizations gain a more in-depth understanding of their processes, streamline operations, and make more informed decisions.

In Figure 13, the visualization of the core, supporting, and management processes of the hospital are presented. The hospital's strategic goals and values are depicted in the motivation layer, while the main business process is presented in the business layer. The main process involves patient care, which is carried out through emergency, intensive care, surgeries, and diagnostic processes. These processes are supported by the hospital system, which has various interfaces. Additionally, the application system component has its own flow as it is a complex hospital application system with its own main and supporting processes. The internal audit process is portrayed as a management process that ensures the hospital achieves its annual goals and conducts audit activities for the main and supporting business processes of the hospital.

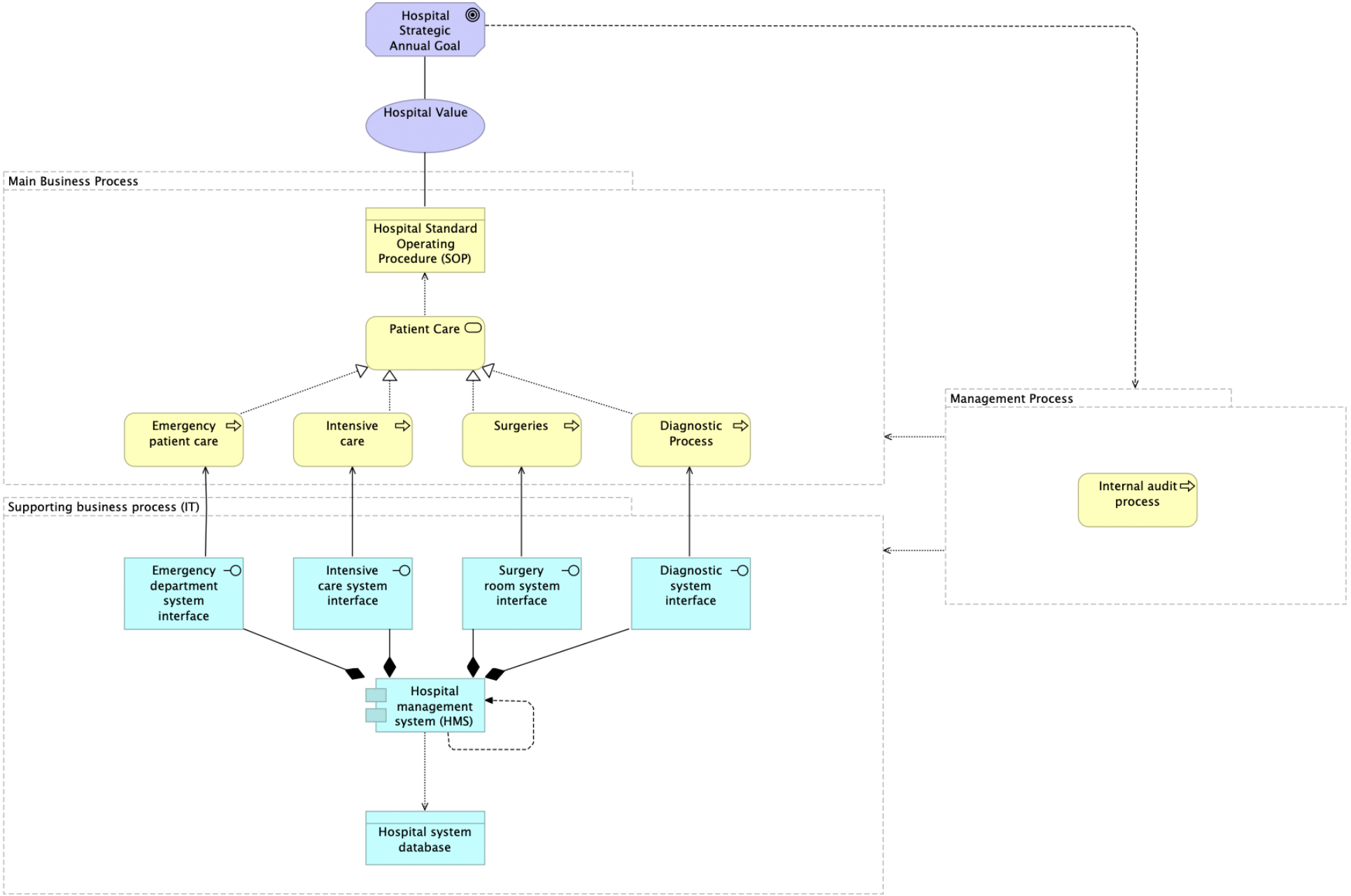



FIGURE 13 ARCHIMATE DIAGRAM OF THE MAIN, SUPPORTING, AND MANAGEMENT PROCESSES OF THE STUDY CASE

In the context of risk management based on the discussion with risk department assistant manager of Delloitte Indonesia presented in Table 4, it is suggested that the responsibility of leading the risk management process does not have to be solely designated to the risk management department. Rather, it is recommended that the leader of this process should be someone from the business side of the organization, whether it be from the operational or strategic planning department. This individual would have a better understanding of the organization's overall goals, objectives, and strategies and would be better equipped to align the risk management process with these goals. Additionally, this approach could help in promoting risk management as a part of the organization's culture, as opposed to being viewed as a separate function.

A redesigned risk template inside the organization must be emphasized to apply the framework effectively. This entails evaluating the risk assessment template's state and locating potential improvement areas. Several self-evaluation questions should be taken into account to do this. One of the most critical questions is how the organization ensures that all significant risks have been identified and addressed. The organization should also review the utilized matrix and the factors employed in the risk assessment process. This entails having explicit knowledge of the rationale for using particular variables, such as likelihood and impact, and whether other variables, such as velocity, should be included in the calculation.

The company should also consider the degrees of identification for each variable, whether a three-by-three, five-by-five, or other formats, and ensure they have a reasonable justification for their chosen level. Finally, it's critical to evaluate whether the variables are consistent across the organization and defined across all departments using the same technique. By thoroughly examining these factors, the business can ensure its risk assessment process is efficient and consistent with its overarching goals.

If an organization does not have all the previously mentioned points figured out or clearly defined, then the following tips might be useful. The risk manager of the organization should execute this particular step of the framework. In this study case, the risk managers will be addressed as “risk experts” and consist of risk managers of both strategic and operational risk department managers.

Within this process, there are mainly two things that they need to redefine. Firstly, they need to define the risk library in the organization (Malfussi et al., 2018). The risk library should consist of a comprehensive list of generic risk topics that have been and will be used repeatedly in the risk assessment process of the organization (in this case, the hospital). Secondly, they must standardize impact, likelihood, and velocity levels for the risk assessment. This is important so that the hospital has the same understanding and quantification when they define the risk in the risk assessment process. This activity is also crucial so the hospital can visualize the risk matrix.

In the process of defining the risk library, it is crucial to identify and categorize the risks that are relevant to the organization. Risk categories serve as a framework to classify risks based on their nature and characteristics (WHO, 2009). For a hospital, various risk categories can be considered. Examples of different risk categories that are specifically relevant to a hospital are operational, clinical, or patient safety, strategic, financial, human capital, legal or regulatory, technology, and hazard risks (Partida, 2021). These risk categories provide a comprehensive list of potential risks that a hospital may face and serve as a starting

point for developing a risk management program. By categorizing risks, the risk manager can ensure that all risks are identified and assessed properly and that the risk assessment process is comprehensive.

The framework's next stage focuses on standardizing the impact, likelihood, and velocity thresholds for risk assessment. A 5-level matrix is preferable than a 3-level matrix, according to qualitative discussions with risk professionals given in Table 4 since it allows greater flexibility in defining the level of risk. In a 5-level matrix, businesses can choose levels 4 or 2 to avoid the extremes, while levels 1 and 5 are reserved for very low and very high risks, respectively. Standardizing these levels is critical because it allows the business to have a shared understanding and quantification of risks, which aids in the visualization of the risk matrix.

Impact and likelihood are two significant factors in risk assessment that are frequently used to define the level of risk. The impact can be defined based on a variety of elements, including financial, company reputation, and other relevant factors particular to the organization or industry. The likelihood, on the other hand, is often assessed by the chance or potential of a risk event occurring based on historical data.

This approach highlights the significance of considering velocity as a third component of risk, impact, and likelihood. The velocity of a risk occurrence is an important issue to examine since it can substantially impact the organization's ability to respond successfully to the risk. By incorporating velocity into the risk assessment process, the business can acquire a complete knowledge of the amount of risk and its possible impact on the organization.

| Velocity Scale | | |
|---|---|---|
| Rating | Description | Definition |
| 5 | Very High | Very rapid onset, little or no warning, instantaneous, days |
| 4 | High | Onset occurs in a matter of days to a few weeks |
| 3 | Medium | Onset occurs in a matter of several months |
| 2 | Low | Onset occurs in a matter of one year |
| 1 | Very Low | Very slow onset, occurs over 3 years or more |

**FIGURE 14 VELOCITY LEVELS (CHAPARRO, 2014)**

According to the literature research, velocity is an important dimension to be added to the organization's risk assessment process. Two ways to quantify velocity in a risk assessment have been proposed in the literature. Chaparro (2014) define velocity on a scale of 5, ranging from very high to very low. A very high velocity means a very rapid onset with little to no warning, while a very low velocity means a very slow onset and occurs every three years or more.

| Velocity | Score | Description |
|---|---|---|
| **Very low** | 0.1 | Very slow onset, occurs over 6 months or more |
| **Low** | 0.3 | Onset occurs in a matter of 4-6 months |
| **Moderate** | 0.5 | Onset occurs in a matter of 2-4 months |
| **Significant** | 0.7 | Onset occurs in a matter of 1-2 month |
| **Very high** | 0.9 | Very rapid onset, in a matter of <1 month |

**FIGURE 15 RISK VELOCITY LEVELS (ALFANDI, 2015)**

On the other hand, Alfandi (2015) defines velocity on a scale of 5, ranging from very high to very low. A very high velocity means a very rapid onset, in less than one month, while a very low velocity means a very slow onset, occurring over six months or more. Including velocity in the risk assessment process can provide additional value and depth to the organization's understanding of its risks.

To determine the level of velocity in a risk assessment, it is important for an organization, such as a hospital, to conduct quantitative research on medical and hospital-related risks based on the discussion with Internal Audit Manager of Astra International Indonesia (Table 4). This research should be used to divide risks into five different categories for velocity. Once the research is completed, the findings should be discussed with the main stakeholders of the hospital to verify the relevance and accuracy of the velocity categories for the hospital. While the literature does not provide clear guidance on deciding the velocity level, this approach would allow hospitals to quantify better and understand the velocity of risks, providing a more comprehensive and accurate risk assessment.

In the next step, the organization needs to determine how they want to calculate the overall risk score by taking into account the defined levels of impact, likelihood, and velocity. This calculation will then be used to create the risk matrix. There are two main methods described in the literature for this purpose. The first method involves calculating the time to cause (TC) and time to impact (TI) (AuditBoard, 2020). TC is calculated by multiplying the sum of likelihood and velocity by impact, while TI is calculated by multiplying the sum of impact and velocity by likelihood. The total risk score can be calculated by averaging TC and TI using the formula ((TC+TI)/2). Although this method involves multiple calculations, it provides a comprehensive understanding of the risk profile.

The second method, proposed by Alfandi, is a simpler calculation method that involves multiplying impact, likelihood, and velocity together using the formula (impact * likelihood) + velocity. This method may be more suitable for organizations that are transitioning from the traditional impact * likelihood calculation to the incorporation of velocity into their risk assessments. Ultimately, the organization needs to determine which method works best for their needs based on their specific risk assessment objectives and priorities. Considering the study case, this thesis will implement the formula by Alfandi to develop the risk matrix visualized in the Table 5 below.

## TABLE 5 RISK SCORE MATRIX WITH VELOCITY

| | | | Likelihood x Impact | Velocity | Likelihood x Impact | Velocity | Likelihood x Impact | Velocity | Likelihood x Impact | Velocity | Likelihood x Impact | Velocity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Likelihood | Almost Certain | 5 | 5 | +0,5 | 10 | +0,5 | 15 | +0,5 | 20 | +0,5 | 25 | +0,5 |
| | | | | +0,4 | | +0,4 | | +0,4 | | +0,4 | | +0,4 |
| | | | | +0,3 | | +0,3 | | +0,3 | | +0,3 | | +0,3 |
| | | | | +0,2 | | +0,2 | | +0,2 | | +0,2 | | +0,2 |
| | | | | +0,1 | | +0,1 | | +0,1 | | +0,1 | | +0,1 |
| | Likely | 4 | 4 | +0,5 | 8 | +0,5 | 12 | +0,5 | 16 | +0,5 | 20 | +0,5 |
| | | | | +0,4 | | +0,4 | | +0,4 | | +0,4 | | +0,4 |
| | | | | +0,3 | | +0,3 | | +0,3 | | +0,3 | | +0,3 |
| | | | | +0,2 | | +0,2 | | +0,2 | | +0,2 | | +0,2 |
| | | | | +0,1 | | +0,1 | | +0,1 | | +0,1 | | +0,1 |
| | Moderate | 3 | 3 | +0,5 | 6 | +0,5 | 9 | +0,5 | 12 | +0,5 | 15 | +0,5 |
| | | | | +0,4 | | +0,4 | | +0,4 | | +0,4 | | +0,4 |
| | | | | +0,3 | | +0,3 | | +0,3 | | +0,3 | | +0,3 |
| | | | | +0,2 | | +0,2 | | +0,2 | | +0,2 | | +0,2 |
| | | | | +0,1 | | +0,1 | | +0,1 | | +0,1 | | +0,1 |
| | Unlikely | 2 | 2 | +0,5 | 4 | +0,5 | 6 | +0,5 | 8 | +0,5 | 10 | +0,5 |
| | | | | +0,4 | | +0,4 | | +0,4 | | +0,4 | | +0,4 |
| | | | | +0,3 | | +0,3 | | +0,3 | | +0,3 | | +0,3 |
| | | | | +0,2 | | +0,2 | | +0,2 | | +0,2 | | +0,2 |
| | | | | +0,1 | | +0,1 | | +0,1 | | +0,1 | | +0,1 |
| | Very Unlikely | 1 | 1 | +0,5 | 2 | +0,5 | 3 | +0,5 | 4 | +0,5 | 5 | +0,5 |
| | | | | +0,4 | | +0,4 | | +0,4 | | +0,4 | | +0,4 |
| | | | | +0,3 | | +0,3 | | +0,3 | | +0,3 | | +0,3 |
| | | | | +0,2 | | +0,2 | | +0,2 | | +0,2 | | +0,2 |
| | | | | +0,1 | | +0,1 | | +0,1 | | +0,1 | | +0,1 |
| | | | 1 | | 2 | | 3 | | 4 | | 5 | |
| | | | Low | | Medium | | High | | Very High | | Catastrophic | |
| | | | Impact | | | | | | | | | |

**Risk Score Legends**

- Very Low
- Low
- Medium
- High
- Extreme

**Velocity Legends**

| | |
|---|---|
| 0,5 | Very High |
| 0,4 | High |
| 0,3 | Medium |
| 0,2 | Low |
| 0,1 | Very Low |

To further implement the framework, I have also developed a risk assessment template incorporating the matrix so the hospital and other organizations can use it as a reference or a start to incorporate velocity into their risk assessment process.

The template has the main risk assessment, variable, matrix, and company objective sheets to input all necessary data. It has already incorporated the risk score calculation, as well as several automated visualizations, such as top 10 risks and bubble chart visualization.

In the case study, the identification of the main stakeholders has not been established. However, it has been determined that certain stakeholders, such as the board of directors and risk managers, are involved in the strategic risk assessment process, while doctors, nurses, and other related stakeholders are involved in the prospective risk assessment process.

Based on qualitative assessments by risk professionals (Table 4), a bottom-up approach is recommended for the operational risk assessment process within the hospital. Various literature sources have also supported this approach (Young & Coleman, 2010), as it provides greater accuracy and completeness in the risk assessment of an organization (Kenett & Raanan, 2011). Further details on this topic will be elaborated in the subsequent subchapter.

In order to proceed with the next step of the risk assessment process, the organization must appoint a risk champion. However, risk practitioners (Table 4) advised to do so only after the visualization of the business process of the organization has been completed. If the business process visualization takes longer than anticipated and the organization needs to implement the risk assessment framework, then the appointment of a risk champion can be made by selecting one from each department within the organization structure.

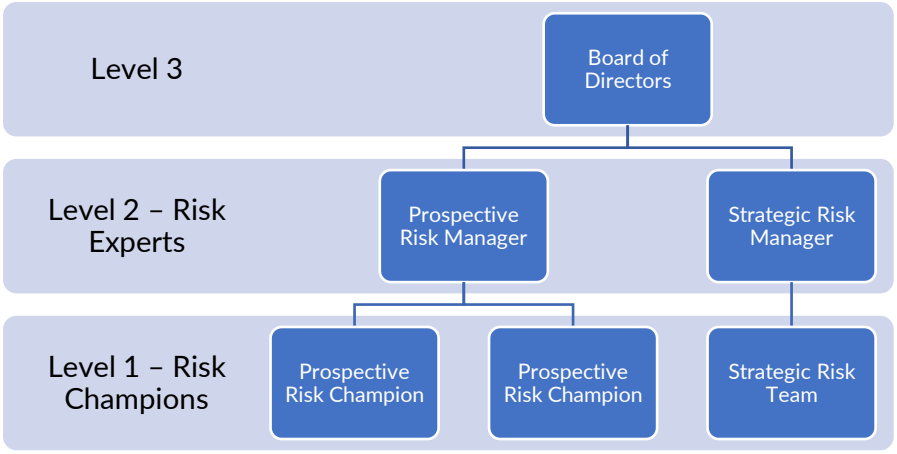



**FIGURE 16 RISK ASSESSMENT STAKEHOLDERS DIAGRAM**

Figure 16 depicts the visualization of stakeholders for risk assessment in this framework. Based on discussion with the risk professional in Table 4, it is advised for the prospective risk manager to appoint their own risk champions from the related stakeholders that are in the scope of the risk assessment.

However, it is also advised to do a piloting project with a small number of risk champions from the top main business process in the hospital.

The implementation of a bottom-up approach in the risk assessment process entails assigning prospective risk champions, such as process managers or process owners, the responsibility of assessing their own risks using the predefined risk assessment template developed by risk experts. Initially, the first year may pose challenges for the risk champions as they engage in the process of defining risks, identifying root causes, assigning risk scores, and establishing controls. However, the risk library will serve as a valuable resource, aiding them in their risk identification process and facilitating their understanding of risk appetite, as well as the risk tolerance established by the risk experts.

In accordance with Jean-Grégoire Manoukian's article on the Wolters Kluwer website (Manoukian, 2016), risk appetite refers to the level of risk an organization is willing to accept while pursuing its objectives prior to determining the need for any risk mitigation actions. Furthermore, the ISO Guide defines risk appetite as the "amount and type of risk that an organization is willing to pursue or retain." Conversely, risk tolerance, as defined by the Committee of Sponsoring Organizations of the Treadway Commission (COSO), reflects the acceptable level of variation in outcomes associated with specific performance measures linked to the objectives the entity seeks to achieve.

Once the risk champions have completed their respective risk assessments, they will submit their risk assessment documents to the prospective risk manager for review. During this review process, the prospective risk manager may extend invitations to the risk champions to engage in discussions regarding the underlying rationale behind their risk assessments. Through these discussions, the prospective risk manager aims to gain a comprehensive understanding of the risk assessments conducted by the risk champions. Subsequently, the prospective risk manager will take into account the inputs provided by the risk champions and proceed to finalize the risk assessment for the prospective risk assessment phase.

Conversely, strategic risk, by its very nature, is typically approached using a top-down methodology (Iverson, 2013). Based on an interview conducted with a risk manager from a hospital as part of the study's case, strategic risks are identified and defined by considering the uncertainties associated with the hospital's annual strategy. Consequently, individuals involved in the management process, such as those from finance, human resources, and treasury departments, are designated strategic risk champions. These champions play a crucial role in assessing risks that are specifically linked to their respective business processes and aligned with the organization's annual strategy.

Similar to the prospective risk assessment process, once the strategic risk champions have completed their risk assessments, the strategic risk manager will consolidate the findings and evaluate them to generate a comprehensive strategic risk assessment. This assessment will provide insights into the potential risks inherent in the hospital's strategic objectives and inform decision-making processes at the organizational level. By adopting a top-down approach, the hospital can effectively address strategic risks and develop appropriate risk mitigation strategies to safeguard its strategic goals and enhance overall resilience.

### *4.2.2. Annual & Ad-Hoc Process Framework*

Once the foundational elements of the risk assessment framework have been established, the focus shifts toward the annual process within the framework. This particular phase of the framework involves an iterative and regular approach tailored to the organization's capacity and preferred frequency for conducting

the process. Insights from discussions conducted with four risk experts indicate that their respective organizations typically engage in this process on an annual basis. Additionally, these organizations emphasize the importance of updating their risk assessment documents whenever significant updates or changes occur, thereby incorporating an ad-hoc process into their overall risk assessment framework. This iterative and adaptive approach ensures that the risk assessment remains relevant and responsive to evolving risks and organizational dynamics.

The annual and ad-hoc process framework for risk assessment in this study draws inspiration from the risk assessment process conducted in the hospital case study, which itself adapted steps from the ISO 31000 standard. The steps in this framework include defining, analyzing, and prioritizing risks, followed by implementing controls and continuous monitoring. However, some modifications were made to the define, analyze, and prioritize risk steps to accommodate the involvement of a newly defined role, the risk champion, as well as the incorporation of the velocity of risk in the assessment process.

The new annual risk assessment framework can be represented visually, as shown in the following image. The steps of defining risk align with the concept of risk identification in ISO 31000. The analysis of shared risks corresponds to the process of risk analysis while prioritizing risk aligns with risk evaluation. The implementation of controls mirrors the risk treatment phase, and the evaluation of risk corresponds to the monitoring and review stage. Notably, within the framework, the level of velocity is defined during the analyzed shared risk step, providing a unique perspective on risk assessment.

It should be noted that ISO 31000's risk identification phase involves identifying and defining risk events, which is followed by risk analysis to determine the levels of likelihood and impact associated with the identified risks. In this framework, the level of velocity is incorporated during the analyzed shared risk step, enhancing the understanding of risk dynamics.

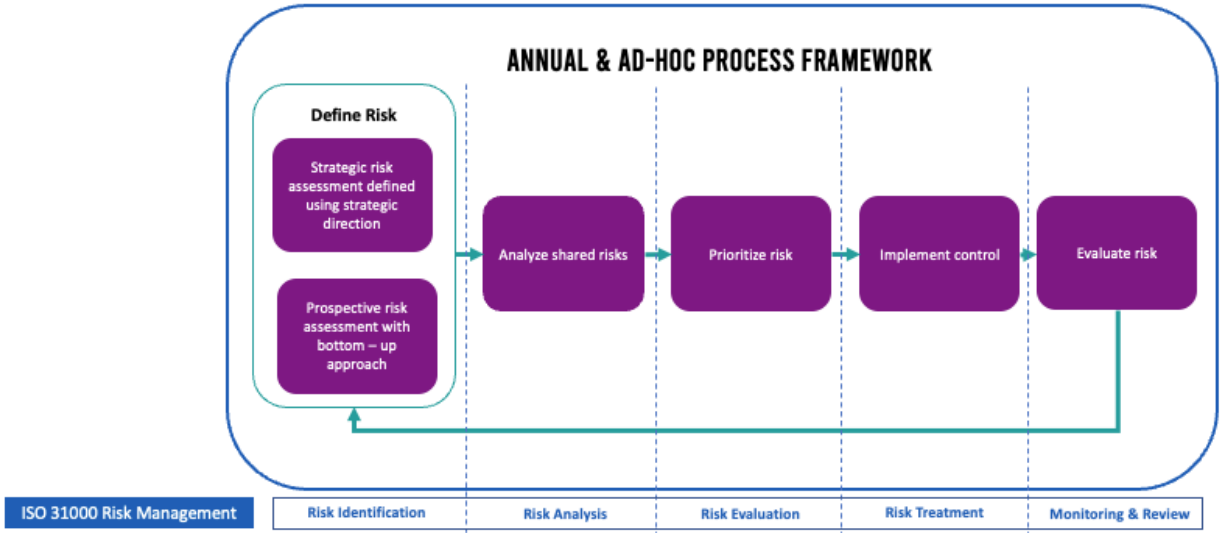



FIGURE 17 ANNUAL AND AD-HOC PROCESS FRAMEWORK COMPARED TO ISO 31000

To provide a more detailed explanation of the annual framework, the first step, "define risk," will be discussed. In this step, two processes are conducted simultaneously. Strategic risk champions define their risk events based on two primary sources: annual organizational goals and their own business processes,

utilizing a top-down approach. Simultaneously, prospective risk champions define risk events specific to their detailed business processes. Both groups of risk champions make use of a predefined risk library.

To visually depict this step, a template with an example risk library has been formulated for the hospital in the case study. The template includes multiple tabs, but for the current process, the focus will be on the first tab, called the "risk register," as shown in Figure 18 below. This tab comprises various columns, including number, risk type, company objectives, risk category, risk event, root cause, impact, likelihood, velocity, risk score, controls, department, risk owner, and director in charge.

During the "define risk" stage, the risk champions are responsible for filling in the risk event and root cause for each risk event based on the predefined risk categories and company objectives. Figure 21 provides an example of prospective risk within the client care process, specifically in the activity of flushing, care, and administration via peripheral and central venous access device assessment. The risk champions need to define the risk event that may occur within that category, such as a blocked catheter caused by catheter occlusion that hinders proper flushing.

| No. | Type | Company objectives 1 2 3 4 5 6 7 8 9 10 | Risk Category | Risk Event | Root Cause | Impact | Likelihood | Velocity | Risk Score | Controls | Department | Risk Owner | Directors in Charge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Strategic | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Not meeting mandatory training standards | Failure to meet or exceed minimum mandatory training standards in some areas leading to possible deficiencies in patient care and governance | 3 | 3 | 0,5 | 9,5 | Consistent improvement has been seen since mandatory training has been linked to appraisal/pay progression. Regular HR and workforce reports continue to show upward trend. Oversight by | Department4 | Risk owner4 | Director4 |
| 2 | Strategic | ☐ ☑ ☐ ☑ ☐ ☐ ☐ ☐ ☐ ☐ | Finance | Major internal or external incident causing harm to staff, patients or the public; or impacting on hospital's ability to maintain services | There are many possible incident types including fire, flood, power failure, gas leak, building collapse, terrorist threat etc. | 5 | 3 | 0,5 | 15,5 | The hospital has an emergency response policy. Business continuity plans are in place. Senior leaders receive briefings from the emergency planning lead as required | Department7 | Risk owner2 | Director2 |
| 3 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device | Potential for inoculation injury | Use of sharps | 3 | 2 | 0,4 | 6,4 | Follow procedure for inoculation injury, report any inoculation injury following incident reporting system | Department4 | Risk owner4 | Director4 |
| 4 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device | Determining correct flush in relation to type of catheter inserted | Type of catheter inserted e.g. open ended or closed | 4 | 5 | 0,4 | 20,4 | Two members of staff must check medication when carrying out this procedure; one being registered nurse. | Department4 | Risk owner4 | Director4 |

FIGURE 18 RISK REGISTER TAB OF RISK ASSESSMENT TEMPLATE

| No. | Type | Company objectives 1 2 3 4 5 6 7 8 9 10 | Risk Category | Risk Event | Root Cause |
|---|---|---|---|---|---|
| 1 | Strategic | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Not meeting mandatory training standards | Failure to meet or exceed minimum mandatory training standards in some areas leading to possible deficiencies in patient care and governance |
| 2 | Strategic | ☐ ☑ ☐ ☑ ☐ ☐ ☐ ☐ ☐ ☐ | Finance | Major internal or external incident causing harm to staff, patients or the public; or impacting on hospital's ability to maintain services | There are many possible incident types including fire, flood, power failure, gas leak, building collapse, terrorist threat etc. |
| 3 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device | Potential for inoculation injury | Use of sharps |
| 4 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device | Determining correct flush in relation to type of catheter inserted | Type of catheter inserted e.g. open ended or closed |
| 5 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device | Leakage of fluid | Catheter damage |
| 6 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device | Bacteraemia septicaemia | Local site infection or blood site infection |

FIGURE 19 TEMPLATE USED IN DEFINE RISK PROCESS

In the subsequent process, "analyze risk," the risk champions determine the levels of likelihood, impact, and velocity for each risk event. These levels are predefined by the risk experts and serve as a reference for the analysis. The determination of risk levels can be achieved through various approaches, including expert opinions and research.

For risks that have occurred in the past, the identification of likelihood, impact, and velocity can be based on historical data. The risk champions, being experts in their respective fields, possess a deep understanding of the risks involved. In cases where a risk event has not been encountered within their experience, they can conduct research with a focus on that specific risk event and make decisions based on the research findings.

By combining their expertise and conducting research, the risk champions are able to assess and assign appropriate levels to the likelihood, impact, and velocity of each identified risk event. This analysis process enhances the understanding of the potential risks and facilitates informed decision-making for subsequent risk management actions.

| Impact | Likelihood | Velocity | Risk Score | Controls | Department | Risk Owner | Directors in Charge |
|---|---|---|---|---|---|---|---|
| 3 | 3 | 0,5 | 9,5 | Consistent improvement has been seen since mandatory training has been linked to appraisal/pay progression. Regular HR and workforce reports continue to show upward trend. Oversight by mandatory training group | Department4 | Risk owner4 | Director4 |
| 5 | 3 | 0,5 | 15,5 | The hospital has an emergency response policy. Business continuity plans are in place. Senior leaders receive briefings from the emergency planning lead as required | Department7 | Risk owner2 | Director2 |
| 3 | 2 | 0,4 | 6,4 | Follow procedure for inoculation injury, report any inoculation injury following incident reporting system | Department4 | Risk owner4 | Director4 |
| 4 | 5 | 0,4 | 20,4 | Two members of staff must check medication when carrying out this procedure; one being registered nurse. | Department4 | Risk owner4 | Director4 |
| 2 | 2 | 0,4 | 4,4 | Always follow manufacturer's instructions for flushing catheter to maintain patency and when administering medication (if available) | Department4 | Risk owner4 | Director4 |
| 3 | 4 | 0,2 | 12,2 | Nurses to be aware of the signs and symptoms of local infection at skin site and systemic blood stream infections | Department4 | Risk owner4 | Director4 |

**FIGURE 20 TEMPLATE USED IN RISK ANALYSIS PROCESS**

Upon determining the risk variables, the next step involves defining the controls necessary to manage the identified risk events. This entails specifying the measures, procedures, or actions in place to prevent or mitigate the occurrence of the identified risks. Additionally, the responsible department, risk owners, and directors in charge need to be assigned to ensure the implementation and monitoring of these controls.

Once the risk champions have completed the definition of the comprehensive risk register, they will submit it to the respective risk experts based on their roles. The risk experts, comprising both the prospective and strategic risk managers, will consolidate the results of the risk assessments conducted by the risk champions. If needed, discussions may be held with the risk champions to clarify any details related to the risk register.

The template utilized will generate a compilation of the top 10 risks from the prospective risk analysis, strategic risk analysis, and a combined assessment of both. This allows for a concise overview of the most significant risks identified in the assessment process.

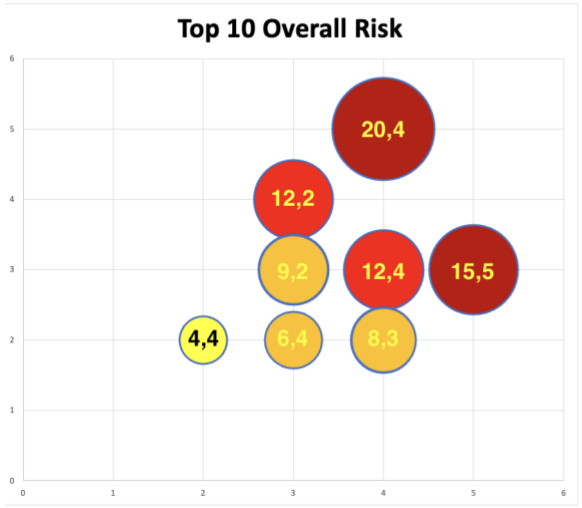
Subsequently, the risk experts will engage in discussions to review the outcomes of the risk assessment. During this review, they will explore the potential implementation of risks identified in one department into another. For instance, hazards such as pandemics or earthquakes, initially classified as strategic risks, may also be incorporated as risk events within the prospective risk assessment. However, it is important to note that a re-assessment of the root cause, risk score variables, controls, department assignments, as well as risk owners and directors in charge, will be conducted to ensure alignment with the respective departments.

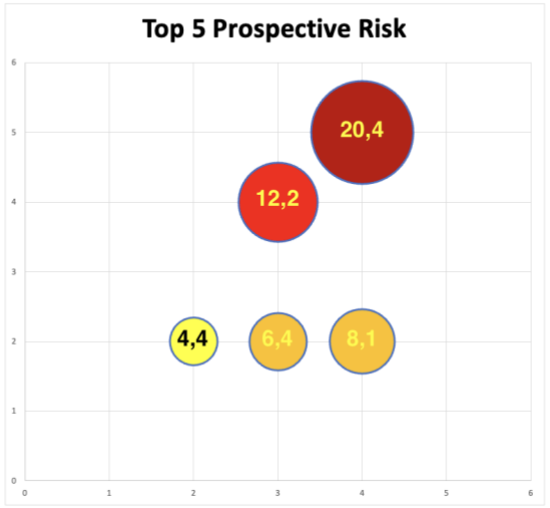
This collaborative process between the risk experts ensures a comprehensive evaluation of risks and facilitates the identification of potential cross-departmental risks that require coordinated risk management efforts.

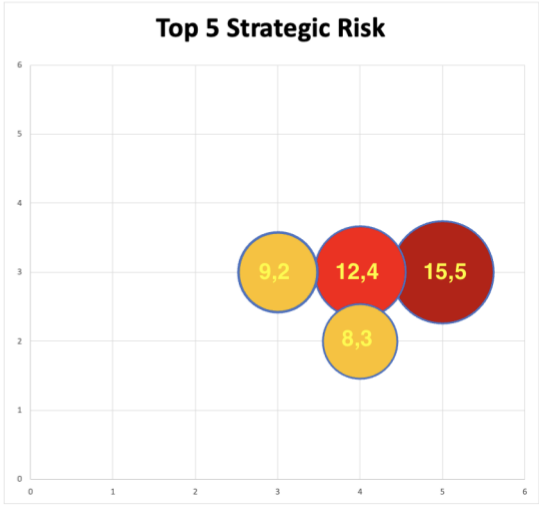
Subsequently, the risk experts proceed to prioritize the overall top 10 risks by merging the strategic and prospective risk assessments. This process involves considering the organization's annual strategy and the risk score results obtained from evaluating the impact, likelihood, and velocity variables. The template employed provides a visual representation of the top 10 risks using a bubble chart. The size of each bubble corresponds to the velocity level of the respective risk event, while the location of the bubbles reflects the likelihood and impact levels. Additionally, the dashboard includes a list of the top 10 risks ranked by velocity score, categorized as prospective, strategic, or overall. This enables a focused presentation of the risk events with high velocity but without explicitly defined likelihood and impact levels

# RISK ASSESSMENT DASHBOARD

09/07/23 17.18




## Top 10 Overall Velocity of Risk Events

| No | Risk Event | Root Cause | Velocity of Risk | Risk Score |
|---|---|---|---|---|
| 1 | Not meeting mandatory training standards | Failure to meet or exceed minimum mandatory training standards in some areas leading to possible deficiencies in patient care and governance | 0,5 | 9,5 |
| 2 | Major internal or external incident causing harm to staff, patients or the public; or impacting on hospital's ability to maintain services | There are many possible incident types including fire, flood, power failure, gas leak, building collapse, terrorist threat etc. | 0,5 | 15,5 |
| 3 | Potential for inoculation injury | Use of sharps | 0,4 | 6,4 |
| 4 | Determining correct flush in relation to type of catheter inserted | Type of catheter inserted e.g. open ended or closed | 0,4 | 20,4 |
| 5 | Leakage of fluid | Catheter damage | 0,4 | 4,4 |
| 6 | Failure to meet statutory obligations for management of our esatate and estate related issues, such as building or facilities compliance. | Complex multi site network, located in many buildings with ageing infastructure, with reliance on other organisations to undertake works, checks and provide assurance | 0,4 | 12,4 |
| 7 | Major IT systems failure which could seriously inhibit day to day function of the hospital | Potential for IT infrastructure failure from a number sources | 0,3 | 8,3 |
| 8 | Bacteraemia septicaemia | Local site infection or blood site infection | 0,2 | 12,2 |
| 9 | Back log of projects identified and difficulty recruiting certain departments | Contractors fill key roles. Recruiting to posts permanently. Temporary bank contracts to cover key projects. | 0,2 | 9,2 |
| 10 | Blocked catheter, patient not able to receive medication | Catheter oclusion not able to flush catheter | 0,1 | 8,1 |

## Top 5 Prospective Velocity of Risk Events

| No | Risk Event | Root Cause | Velocity of Risk | Risk Score |
|---|---|---|---|---|
| 1 | Determining correct flush in relation to type of catheter inserted | Type of catheter inserted e.g. open ended or closed | 0,4 | 20,4 |
| 2 | Potential for inoculation injury | Use of sharps | 0,4 | 6,4 |
| 3 | Leakage of fluid | Catheter damage | 0,4 | 4,4 |
| 4 | Bacteraemia septicaemia | Local site infection or blood site infection | 0,2 | 12,2 |
| 5 | Blocked catheter, patient not able to receive medication | Catheter oclusion not able to flush catheter | 0,1 | 8,1 |

## Top 5 Strategic Velocity of Risk Events

| No | Risk Event | Root Cause | Velocity of Risk | Risk Score |
|---|---|---|---|---|
| 1 | Major internal or external incident causing harm to staff, patients or the public; or impacting on hospital's ability to maintain services | There are many possible incident types including fire, flood, power failure, gas leak, building collapse, terrorist threat etc. | 0,5 | 15,5 |
| 2 | Not meeting mandatory training standards | Failure to meet or exceed minimum mandatory training standards in some areas leading to possible deficiencies in patient care and governance | 0,5 | 9,5 |
| 3 | Failure to meet statutory obligations for management of our esatate and estate related issues, such as building or facilities compliance. | Complex multi site network, located in many buildings with ageing infastructure, with reliance on other organisations to undertake works, checks and provide assurance | 0,4 | 12,4 |
| 4 | Major IT systems failure which could seriously inhibit day to day function of the hospital | Potential for IT infrastructure failure from a number sources | 0,3 | 8,3 |
| 5 | Back log of projects identified and difficulty recruiting certain departments | Contractors fill key roles. Recruiting to posts permanently. Temporary bank contracts to cover key projects. | 0,2 | 9,2 |

FIGURE 21 RISK TEMPLATE DASHBOARD

By combining both strategic and prospective perspectives, the prioritization process offers a comprehensive overview of the organization's top 10 risks for the given year. This approach ensures that risks aligned with the organization's annual strategy are considered alongside risks identified through detailed business processes. The visualization techniques employed in the template facilitate a clear understanding of the risk landscape, allowing stakeholders to identify critical risks and allocate appropriate resources for risk management and mitigation.

Following the risk prioritization, the subsequent step involves the implementation of controls to manage the identified risks. The controls specified in the risk assessment are crucial in addressing the risks through measures such as avoidance, transfer, mitigation, or acceptance. It is essential for this implementation process to align with the overall business process since controls become an integral part of the business operations. Hence, the involvement of risk champions, who are key stakeholders, is of utmost importance. They play a vital role in the risk assessment process and are responsible for implementing the controls. Moreover, they are the ones who will directly experience the impact of the risk if it materializes.

Throughout this phase, all stakeholders are accountable for monitoring and evaluating the risk assessment. If new risk trends emerge in relation to any business process, they must promptly update the risk assessment to reflect these developments. Similarly, if any member of the organization identifies inefficiencies in the controls implemented to manage the risk, they can propose adjustments to the risk experts. This enables a coordinated effort to update the risk assessment and align it with the corresponding modifications made to the business process controls.

By actively monitoring and evaluating risk assessment, organizations can adapt to evolving risk landscapes and ensure the effectiveness of their risk management strategies. The collaborative engagement of stakeholders fosters a proactive approach to risk mitigation and enhances the organization's resilience in the face of emerging threats.

**TOP 5 PROSPECTIVE RISK**

| No. | Type | Company objectives 1 2 3 4 5 6 7 8 9 10 | Risk Category | Risk Event | Root Cause | Impact | Likelihood | Velocity | Risk Score | Controls | Department | Risk Owner | Directors in Charge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Determining correct flush in relation to type of catheter inserted | Type of catheter inserted e.g. open ended or closed | 4 | 5 | 0,4 | 20,4 | Two members of staff must check medication when carrying out this procedure; one being registered nurse. | Department4 | Risk owner4 | Director4 |
| 2 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Bacteraemia septicaemia | Local site infection or blood site infection | 3 | 4 | 0,2 | 12,2 | Nurses to be aware of the signs and symptoms of local infection at skin site and systemic blood stream infections | Department4 | Risk owner4 | Director4 |
| 3 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Blocked catheter, patient not able to receive medication | Catheter oclusion not able to flush catheter | 4 | 2 | 0,1 | 8,1 | Ask patient to cough, deep breathe, change position, stand up or lie down | Department4 | Risk owner4 | Director4 |
| 4 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Potential for inoculation injury | Use of sharps | 3 | 2 | 0,4 | 6,4 | Follow procedure for inoculation injury, report any inoculation injury following incident reporting system | Department4 | Risk owner4 | Director4 |
| 5 | Prospective | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Leakage of fluid | Catheter damage | 2 | 2 | 0,4 | 4,4 | Always follow manufacturer's instructions for flushing catheter to maintain patency and when administering medication (if available) | Department4 | Risk owner4 | Director4 |

FIGURE 22 TOP 5 PROSPECTIVE RISK DETAILS IN RISK ASSESSMENT TEMPLATE

**TOP 10 STRATEGIC RISK**

| No. | Type | Company objectives 1 2 3 4 5 6 7 8 9 10 | Risk Category | Risk Event | Root Cause | Impact | Likelihood | Velocity | Risk Score | Controls | Department | Risk Owner | Directors in Charge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Strategic | ☐ ☑ ☐ ☑ ☐ ☐ ☐ ☐ ☐ ☐ | Finance | Major internal or external incident causing harm to staff, patients or the public; or impacting on hospital's ability to maintain services | There are many possible incident types including fire, flood, power failure, gas leak, building collapse, terrorist threat etc. | 5 | 3 | 0,5 | 15,5 | The hospital has an emergency response policy. Business continuity plans are in place. Senior leaders receive briefings from the emergency planning lead as required | Department7 | Risk owner2 | Director2 |
| 2 | Strategic | ☐ ☑ ☐ ☑ ☐ ☐ ☐ ☐ ☐ ☐ | Legal compliance | Failure to meet statutory obligations for management of our esatate and estate related issues, such as building or facilities compliance. | Complex multi site network, located in many buildings with ageing infastructure, with reliance on other organisations to undertake works, checks and provide assurance | 4 | 3 | 0,4 | 12,4 | Our hospital has a system for recording all stautory and mandatory compliance, recording the area of compliance for each site and identifying where areas of non-compliance exist. | Department2 | Risk owner4 | Director7 |
| 3 | Strategic | ☑ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Not meeting mandatory training standards | Failure to meet or exceed minimum mandatory training standards in some areas leading to possible deficiencies in patient care and governance | 3 | 3 | 0,5 | 9,5 | Consistent improvement has been seen since mandatory training has been linked to appraisal/pay progression. Regular HR and workforce reports continue to show | Department4 | Risk owner4 | Director4 |
| 4 | Strategic | ☐ ☐ ☑ ☐ ☑ ☐ ☐ ☐ ☐ ☐ | HR recruitment | Back log of projects identified and difficulty recruiting certain departments | Contractors fill key roles. Recruiting to posts permanently. Temporary bank contracts to cover key projects. | 3 | 3 | 0,2 | 9,2 | 0 | | 0 | 0 |
| 5 | Strategic | ☐ ☐ ☐ ☐ ☐ ☐ ☑ ☐ ☐ ☑ | Major IT systems failure which could seriously inhibit day to day function of the hospital | Major IT systems failure which could seriously inhibit day to day function of the hospital | Potential for IT infrastructure failure from a number sources | 4 | 2 | 0,3 | 8,3 | System has been consistently stable for more than 18 months. Disaster Recovery and Business Continuity Plans are documented. A desktop DR test exercise was completed in March 2016. Recovery tested in December when incident occurred. Further configuration changes to secondary server room and network completed in March. | Department8 | Risk owner6 | Director2 |

FIGURE 23 TOP 5 STRATEGIC RISKS IN RISK ASSESSMENT TEMPLATE

## TOP 10 OVERALL RISK

| No. | Type | Company objectives 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Risk Category | Risk Event | Root Cause | Impact | Likelihood | Velocity | Risk Score | Controls | Department | Risk Owner | Directors in Charge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Prospective | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Determining correct flush in relation to type of catheter inserted | Type of catheter inserted e.g. open ended or closed | 4 | 5 | 0,4 | 20,4 | Two members of staff must check medication when carrying out this procedure; one being registered nurse. | Department4 | Risk owner4 | Director4 |
| 2 | Strategic | ☐ | ☑ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Finance | Major internal or external incident causing harm to staff, patients or the public; or impacting on hospital's ability to maintain services | There are many possible incident types including fire, flood, power failure, gas leak, building collapse, terrorist threat etc. | 5 | 3 | 0,5 | 15,5 | The hospital has an emergency response policy. Business continuity plans are in place. Senior leaders receive briefings from the emergency planning | Department7 | Risk owner2 | Director2 |
| 3 | Strategic | ☐ | ☑ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Legal compliance | Failure to meet statutory obligations for management of our esatate and estate related issues, such as building or facilities compliance. | Complex multi site network, located in many buildings with ageing infastructure, with reliance on other organisations to undertake works, checks and provide | 4 | 3 | 0,4 | 12,4 | Our hospital has a system for recording all stautory and mandatory compliance, recording the area of compliance for each site and identifying where areas of | Department2 | Risk owner4 | Director7 |
| 4 | Prospective | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Bacteraemia septicaemia | Local site infection or blood site infection | 3 | 4 | 0,2 | 12,2 | Nurses to be aware of the signs and symptoms of local infection at skin site and systemic blood stream infections | Department4 | Risk owner4 | Director4 |
| 5 | Strategic | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Not meeting mandatory training standards | Failure to meet or exceed minimum mandatory training standards in some areas leading to possible deficiencies in patient care and governance | 3 | 3 | 0,5 | 9,5 | Consistent improvement has been seen since mandatory training has been linked to appraisal/pay progression. Regular HR and workforce reports | Department4 | Risk owner4 | Director4 |
| 6 | Strategic | ☐ | ☐ | ☑ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | HR recruitment | Back log of projects identified and difficulty recruiting certain departments | Contractors fill key roles. Recruiting to posts permanently. Temporary bank contracts to cover key projects. | 3 | 3 | 0,2 | 9,2 | 0 | | 0 | 0 |
| 7 | Strategic | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☑ | ☐ | ☐ | ☑ | Major IT systems failure which could seriously inhibit day to day function of the hospital | Major IT systems failure which could seriously inhibit day to day function of the hospital | Potential for IT infrastructure failure from a number sources | 4 | 2 | 0,3 | 8,3 | System has been consistently stable for more than 18 months. Disaster Recovery and Business Continuity Plans are documented. A desktop DR test | Department8 | Risk owner6 | Director2 |
| 8 | Prospective | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Blocked catheter, patient not able to receive medication | Catheter oclusion not able to flush catheter | 4 | 2 | 0,1 | 8,1 | Ask patient to cough, deep breathe, change position, stand up or lie down | Department4 | Risk owner4 | Director4 |
| 9 | Prospective | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Potential for inoculation injury | Use of sharps | 3 | 2 | 0,4 | 6,4 | Follow procedure for inoculation injury, report any inoculation injury following incident reporting system | Department4 | Risk owner4 | Director4 |
| 10 | Prospective | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Flushing, care, and administration via peripheral and central venous access device assessment | Leakage of fluid | Catheter damage | 2 | 2 | 0,4 | 4,4 | **Always follow manufacturer's instructions for flushing catheter to maintain patency and when administering medication (if available)** | **Department4** | **Risk owner4** | **Director4** |

**FIGURE 24 TOP 10 OVERALL RISK IN RISK ASSESSMENT TEMPLATE**

The figures presented above provide a visual representation of the top 10 detailed risks in the overall, strategic, and prospective categories, respectively. These figures, along with the risk assessment dashboard, serve as valuable tools for risk experts to present their assessment outcomes to the board of directors and medical directors. The risk assessment template employed in this study exhibits a generic nature, making it adaptable for organizations that implement enterprise risk management encompassing both operational and strategic risk assessments.

In the context of this template, operational risk can serve as a substitute for prospective risk. However, the fundamental concept of strategic risks remains unchanged. This flexibility allows organizations across different sectors to utilize the template effectively, aligning their risk assessment processes with the principles of enterprise risk management. By employing such a comprehensive template, organizations can enhance their risk management practices, improve decision-making, and promote a culture of risk awareness throughout the entire organization.

## 4.3. Proposed Timeline

To facilitate the implementation of the framework, a timeline has been devised to provide a clear visualization of the necessary steps involved. It is important for organizations to assess their maturity level and suitability for adopting this framework, as it specifically aims to assist risk managers in incorporating the concept of velocity of risk into their risk assessment process. For organizations lacking a dedicated risk management department, it is advisable to initially focus on implementing existing risk management standards and frameworks.

By understanding the current state of their organization and considering its readiness for embracing this framework, organizations can effectively plan and execute the necessary steps for implementation. This timeline serves as a roadmap for organizations to navigate the implementation process and ensure a smooth integration of the framework into their existing risk management practices. Additionally, it allows organizations to gauge the feasibility and potential benefits of incorporating velocity of risk into their risk assessment processes, thus enabling them to make informed decisions regarding its adoption.

The timeline for implementing the framework consists of five distinct phases. The first phase is dedicated to establishing the initial components of the framework. During this phase, the risk experts collaborate closely to redesign the risk template, incorporating new levels for the velocity of risk and enhancing the risk library. Additionally, business process visualization plays a crucial role in this phase. Simultaneously, pieces of training are conducted for the newly appointed risk champions to familiarize them with the concept of risk within the organization.

Moving to the second phase, a pilot project is initiated, selecting three key business processes to execute the annual and ad-hoc risk assessment processes. Close communication and collaboration between the risk champions and risk experts are essential during this phase. Adjustments to the newly developed risk template are expected, and the risk library requires continuous refinement to ensure its comprehensiveness. The risk experts, who may not be directly involved in the day-to-day processes, might overlook certain items that need to be added to the risk library. Conversely, the risk champions may experience challenges in understanding risk appetite and defining risk events and controls. Hence, the risk experts must be readily available to guide the risk champions and foster a strong risk culture within the organization.

The third phase marks the continuation of the pilot project. If the second phase progresses smoothly and the risk experts have confidence in scaling up the project, the risk assessment can be expanded to cover the entire organization. This phase involves the participation of the entire organization in the new risk assessment process. Subsequently, the fourth phase, characterized by ongoing ad-hoc updates, research, and reviews, is likely to be an extended period in which the organization continues to refine and enhance the risk assessment process.

The final phase of the implementation timeline focuses on control evaluation. In this phase, the risk experts, in collaboration with the risk champions, assess the effectiveness of the controls implemented for each risk event. The evaluation process involves re-assessing the risk scores using the same variables of impact, likelihood, and velocity. The risk experts and champions analyze the impact of the controls on these variables and determine whether the controls have successfully reduced the risk level.

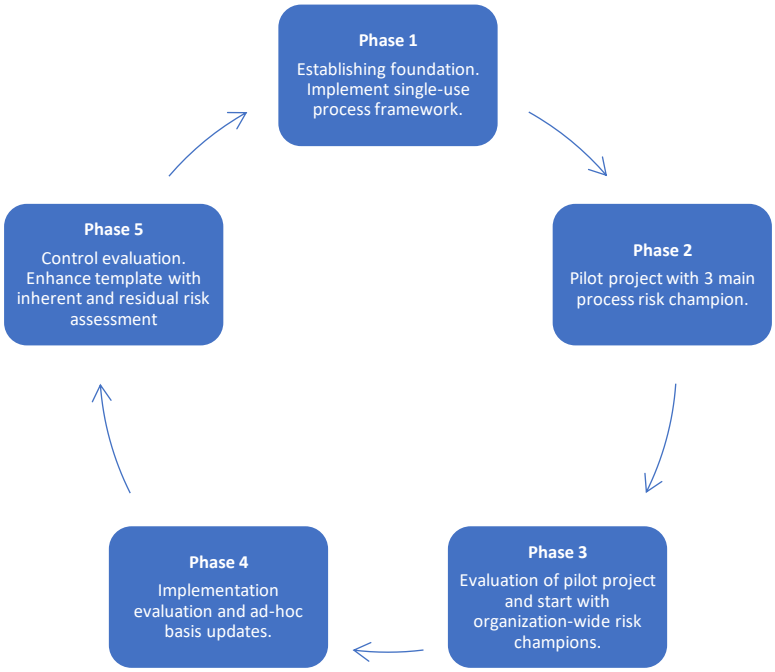



**FIGURE 25 FRAMEWORK TIMELINE**

During the evaluation, the risk experts and champions examine the extent to which the controls have influenced the risk scores. If the controls have significantly reduced the risk level across the variables, it indicates that the controls effectively manage the risk. However, if the reduction is insignificant or nonexistent, it suggests that the controls in place are ineffective in mitigating the identified risk. In such cases, the risk experts and champions need to identify and define alternative controls that are expected to be more effective in managing the risk than the previous controls.

Control evaluation plays a crucial role in ensuring that the controls implemented align with the risk management objectives of the organization. It allows for continuous improvement and refinement of the control measures to enhance risk mitigation capabilities. By assessing the impact of controls on risk scores, organizations can make informed decisions regarding the suitability and effectiveness of the controls and make necessary adjustments to enhance risk management practices.

## 4.4. ARCHIMATE VISUALIZATION FOR SOLUTION DESIGN

The designed hospital risk assessment guidance can be visualized in greater detail using ArchiMate, as depicted in Figure 26. This visualization consists of three main components: plateaus, gaps, and work packages. Plateaus represent different phases of guideline implementation, while gaps illustrate the differences between each plateau. Work packages outline the simplified steps within each phase to visualize the guideline's implementation process.

The first plateau portrays the current state of the organization's risk assessment process. In Figure 26, the plateaus are presented in simplified and the differences between them are captured in the corresponding gaps. For instance, the gap between the first and second plateau represents the achievement of milestones such as business process visualization, redefined risk assessment templates, and the appointment of a risk champion. These gaps serve as indicators of progress and improvement.

To progress from one plateau to the next, the organization needs to execute specific projects. Project 1, for example, entails the creation of three artifacts: a business process visualization document, the appointment of risk champions, and the redefined risk template with updated velocity levels and a risk library. Project 2, referred to as the pilot project, enables the implementation of risk velocity in the risk assessment process through the involvement of three core business process risk champions. This project relies on the deliverables from Project 1, namely the redefined risk assessment template.

The third and fourth plateaus involve scaling up the pilot project to encompass the entire organization, engaging all appointed risk champions. As the project progress, risk experts compile the risk assessments conducted by risk champions, ensuring completeness and alignment between strategic and prospective risk managers. The final plateau focuses on reviewing the effectiveness of controls. Although the risk assessment template includes controls, their efficacy is not measured until the occurrence of risks. Project 4, therefore, involves conducting inherent and residual risk evaluations, analyzing the respective controls, and identifying gaps. This enables the organization to update the risk assessment with controls for inherent and residual risks.

By visualizing the guidance using ArchiMate, organizations can gain a comprehensive understanding of the implementation phases, milestones, and the interconnectedness between different elements of the risk assessment process. This visualization aids in facilitating effective communication and collaboration among stakeholders, ultimately enhancing the organization's risk management capabilities.

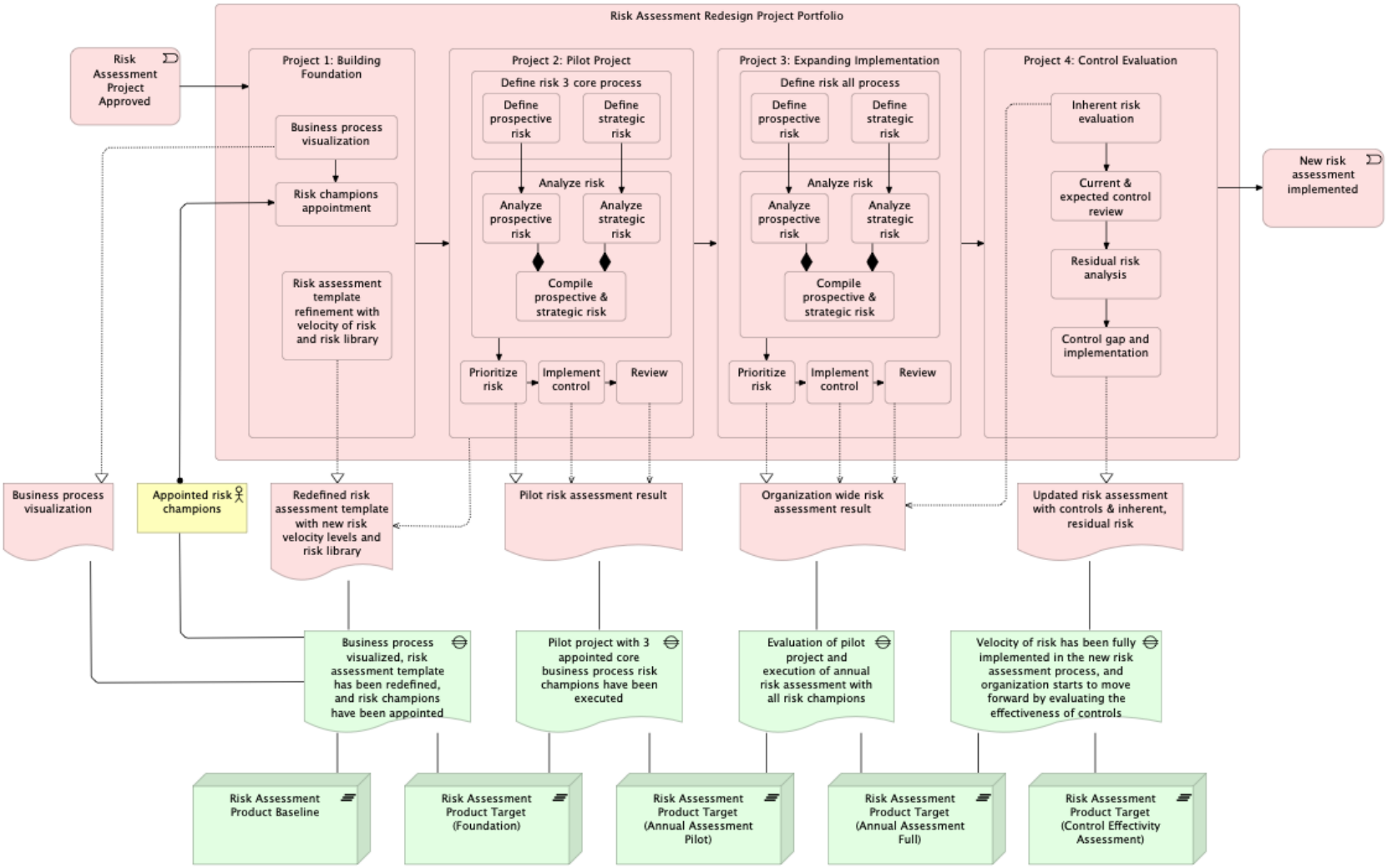



**FIGURE 26 SOLUTION DESIGN DEPICTED IN ARCHIMATE**

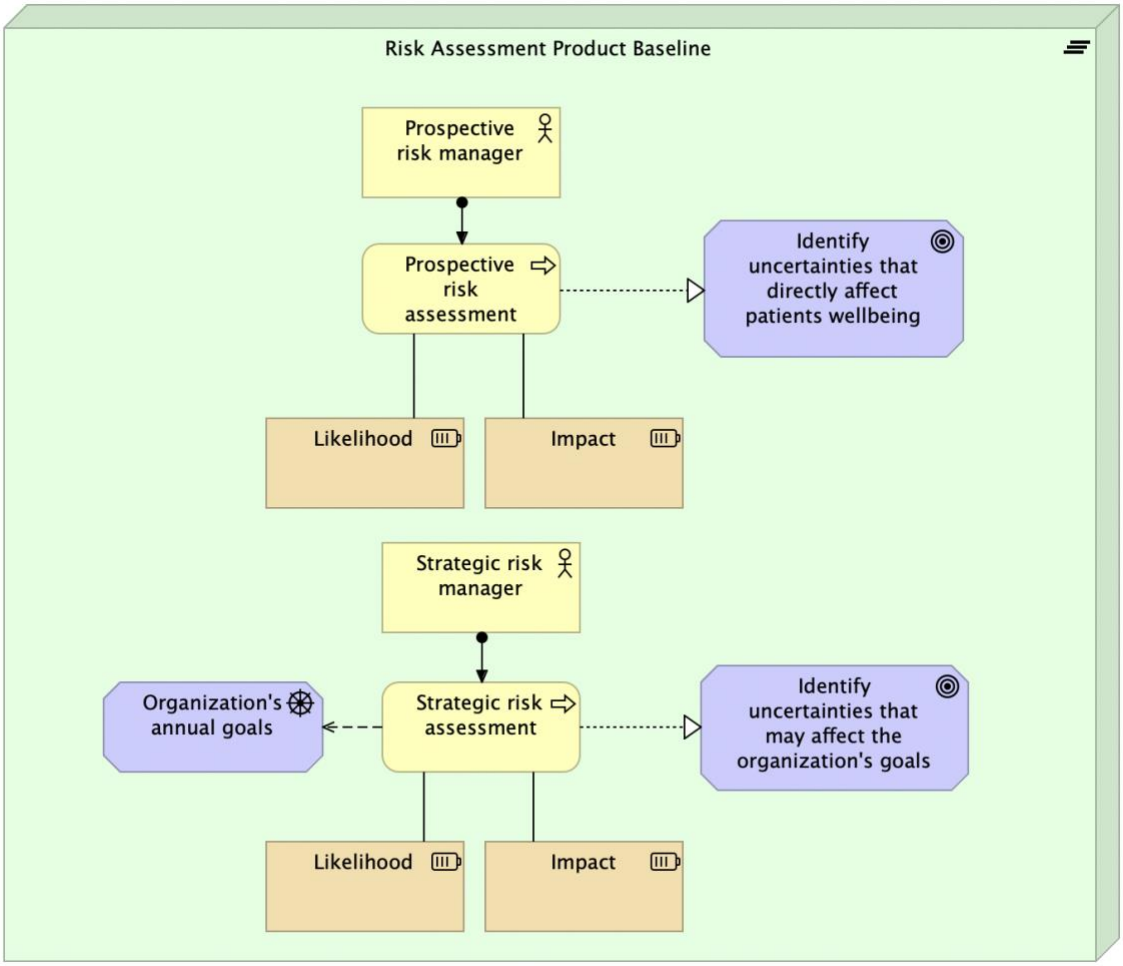



**FIGURE 27 RISK ASSESSMENT PRODUCT BASELINE PLATEAU**

Figure 27 provides a detailed depiction of the first plateau illustrated in Figure 26. This plateau represents the current state of the case study organization's risk assessment process. The figure highlights three key elements: the business perspective, the risk variables, and the company's goals. It visually represents the existing condition of the hospital's risk assessment process, wherein two distinct risk assessments are being conducted by the prospective risk manager and strategic risk manager, each serving a specific purpose for the organization.

Moving on to Figure 28, it portrays the visualization of the risk assessment foundation implementation in the hospital, representing the next plateau in the guideline. This visualization encompasses three primary business processes: the appointment of new risk assessment champions and the visualization of the business process itself, alongside the redefinition of the risk assessment template. The figure provides insights into the individuals responsible for each process, the nature of the processes, and the stakeholders involved in these activities. This visual representation aids in understanding the implementation steps and the roles of various stakeholders within the risk assessment framework.

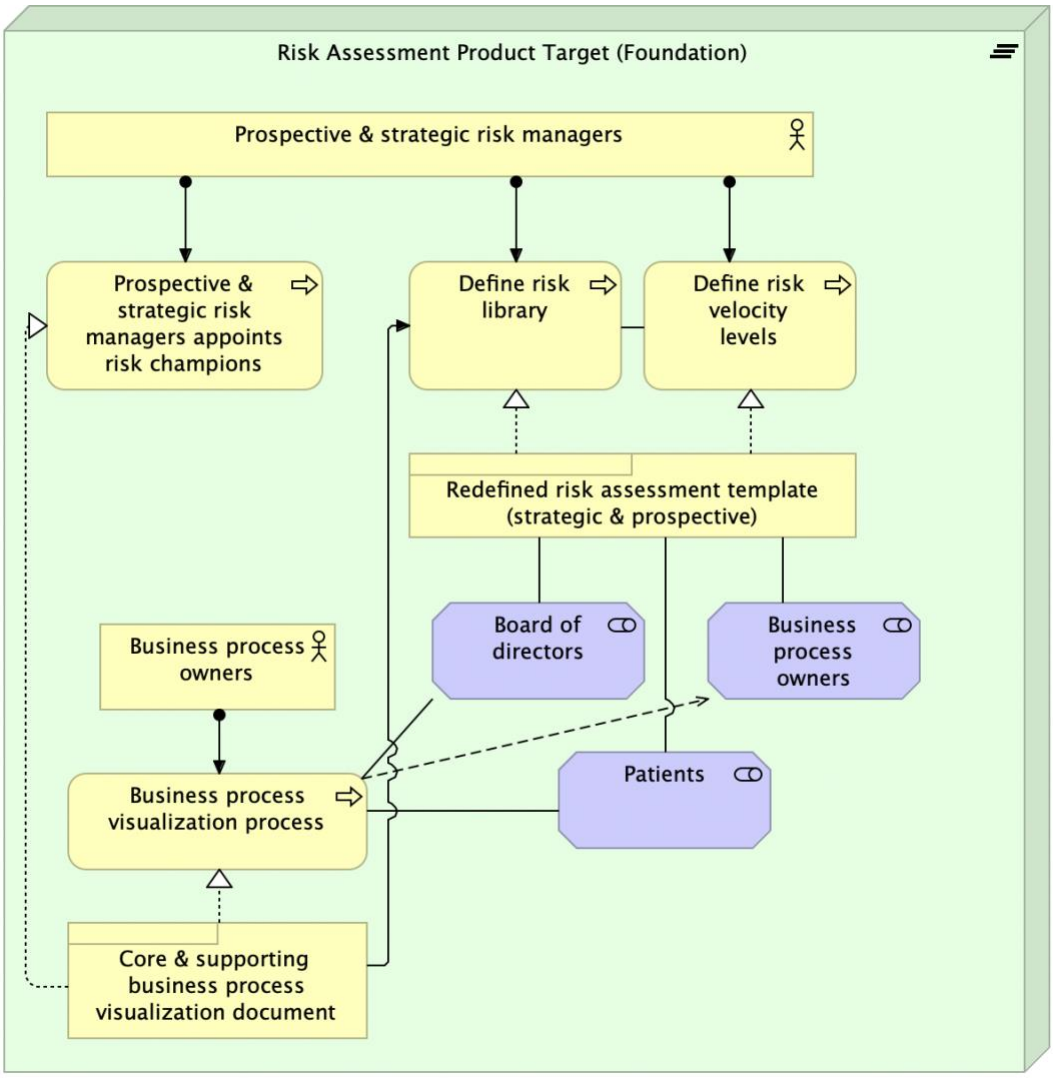



**FIGURE 28 RISK ASSESSMENT PRODUCT TARGET (FOUNDATION)**

Following the implementation of the foundation, Figure 29 illustrates the subsequent plateau, showcasing the process conducted using the proposed framework. In this stage, a pilot project is undertaken by the hospital, focusing on three key processes mapped during the business process visualization phase, namely the emergency department, operating department, and intensive care department. The ArchiMate diagram represents three distinct levels of visualization: purple-colored shapes depict the goals of the company or departments, yellow shapes represent the business processes and actors involved, and orange shapes represent the variables utilized within the business process.

Within this pilot phase, the diagram demonstrates the integration of previously separate and disconnected processes, specifically the recessed moment between prospective and strategic risk assessments. The goals of these processes are now interconnected, with the purple-colored shapes indicating the goal of identifying uncertainties that directly impact patients' well-being and the goal of identifying uncertainties that may affect the organization's overall objectives. These goals are linked by arrows representing "influence,"

signifying that the realization of the prospective risk assessment's goal is influenced by the strategic risk assessment process.

The subsequent plateau, as depicted in Figure 30, represents the next phase in the framework following the successful pilot implementation. This phase involves the integration of the new risk assessment framework into both the core and supporting processes of the hospital. Once the pilot phase, conducted with three core business processes, has proven successful, the hospital can proceed with implementing the framework across all business processes within the organization.

After several years of successfully implementing the risk assessment framework with velocity of risk, the next phase involves the evaluation of controls utilized in the previous risk assessments. Figure 31 illustrates the plateau and the steps involved in conducting the evaluation of control within a hospital that has implemented the risk assessment framework. The diagram includes two additional processes depicted in yellow shapes, which entail reassessing the impact, likelihood, and velocity of previously assessed risks, now referred to as the "residual risk score." Risk managers can then assess the gap between the new and old risk scores to determine the effectiveness of the controls implemented within the hospital's risk assessment process.

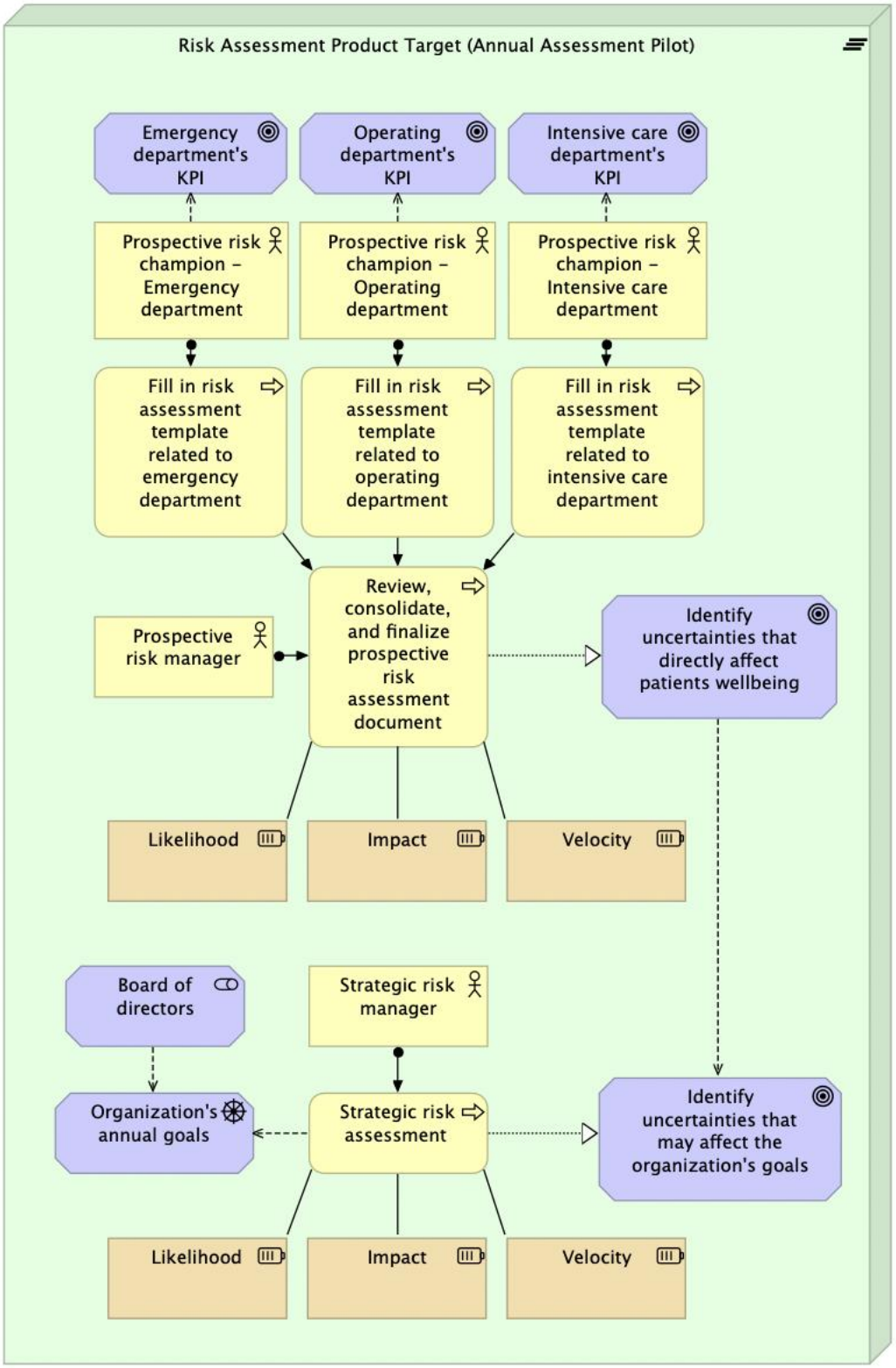



**FIGURE 29 RISK ASSESSMENT PRODUCT TARGET (ANNUAL ASSESSMENT PILOT))**

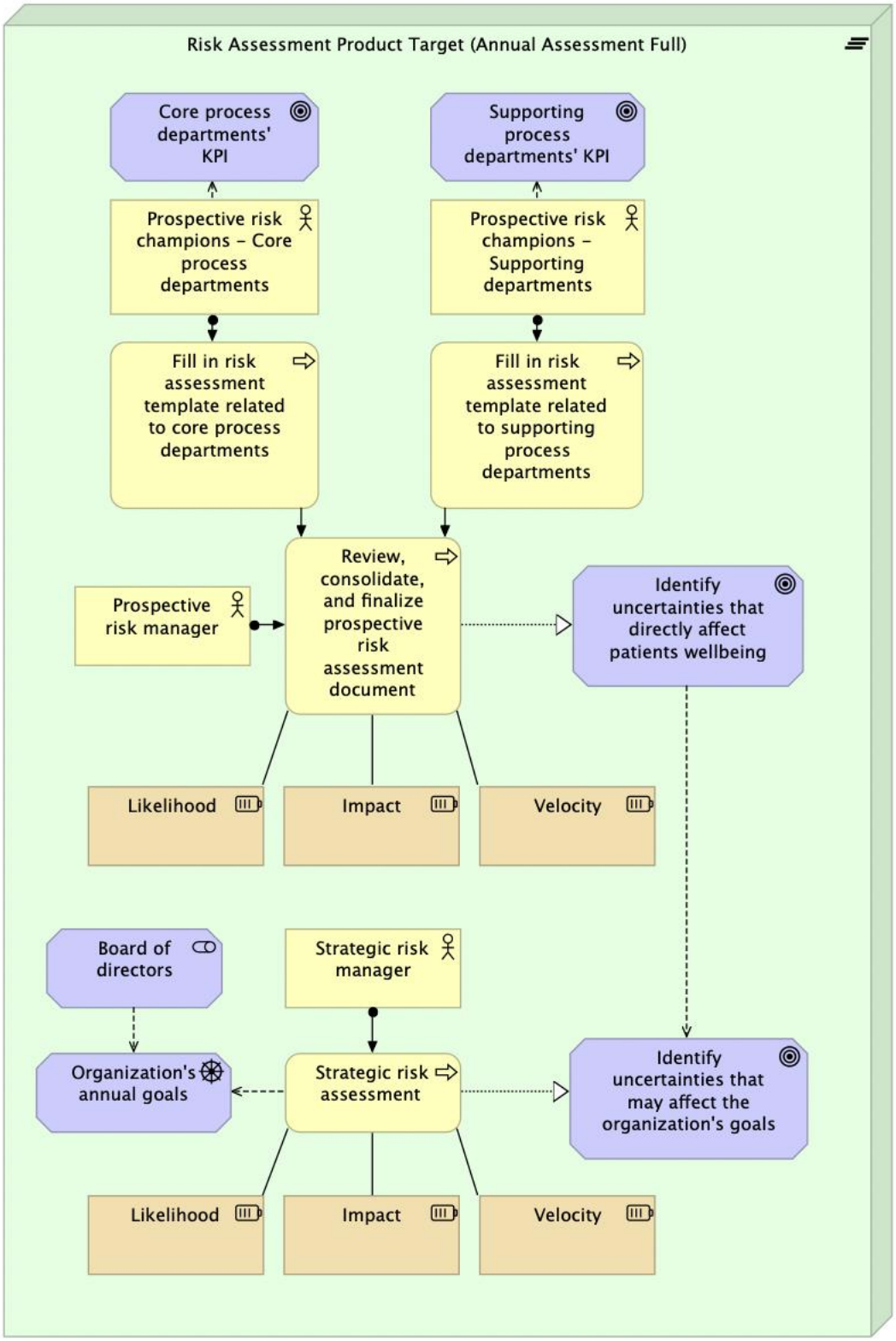



**FIGURE 30 RISK ASSESSMENT PRODUCT TARGET (ANNUAL ASSESSMENT FULL)**

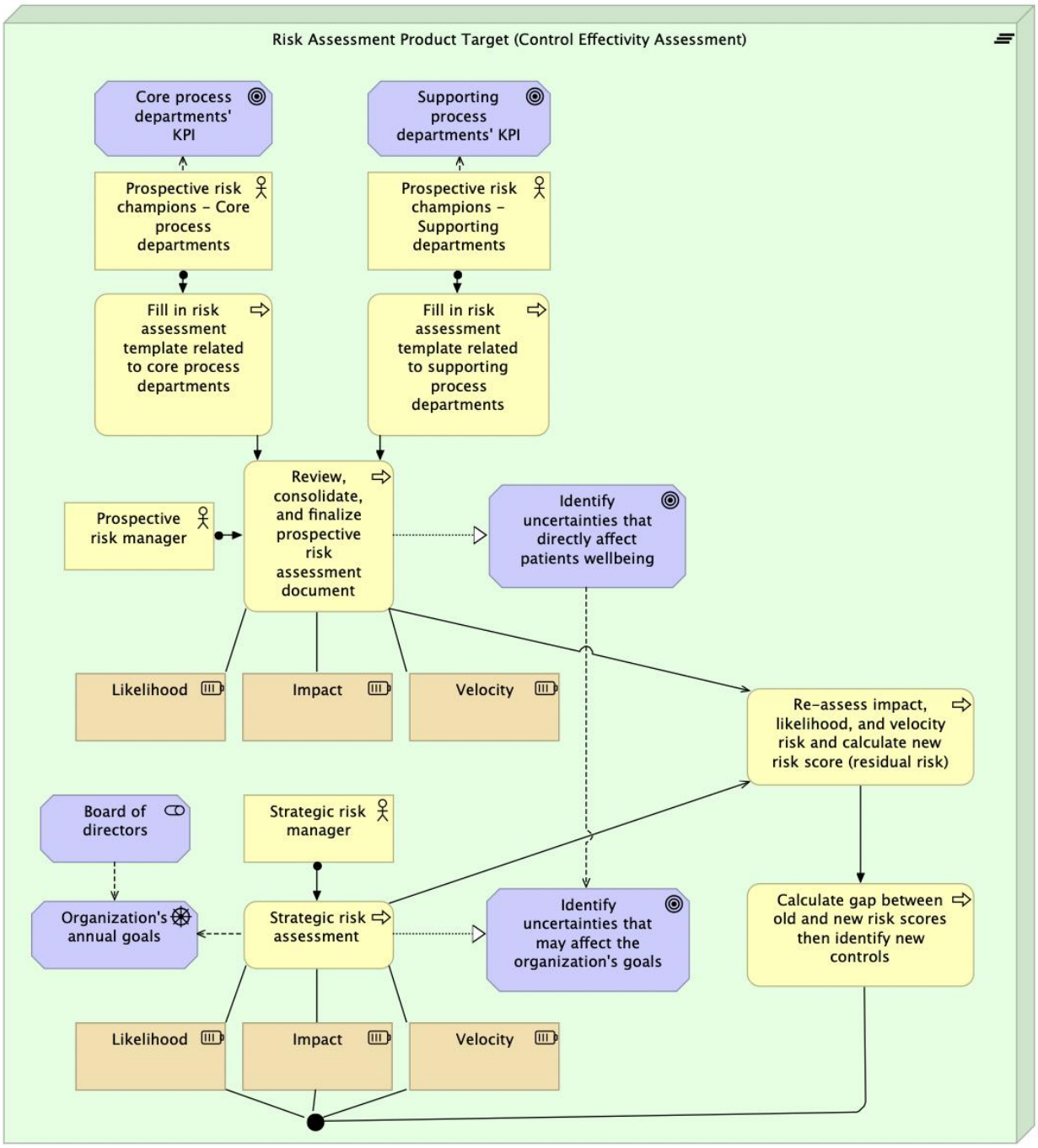



FIGURE 31 RISK ASSESSMENT PRODUCT TARGET (CONTROL EFFECTIVITY ASSESSMENT)

To conclude the solution design chapter, the questions that were previously formulated and mentioned at the beginning of this chapter can be answered in detail as follows:

**How and to what extent can risk assessment be captured by enterprise architecture models such as ArchiMate?**

ArchiMate, as a comprehensive modeling language, offers extensive capabilities for visualization purposes. In the context of this research, ArchiMate is employed to visualize various aspects, including the relationship between the velocity of risk and the risk assessment process, as well as the alignment of the change management timeline with the guideline implementation process. By leveraging ArchiMate, a clear and concise representation of these interconnected elements is achieved, aiding in the understanding and communication of the proposed solution. Moreover, ArchiMate proves to be a valuable tool for business process visualization, as it facilitates the depiction of the organization's business processes and objectives. Given its versatility and recommended use, ArchiMate serves as an effective means to visually capture and communicate complex relationships and processes within the proposed guidance.

**What are the key components of the guidance for capturing and analyzing velocity in ArchiMate enterprise architecture models for risk assessment in a hospital?**

The guidance proposed for capturing and analyzing the velocity of risk encompasses key components outlined in a series of defined steps. The initial phase involves establishing a foundation using the single-use process framework, which includes steps such as business process visualization, risk template redefinition, and risk champion appointment. This foundation serves as the basis for subsequent activities. The subsequent phase utilizes an annual and ad-hoc process framework characterized by an iterative process of identifying, analyzing, and prioritizing risks, as well as evaluating controls. These steps provide a systematic approach to comprehensively capture and analyze the velocity of risk within an organization's risk assessment process. By following this guidance, organizations can enhance their understanding of risk velocity and incorporate it into their overall risk management practices.

# CHAPTER 5

## SOLUTION VALIDATION (IMPLEMENTATION & EVALUATION)

This chapter discusses the validation process of the proposed solution that was outlined in the previous chapter. To ensure a methodical and comprehensive validation of the proposed solution in this research, a set of structured questions has been formulated. These questions are designed to guide the validation process and facilitate a systematic and thorough assessment of the effectiveness and suitability of the proposed solution. The answers to these questions will be presented in sub-chapter 5.3, which focuses on the conclusion of Chapter 5.

The following questions have been formulated for the validation process:

**What are the steps for the hospital to implement velocity in their risk assessment process?**

**What are the limitations and potential drawbacks of using an ArchiMate enterprise architecture model to capture and analyze velocity in a hospital, and how can they be addressed?**

**What is the feedback of hospital stakeholders (such as risk managers, IT professionals, and hospital administrators) on the proposed risk assessment model that incorporates velocity using ArchiMate models?**

## 5.1. VALIDATION PARTICIPANTS

In order to validate the proposed solution, a methodology inspired by Wieringa was employed. The validation process involved conducting structured interviews with three individuals from different companies, each representing a distinct perspective. The aim was to gather feedback and assess the suitability of the solution in different organizational contexts.

The first interviewee was the risk manager from a hospital in the Netherlands, who was also a participant in the earlier case study. This individual's insights were crucial in determining whether the developed solution adequately addressed the specific challenges faced by their hospital. Their feedback provided validation regarding the applicability of the solution within their own organization.

The second interview was conducted with the chief audit executive of another hospital in the Netherlands; he is the **Head of Internal Audit and Risk in Radboudumc Nijmegen, The Netherlands, named Ruud Franssen**. Ruud's role provided a broader perspective, allowing for an assessment of the solution's suitability across multiple hospitals in the country. His feedback served to validate the scalability and transferability of the solution within the healthcare sector in the Netherlands.

Lastly, a risk partner from a company in Indonesia participated in the validation process, **Erikman Pardamean, CISA, ERMCP, CC, GRCA, GRCP, QRMP, QIA, IIAP, and the Technology Risk Consulting Partner of RSM Indonesia**. He represented a different industry and geographical location, offering a diverse viewpoint. His input was essential in determining the solution's generalizability and whether it could be effectively implemented in a different business context and country.

**TABLE 6 VALIDATION INTERVIEWEE INFORMATION**

| No | Name | Position | Company | Location | Company Information |
|---|---|---|---|---|---|
| 1 | **Confidential** | Risk Manager | **Confidential** | The Netherlands | One of the UMC (University Medical Center) |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | with >12,000 employees |
| 2 | Ruud Franssen | Head of Internal Audit and Risk (chief audit executive) | Radboudumc | The Netherlands | >12,000 employees |
| 3 | Erikman Pardamean, CISA, ERMCP, CC, GRCA, GRCP, QRMP, QIA, IIAP | Technology Risk Consulting Partner | RSM Indonesia | Indonesia | A global network of assurance, tax, and consulting with a global team of 57,000 people in 830 offices across the USA, Europe, MENA, Africa, and Asia Pacific. |

The participants in the validation interviews were carefully selected to ensure a comprehensive evaluation of the proposed solution. By including individuals from different organizations, sectors, and geographical locations, the validation process aimed to gather diverse perspectives and validate the suitability and effectiveness of the developed solution across various scenarios.

The structured interviews followed a systematic approach guided by a set of predefined questions and criteria. The insights gathered from these interviews were analyzed and compared to identify common themes, patterns, and potential areas for improvement. The validation process aimed to provide empirical evidence supporting the feasibility and usefulness of the proposed solution while also identifying any potential limitations or areas that may require further refinement.

In order to gather feedback and validate the proposed solution, a structured interview approach was employed. The interview consisted of eight carefully crafted questions designed to elicit specific information related to the sub-research questions identified in the initial chapter of the thesis. The interview questions were intended to generate yes or no responses, ensuring a clear and concise format.

Prior to conducting the interview, a comprehensive presentation of the proposed solution was delivered to each interviewee. The presentation, conducted in the form of a PowerPoint, included various visualizations and illustrations to enhance understanding of the solution's context. During this presentation, the interviewees were encouraged to ask questions and engage in discussions to further clarify any aspects of the proposed solution that required additional explanation.

The purpose of the interview questions was to gather feedback and statements from the interviewees regarding the completeness and utility of the developed solution for their respective organizations or other organizations they were familiar with. All the interviewees held significant expertise in the field of risk management, with more than ten years of experience. It is worth noting that each of the companies represented by the interviewees had a substantial workforce of over 12,000 employees, indicating a complex organizational structure and risk landscape.

By structuring the interview questions around the sub-research questions and involving experienced risk professionals from diverse organizations, the aim was to obtain valuable insights regarding the efficacy and

applicability of the proposed solution. The feedback provided by these knowledgeable experts would contribute to the validation process and provide a robust evaluation of the solution's completeness and potential usefulness in different organizational contexts.

## 5.2. Validation Design and Results

The validation interview questions were structured into several sections and themes to ensure a comprehensive assessment of the proposed solution. The first section aimed to confirm the interviewee's understanding of the proposed solution, which was presented in the form of a guideline. This section included questions regarding their comprehension of the solution and provided an opportunity for the interviewees to express any aspects that they found confusing or unclear.

The second section focused on identifying potential gaps or missing elements in the guideline. The interviewees were asked if there were any specific expectations they had from the proposed solution that were not met. This section aimed to capture any essential components that may have been overlooked and ensure that the solution fulfilled the interviewees' requirements and expectations.

The third section explored the perceived usefulness of the guideline or solution. The interviewees were asked two questions: whether they believed the guideline would be beneficial for their organization and if they had any suggestions to improve the solution. This section allowed the interviewees to provide feedback on the practicality and effectiveness of the proposed solution while also encouraging them to contribute ideas for enhancing its utility.

The fourth section delved into the implementation aspect of the guideline. The interviewees were asked if they considered the guideline valuable enough to be implemented in their current risk assessment process. Additionally, they were prompted to consider any adaptations or tailoring of the solution that might be necessary to align it with their specific business or organizational requirements.

The final section of the interview aimed to gauge the interviewees' willingness to recommend the solution or guideline to others. They were asked if they would endorse the solution and if they were aware of any other organizations that could benefit from implementing the velocity of risk into their risk assessment process. This section sought to assess the potential wider applicability and endorsement of the proposed solution.

By structuring the interview questions around these sections and themes, a comprehensive evaluation of the understanding, completeness, usefulness, implementation feasibility, and potential recommendation of the proposed solution could be obtained from the interviewees. Their insights and feedback would contribute to the validation process and aid in further refining and improving the solution.

In the validation interview, the following list of questions was posed to gather feedback and insights from the interviewees:

**TABLE 7 VALIDATION INTERVIEW QUESTIONS AND OBJECTIVES**

| Theme | Questions | Question objective |
|---|---|---|
| Confirmation of understanding | 1. Can you confirm if you understand the purpose of the proposed guideline? | To assess the interviewee's comprehension of the guideline's |

| | | |
|---|---|---|
| | | intended purpose, ensuring that they grasped its overall objective. |
| | 2. Did you find any part of the guideline confusing? If yes, please explain which part or why. | Provided the interviewee with an opportunity to express any areas of the guideline that they found unclear or difficult to understand. Their feedback helped identify potential areas for improvement or clarification. |
| Potential gaps in solution design | 3. Was there anything missing from the guideline that you expected to find? If yes, what was it? | To determine if there were any specific elements or information that the interviewee anticipated in the guideline but did not find. Their response shed light on potential gaps in the guideline's content. |
| Perceived usefulness | 4. Did you find any aspect of the guideline useful? If yes, what is it? | To identify the aspects of the guideline that the interviewee found beneficial or valuable. Their feedback helped ascertain the strengths and positive attributes of the proposed solution. |
| | 5. Do you have any suggestions for how we can improve the guideline? | The interviewee was encouraged to provide suggestions for enhancing the guideline, whether it be in terms of content, clarity, or usability. Their input helped identify opportunities for refinement and improvement. |
| Solution design implementation | 6. If you were to implement this guideline, is there any specific part that you would like to change to tailor it to your business? | To explore the interviewee's perspective on customizing the guideline to align with their specific business or organizational context. It aimed to identify any modifications or adaptations they would consider making the guideline more applicable and effective in their setting. |
| | 7. Will this guideline be helpful for you to implement velocity of risk in your risk assessment process? | To gauge the interviewee's perception of the guideline's practicality and its potential impact on their risk assessment process. It aimed to determine if the proposed solution would effectively assist in implementing the concept of velocity of risk. |
| Promoting solution design | 8. Would you recommend this guideline to others? If yes, why? If not, why not? | To endorse the guideline to other individuals or organizations. Their response provided insights into the perceived value and relevance of the proposed solution, aiding in evaluating its potential applicability beyond their specific context. |

These questions were designed to elicit specific feedback from the interviewees, addressing different aspects of their understanding, expectations, usefulness, implementation feasibility, and recommendation of the proposed guideline. Their responses played a crucial role in validating the solution and guiding further improvements.

The results of the interview are divided based on the five themes of the validation questions with the following results:

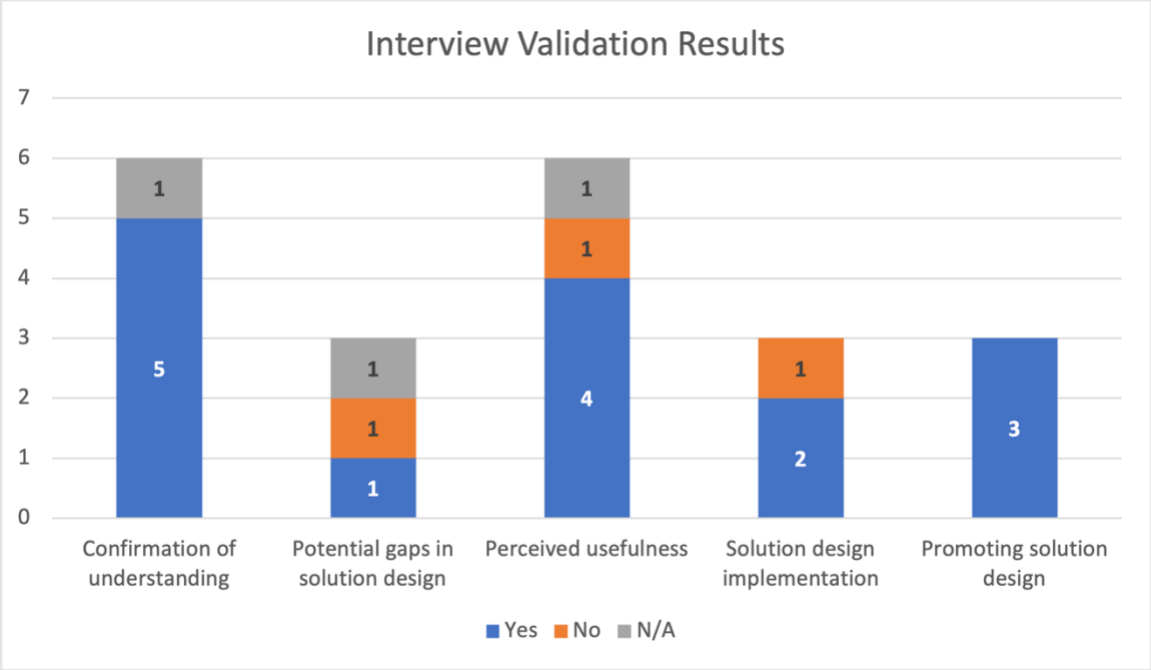



FIGURE 32 VALIDATION RESULTS

1. **Confirmation of understanding**
   Within this particular theme, two questions were posed to the interviewees, focusing on their understanding of the proposed solution. It was found that all of the interviewees had a clear understanding of the purpose and content of the solution. However, during the interview with Ruud from Radboudumc, it was mentioned that his organization lacks a dedicated risk management department, making it challenging to implement the proposed solution effectively. As a result, Ruud answered "not applicable" to the second question regarding any confusing aspects of the solution, as the discussion did not delve into the specific details of the proposed solution in his organization's context.

2. **Potential gaps in solution design**
   The responses to this question exhibited some variation among the interviewees. The risk manager from our case study expressed satisfaction, confirming that the proposed solution had fulfilled all of his expectations. In contrast, Erikman provided a suggestion to enhance the solution by incorporating a risk aggregator in the "risk champion appointment" step within the guidance. However, it is important to note that this question was deemed not applicable to Radboudumc, as

their organization did not possess a dedicated risk management department to engage with the proposed solution fully.

3. **Perceived usefulness**
   Within this theme, two questions were posed to the interviewees, and the majority responded affirmatively, indicating that they perceived the proposed solution as useful for implementing the velocity of risk in their organization's risk assessment process. Furthermore, minor suggestions were put forward to enhance the guideline. One such suggestion involved incorporating a risk aggregator as an intermediary function between prospective and strategic risk managers, facilitating the connection between these two risk experts and the board of directors.

   Additionally, it was proposed that the business process visualization step within the guideline be conducted by the department responsible for maintaining the organization's standard operating procedures (SOPs). Another suggestion pertained to the need for further research on the relationship between the velocity of risk and controls. Exploring this relationship would enable organizations to effectively identify and respond to specific risks based on their level of risk velocity.

4. **Solution design implementation**
   In this section, two out of the three interviewees indicated that no major changes would be required to the guideline if they were to utilize it for implementing the velocity of risk within their organization. However, as previously mentioned, Ruud responded negatively as the proposed solution was not applicable to his organization.

5. **Promoting solution design**
   However, to conclude the interview questions, all of the interviewees agreed that they would promote the guidance to other organizations that are interested in implementing velocity of risk as an additional variable for risk score calculation in their risk assessment process. Ruud added that this would be particularly useful for an organization that specifically has a risk management department within their organization and is using mathematical computation and calculation as a method to prioritize their risk events.

In conclusion, by synthesizing the findings from the validation interview, we can provide comprehensive and evidence-based answers to the research questions and objectives outlined in this study. These answers will contribute to a deeper understanding of the proposed solution's potential impact, benefits, challenges, and implications for the hospital's risk assessment process. Furthermore, they will provide valuable insights that can inform future research, practice, and decision-making in the field of risk management.

**What are the steps for the hospital to implement velocity in their risk assessment process?**

The majority of the interviewees agreed that the steps in the guidance are to be followed to implement the velocity of risk within their risk assessment process. This includes building the foundation and executing an iterative process of annual and ad hoc process framework in risk assessment.

**What are the limitations and potential drawbacks of using an ArchiMate enterprise architecture model to capture and analyze velocity in a hospital, and how can they be addressed?**

During the discussion, all of the participants, as risk practitioners, mentioned that they were not familiar with ArchiMate as a tool to visualize the process. However, ArchiMate is going to be used mainly within the step of business process visualization that is being conducted, not by risk managers. The company of the case study informed me that their IT department is currently doing a project of enterprise architecture visualization using ArchiMate, and they will request involvement and expansion of the scope to also visualize the whole organization's business process and not only limited to IT-related visualization.

**What is the feedback of hospital stakeholders (such as risk managers, IT professionals, and hospital administrators) on the proposed risk assessment model that incorporates velocity using ArchiMate models?**

There are several feedbacks from the participants of the interview regarding the proposed solution. Here are the details of the suggestions categorized by interviewees, along with my response to them.

| No | Interviewee | Feedback | Response to feedback |
|---|---|---|---|
| 1. | Case study owner | Further research can **explore the correlation between risk velocity and controls**, focusing on the controls needed for high and low-velocity risks. For high-velocity risks, organizations can investigate controls such as early warning systems, real-time monitoring, and agile decision-making processes to proactively respond to rapidly evolving risks. On the other hand, for low-velocity risks, controls like robust preventive measures, comprehensive risk assessment frameworks, and a risk-aware culture can help prevent their occurrence or reduce their impact. Understanding the relationship between risk velocity and controls can enhance risk management strategies, guide the development of effective risk mitigation plans, and contribute to frameworks that assist organizations in managing risks based on their velocity characteristics. | The feedback provided regarding the correlation between risk velocity and controls is valuable for further research and will be discussed in Chapter 6. |
| 2. | Ruud Franssen | **This guideline serves as a valuable resource for organizations aiming to quantify their risks using numerical assessments and possessing a dedicated risk management department**. By following this guideline, organizations can establish a systematic approach to evaluating and prioritizing risks, enabling informed decision-making, efficient resource allocation, and effective risk communication. The guideline's recognition of the importance of a dedicated risk management department emphasizes the need for specialized expertise and resources, enabling organizations to streamline their risk assessment practices, ensure | This feedback will be included as a limitation of the solution design as this feedback posed that the solution design can only be implemented for organization that has a dedicated risk management department and quantify their risk scores. |

| | | | |
|---|---|---|---|
| | | consistency in evaluations, and proactively identify and mitigate potential risks. It is important for organizations to consider their unique context, resources, and risk management maturity when applying this guideline, adapting it to align with their specific needs and capabilities. | |
| 3. | Erikman Pardamean | To enhance the effectiveness of risk assessment at the enterprise level and facilitate seamless coordination between prospective and strategic risk managers, it is **recommended to incorporate a risk aggregator function as an additional role**. The risk aggregator would assume the responsibility of leading the risk assessment process and serving as a bridge between the two risk managers. This role would play a crucial role in consolidating and synthesizing risk information from various sources, ensuring comprehensive risk identification and evaluation. | Both feedbacks are useful and are implemented within the solution and is presented in the next subchapter. |
| | | To optimize the effectiveness of the business process visualization step, it is advisable **to assign this task to the department responsible for managing the organization's Standard Operating Procedures (SOP)**. This independent department possesses extensive knowledge of the organization's business processes and is well-suited to undertake the visualization process. By leveraging the expertise of the SOP department, organizations can ensure a thorough and accurate representation of their business processes. This approach guarantees that the visualization captures the intricacies of the organization's operations, facilitating a comprehensive understanding of the interdependencies between different processes. Ultimately, involving the SOP department in the business process visualization step enhances the reliability and usefulness of the resulting visual models for risk assessment and decision-making purposes. | |

However, it is important to acknowledge that due to the constraints of time in this research study, feedback from stakeholders other than risk managers and experts was not obtained. While it would have been valuable to gather feedback from a broader range of hospital stakeholders, such as IT professionals and hospital administrators, the focus was primarily on risk managers and experts who possess dedicated expertise in risk management within their respective organizations. By engaging with these individuals, insights, and perspectives specific to risk management were gathered, allowing for a comprehensive understanding of the proposed solution's effectiveness and suitability. Nonetheless, future research endeavors could consider incorporating a more diverse range of stakeholders to obtain a more holistic and comprehensive assessment of the proposed solution's impact on the organization as a whole.

## 5.3. Updated Solution After Feedback

The feedback received from the 3rd participant during the validation phase is deemed valuable and will be incorporated into the thesis. Specifically, this subchapter focuses on the implementation of two suggested enhancements within the proposed framework. Firstly, the inclusion of a risk aggregator function as one of the roles will be explored, aiming to consolidate risk-related information and provide a comprehensive view of the organization's risk landscape. Secondly, the responsibility of business process visualization will be assigned to the department overseeing the management of the organization's Standard Operating Procedures (SOP). These enhancements aim to improve the effectiveness and efficiency of the risk assessment process within the proposed framework.

### *5.3.1. Adopt Risk Aggregator Function as one of the Roles*

Within the revised implementation of the risk assessment framework, a new role of risk aggregator has been introduced, positioned between the board of directors and the risk experts. As recommended by Erikman, the risk aggregator serves as an intermediary between the prospective and strategic risk managers. This role facilitates the consolidation of risk assessments conducted by both managers and subsequently reports the consolidated findings to the board of directors. Figure 33 illustrates the updated roles, with the inclusion of the risk aggregator highlighted in a green box.

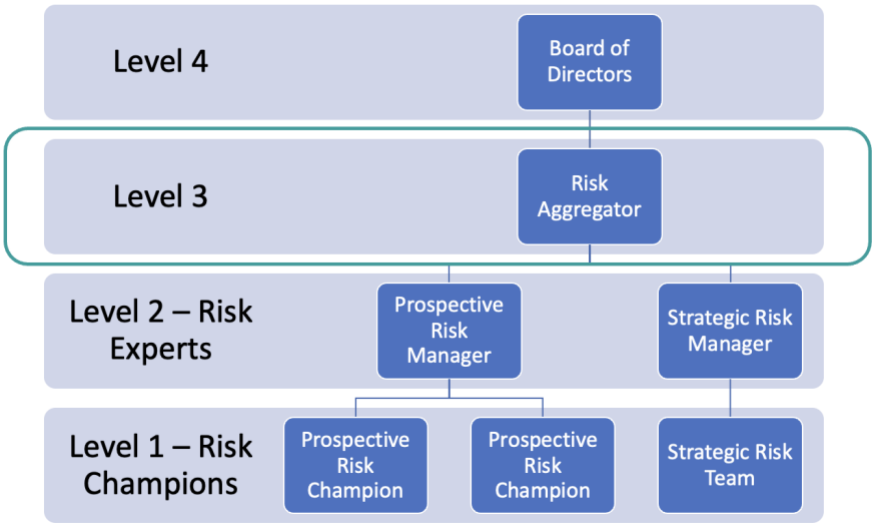



**Figure 33 Updated Roles for Risk Assessment Framework**

### *5.3.2. Role for Business Process Visualization Process*

The feedback regarding the emphasis on the role of business process facilitation has been incorporated into the second plateau of ArchiMate, specifically the "Risk Assessment Product Target Foundation" phase. This plateau corresponds to the stage where business process visualization takes place. In Figure 34, the

role of the process owner of standard operating procedure is visualized and highlighted with a green box to signify its importance and inclusion in the framework.

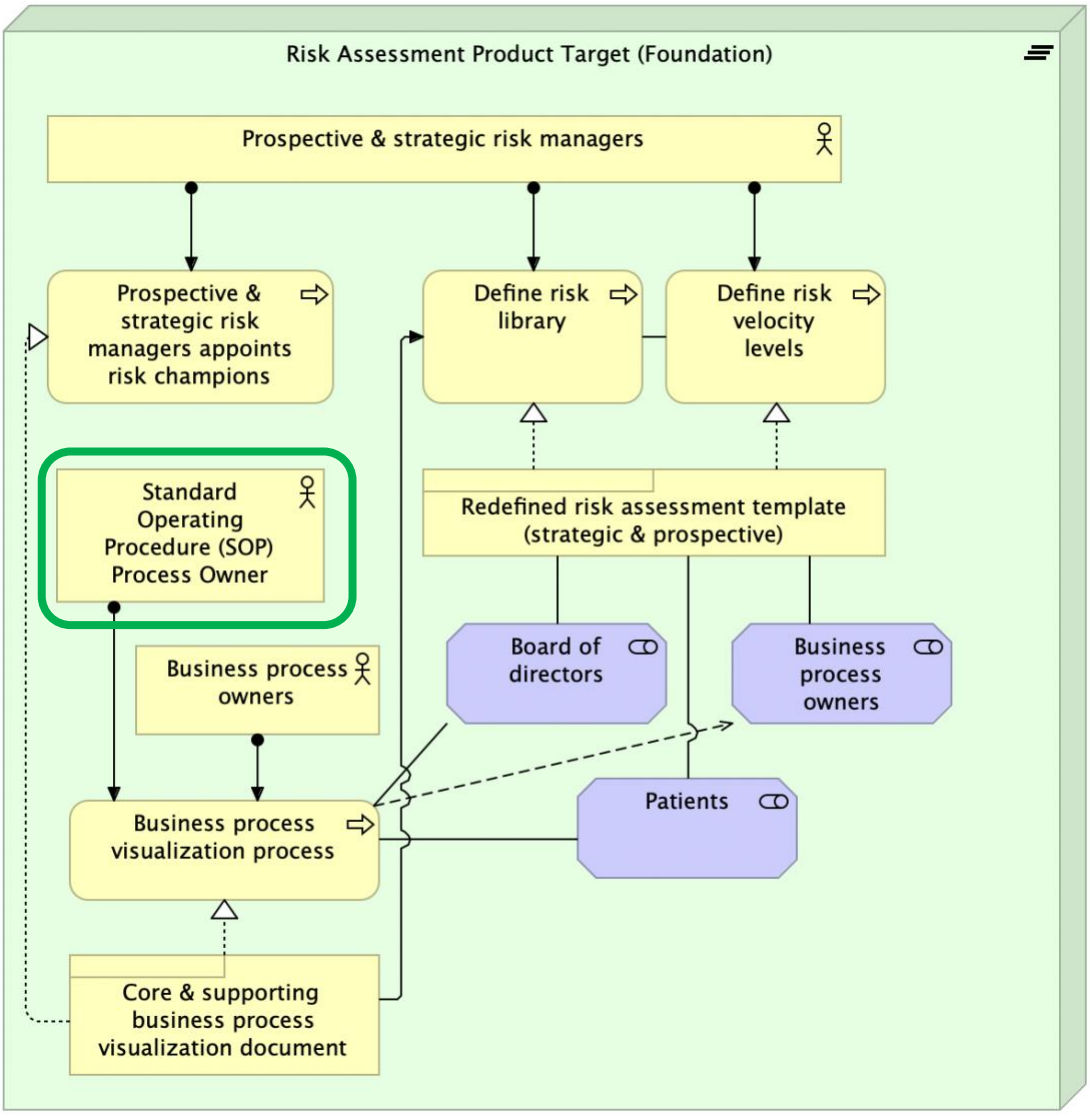



**FIGURE 34 UPDATED RISK ASSESSMENT PRODUCT TARGET (FOUNDATION)**

# CHAPTER 6
# DISCUSSION & CONCLUSION

## 6.1. Discussion

The research limits due to time restrictions are highlighted in the thesis discussion chapter. The thesis was able to conduct professional interviews on the guidance's possible implementation. However, it could not move on to the guidance's implementation and evaluation. This limitation makes evaluating the guidance's effectiveness and practical effects difficult. The lack of post-implementation evaluation creates a research gap, making it difficult to verify the benefits and outcomes of using risk velocity in the risk assessment process. Evaluation would have given helpful information about the suggested guideline's applicability, usefulness, and efficacy in actual situations. It might have also highlighted any difficulties, restrictions, or possible areas for improvement that might have emerged during the implementation procedure.

The inability to complete post-implementation evaluation indicates the demand for additional study and research. The long-term consequences and implications of including risk velocity might be studied, along with how it improves risk management procedures and aids in improved decision-making inside firms. To understand the impact of the advice, these evaluations may involve extensive data collection, analysis of key performance indicators, and stakeholder feedback.

## 6.2. Limitations

The current study has various limitations that require being addressed, including the following:

- The quality of data collected from KPMG clients may be less than optimal since they may not use the "correct" risk assessment procedures. As a result, the data may not represent the whole population of KPMG customers, and the conclusions may not be generalizable to other businesses.
- The data obtained may be incomplete since key risks or variables may be missing. As a result, the findings should be regarded with caution, and additional research may be required to provide a full knowledge of velocity's function in risk management.
- A language barrier is another potential restriction of the study. Because the clients are Dutch and the materials utilized in this study are in English, translation errors may occur, affecting the accuracy of the data obtained.
- The study's scope is limited because it focuses on KPMG's healthcare clients during the COVID-19 epidemic. This limits the findings' applicability to other industries and circumstances. The study could only include one customer as a case study due to time constraints and client availability, limiting the analysis depth and the findings' generalizability. However, a more diversified interviewee made up for this disadvantage in the validation phase.

Despite this drawback and limitation, the study offers a framework and instructions for businesses considering including risk velocity in their risk assessment processes. The results of the professional interviews offer insightful and important viewpoints on the probable relevance and usefulness of the suggested guidelines. Future research projects should try to close this gap by performing in-depth post-implementation evaluations to confirm the value and significance of the advice in real-world settings.

## 6.3. Future Work

This thesis's future work includes several prospective directions for more study and development. Following up on the comments and recommendations made during the validation interviews, the following areas can be investigated:

1. Investigating the relationship between velocity scores and other controls: A study can examine the connection between velocity scores and the efficacy of various controls based on the input from the case study interview. In addition to addressing the controls required for lower velocity risks, this research would go into understanding how specialized controls can foresee and manage higher velocity hazards.
2. Implementing the guidelines in additional case studies: Additional case studies might be used to implement the guidelines in order to test their relevance and ramifications in real-world situations. This research would allow one to examine how well the guidelines work in various organizational contexts and confirm their applicability in real-world situations.
3. Investigating the connection between organizational resilience and velocity incorporation in risk assessment: This study would investigate whether incorporating the risk-and-velocity concept into the risk assessment process enhances an organization's overall resilience. Insights into the potential advantages of adding velocity to risk management techniques can be obtained by researching the connection between risk assessment and organizational resilience.
4. Analyzing the proposed model compared to current risk assessment models: The proposed risk assessment model created with ArchiMate can be compared to existing models used in different healthcare organizations in a comparative study. The goal would be to find the model's advantages and disadvantages and suitability for use in various healthcare contexts. This study would shed light on the effectiveness of the suggested model and suggest possible directions for its development.

A more thorough comprehension of the suggested solution, its consequences, and its potential for widespread acceptance can be attained by following these future study topics. These research projects would aid in continuously improving risk assessment procedures, particularly concerning the inclusion of velocity as a significant factor.

## 6.4. Conclusion

In conclusion, this research has addressed the main research question of how velocity can be captured and analyzed in ArchiMate enterprise architecture models to create a risk assessment model in a hospital. Velocity has been incorporated as a variable within the risk assessment process, providing a means to quantify and assess the speed at which risks manifest. The utilization of ArchiMate enterprise architecture models has played a crucial role in two key aspects of the research. Firstly, it has served as the primary model for business process visualization, enabling a clear understanding of the organization's risk assessment process. Secondly, ArchiMate has facilitated the visualization of the organization's journey through different phases of implementing the proposed guideline, highlighting the gaps and the necessary deliverables in each phase.

The research has developed a comprehensive guideline, structured into a single-use process framework and an annual and ad hoc process framework. Validation interviews were conducted with stakeholders, including the case study hospital in the Netherlands, a chief audit executive, and a technology risk partner from a company in Indonesia. The feedback from these interviews highlighted the prospective usefulness of the proposed guideline in real-world scenarios.

It is important to acknowledge the limitations of this research, such as the limited time available to gather feedback from a wider range of stakeholders. Future work can build upon these limitations and explore areas for further research. This thesis contributes valuable insights that can benefit-risk departments across various industries worldwide, offering a foundation for enhancing risk assessment practices and incorporating velocity as a key component in the risk management process.

# APPENDIX & REFERENCE

# APPENDIX

## APPENDIX 1: INTERVIEW 1 QUESTIONS

| No | Theme | Questions | Purpose of the question |
|---|---|---|---|
| **1** | Introduction of the company | What are the main business processes of your hospital? | To be able to replicate the business process for enterprise architecture design in the solution, and also to understand the vital points of the hospital to later connect it to their risk assessment process. |
| **2** | | What are the main risks associated with these processes? | |
| **3** | | Who are the main stakeholders that are associated with the risk assessment process? | |
| **4** | Knowing the process | What are the procedures for risk assessment in your hospital? | To understand their standard procedure in conducting risk assessment, specifically, the factors used to define each risk. |
| **5** | | How do you ensure that your risk assessment procedures are up-to-date and reflect the latest best practices in the industry? | To understand the background study during the risk assessment process, whether there are ad-hoc processes or only regular updates. |
| **6** | | What are the main elements of your risk assessment template? | To be able to understand all of the factors used to define risk in their risk assessment, as well as how they define controls for each risk. |
| **7** | Risk appetite in the company | How do you prioritize the risks in this hospital? | To understand how risk assessment is being reviewed and finalized, as well as know the importance/ significance of risk assessment in the hospital. |
| **8** | | How do you involve stakeholders in the risk assessment process? | |
| **9** | | How do you ensure that your risk assessment procedures align with the overall goals and objectives of your hospital? | To understand how risk assessment in the hospital incorporates the company's objectives and goals. |
| **10** | Challenges | what are the challenges you face in the process of risk assessment? | Understanding the main challenges in defining risk assessment specific in the hospital and if the solution with velocity and enterprise architecture could help. |
| **11** | | What are the main factors that cause the Change in risk assessment templates over the years? | To understand the cause of changes in the format of risk assessments, to be able to understand the feasibility of implementing a new concept specifically related to risk velocity. |
| **12** | The velocity of risk* | How do you classify the current top risks into the velocity matrix? (for example, low, medium, and high in velocity, with the elaboration of why each of the measurements is low, medium, or high) | this question will help with the understanding of how a risk manager would define the measurement of velocity. |

## APPENDIX 2: RESULTS OF 1ST INTERVIEW

| no | Theme | Question | Answers |
|---|---|---|---|
| 1 | Introduction of the company | What is the main business process of your hospital? | The main focus of the risk department in the hospital is strategic risk management.<br>There are two risk assessment processes in this hospital - strategic risk management and prospective risk assessment.<br>There is no patent information about the main business process in this hospital as all of the departments in this hospital are interconnected with each other, but from my experience, I would say that the main business process is mainly to provide care for patients in the hospital, intensive care, surgeries, diagnostic process, e.g., blood, CT scan, etc., and operational departments, i.e., emergency room. |
| 2 | | What are the main risks associated with these processes? | The main risks related to the strategic risk are (not limited to):<br>- lack of staff (nurses and other support staff) quantity and quality could be influenced by the job market but can also be by diseases<br>- electricity & utilities (energy, water)<br>- IT: monitoring in intensive care, they have a patient data monitoring<br>- continuity of medical devices: MRI, scans, facilities |
| 3 | | Who are the main stakeholders that are associated with the risk assessment process? | Since this hospital is one of the third-line hospitals in the Netherlands, there are a lot of stakeholders involved. To mention a few based on the stakeholder's type:<br><br>Internal stakeholders: doctors (50 departments in the hospital), Board of directors, and director of departments<br>external stakeholders: patients, health insurance, safety organization |
| 4 | Knowing the process | What are the procedures for risk assessment in your hospital? | The risk assessment process (specifically for the strategic risk) are:<br>- identify: identification is performed by correlating the risks based on the hospital's annual goals.<br>- analyze<br>- prioritize: prioritization is done by calculating impact and likelihood.<br>- control<br>- evaluate |

| | | | |
|---|---|---|---|
| 5 | | How do you ensure that your risk assessment procedures are up-to-date and reflect the latest best practices in the industry? | The risk assessment process is conducted annually, so it is updated with the latest best practices and in line with the company's goals. |
| 6 | | What are the main elements of your risk assessment template? | The hospital is using a bowtie method for risk analysis, with the middle part being the possible risks, the right side for impact, and the left side for the root cause. |
| 7 | Risk appetite in the company | How do you prioritize the risks in this hospital? | -Strategic risk assessment: before 2022, we prioritized based on probability and impact; in 2022, we prioritized on which objective (of our strategy) we accept the least deviation.<br>-Prospective risk assessment: prioritizing based on probability and impact |
| 8 | | How do you involve stakeholders in the risk assessment process? | -Strategic risk assessment: we do brainstorms with several representatives for each objective of the strategy. The outcome of the brainstorms was discussed and reviewed by the responsible managing directors and the Board of directors.<br>-Prospective risk assessment: involved are the main employees who are responsible or who are part of the process |
| 9 | | How do you ensure that your risk assessment procedures align with the overall goals and objectives of your hospital? | Since the strategic risk assessment is being defined according to the hospital's goal, it is always in line with the overall goals and objectives of the hospital. |

| | | | |
|---|---|---|---|
| 10 | Challenges | what are the challenges you face in the process of risk assessment? | -In the last five years, there have been a lot of situations that have had a large impact on our organization (Ukraine, Covid, Brexit, lack of staff).<br>-Five years ago, nobody was interested in pandemic risks.<br>-It is complex to define the main (core and supporting) processes in the hospital. At first, there are a lot of dependencies between core processes themselves and also between supporting processes, like IT. Especially for IT, there are a lot of information systems.<br>-Some risks appear quickly, and we are insufficiently prepared because of a lack of attention. A hospital is able to react very quickly to the doctors and nurses. But the size (of our hospital) requires an appropriate approach like a large company.<br>-Calamities can have several impacts on our hospital. A calamity (for instance, an earthquake) can damage our buildings, but it also causes a large influx of patients. |
| 11 | | What are the main factors that cause the Change in risk assessment templates over the years? | -COVID<br>-Ukraine<br>-Lack of staff |
| 12 | Velocity | How do you classify the current top risks into the velocity of the risk matrix? | -Lack of staff and capacity: velocity is low<br>-Concentration of cure: velocity is medium<br>-Financial: medium<br>-Operating and control model: low |

# APPENDIX 3: INTERVIEW 2 (VALIDATION) QUESTIONS & RESULTS

| Question | | Answer | | |
|---|---|---|---|---|
| | | **<<redacted>>** | **Radboud UMC** | **RMS** |
| 1 | Can you confirm if you understand the purpose of the proposed guideline? | yes, it is clear | Yes, the purpose of the guideline is understood | Yes, the purpose of the guideline is understood. |
| 2 | Did you find any part of the guideline confusing? If yes, please explain which part/ why. | No, it is clear | We did not go into detail about the guidance because it is irrelevant to our organization's risk culture. | No, it is quite clear. There were several questions, but it has been explained during our discussion. |
| 3 | Was there anything missing from the part of the guideline that you expected to find? If yes, what was it? | no, so far, it is quite good | N/A | yes, I suggested adding the function of risk aggregator in step "risk champion appointment" within the guidance. |
| 4 | Did you find any aspect of the guideline useful? If yes, what is it? | Two ways: 1st about the relationship between business process architecture and general risk, and the 2nd is the matrix; I think it is a good one. | The guideline is useful but not specific for this organization because this guidance is intended for organizations with designated risk departments. | yes, the guideline is useful because it is generic. |
| 5 | Do you have any suggestions for how we can improve the guideline? | The next step is the relationship between velocity and the measures (detect and react). | No | yes, adding the function of risk aggregator as a middle function between prospective and strategic risk managers. The risk aggregator will also manage the connection between risk experts and the Board of directors (BOD). Aside from that, I also suggest that the business process visualization is conducted by Standard Operating Procedure Department. |

| | | | | |
|---|---|---|---|---|
| 6 | If you were to implement this guideline, was there anything specific that you would like to change from the guideline to tailor to your business? | The Change will be about the organization between EA and business (but not the guideline) level maturity of the | This guideline will not be applied in our organization for two key reasons:<br>1. There is no specialized risk management department.<br>2. Our risk culture is unique in that we do not calculate our risks using formulas but rather define them using colors with the assistance of our department leaders, who serve as risk champions. | Not a lot, mainly about adding the function of risk aggregator in the guidance. |
| 7 | Will this guideline be helpful to you in implementing the velocity of risk in your risk assessment process? | Yes | N/A | yes, since this guidance is pretty generic and can be implemented in most large organizations/ enterprises with dedicated risk management functions. |
| 8 | Would you recommend this guideline to others? If yes, why? If not, why not? | Yes, of course, with other risk management colleagues in UMCs because usually, it is only a list, not a process | Yes, in the case of an organization with calculated risk impacts. | Yes, to organizations that need to implement velocity risk. |

# REFERENCE


AlAli, M. (2020). *Risk velocity and financial markets performance: Measuring the early effect of COVID-19 pandemic on major stock markets performance*: pdfs.semanticscholar.org.

Aldea, A., Vaicekauskaite, E., Daneva, M., & Piest, J. P. S. (2021). *Enterprise Architecture Resilience by Design: A Method and Case Study Demonstration*.

Alfandi, G. (2015). *Investigating risk management capability of construction firms in the Gulf Cooperation Council (GCC) countries*: bura.brunel.ac.uk.

AuditBoard. (2020). Applying Risk Velocity to Your Audit Risk Assessment. Retrieved from https://www.auditboard.com/blog/applying-risk-velocity-to-audit-risk-assessment/

Campbell, S. (2006). Determining overall risk. *Journal of Risk Research, 8*(7-8), 569-581. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/13669870500118329

Carroll, R., ARM, M., CPHRM, H., Charney, F., & ... (2020). *ENTERPRISE RISK MANAGEMENT: Implementing ERM*: ashrm.org.

Chaparro, M. R. (2014). *A new dimension to Risk Assessment*: lup.lub.lu.se.

COSO, P. (2013). COSO Internal Control - Integrated Framework.

Curtis, P. D. C., M. (2012). Risk Assessment in Practice. 28.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of management journal, 50*(1), 25-32.

Foorthuis, R., Steenbergen, M. v., Brinkkemper, S., & Bruls, W. (2016). A THEORY BUILDING STUDY OF ENTERPRISE ARCHITECTURE PRACTICES AND BENEFITS. *Information Systems Frontiers, 18*(3), 541-564. doi:10.1007/s10796-014-9542-1

Fraser, J. R. S. (2014). *Implementing Enterprise Risk Management* (J. R. S. F. Betty Simkins, Kristina Narvaez Ed.): Wiley.

Group, T. O. (2023). ArchiMate® 3.2 Specification. Retrieved from https://pubs.opengroup.org/architecture/archimate3-doc/ch-Language-Structure.html#sec-The-ArchiMate-Core-Framework

Grove, H., & Clouse, M. (2020). *Financial and non-financial fraud risk assessment*: nacva.com.s3.amazonaws.com.

Harmon, P. (2002). *Business Process Change: A Manager's Guide to Improving, Redesigning, and Automating Processes*: Elsevier Science.

Harrison, R. (2018). TOGAF® 9 Certified Study Guide – 4thEdition: Preparation for the TOGAF 9 Part 2 Examination. 350.

Hopkin, P. (2013). Risk Management. 288.

Hosiaisluoma, E. (2021). ArchiMate Metamodel For Enterprise Development. Retrieved from https://www.hosiaisluoma.fi/blog/archimate-metamodel/

IRGC. (2005). Risk Governance – Towards an Integrative Approach. *White Paper no 1*.

ISO. (2002). Risk Management Vocabulary. *ISO/IEC Guide 73*.

ISO. (2009). Risk Management - Principles and guidelines.

Iverson, D. (2013). *Strategic Risk Management: A Practical Guide to Portfolio Risk Management*: Wiley.

Jedynak, P., & Bąk, S. (2021). *Risk Management in Crisis: Winners and Losers during the COVID-19 Pandemic*.

Jonkers, H., Lankhorst, M. M., Doest, H. W. L. t., Arbab, F., Bosma, H., & Wieringa, R. J. (2006). Enterprise architecture: Management tool and blueprint for the organisation. Retrieved from https://www.researchgate.net/profile/Farhad-Arbab/publication/220198712_Enterprise_architecture_Management_tool_and_blueprint_for_the_organisation/links/09e4150a2f6fca1010000000/Enterprise-architecture-Management-tool-and-blueprint-for-the-organisation.pdf

Kenett, R. S., & Raanan, Y. (2011). *Operational Risk Management: A Practical Approach to Intelligent Data Analysis*: Wiley.

Levine, D. (2013). *The GPS Framework: A New Approach to Comprehensive Strategic Risk Management*: soa.org.

Malfussi, L. B. H. d., Bertoncello, K. C. G., Nascimento, E. R. P. d., Silva, S. G. d., Hermida, P. M. V., & Jung, W. (2018). AGREEMENT OF AN INSTITUTIONAL RISK CLASSIFICATION ASSESSMENT PROTOCOL. 8. Retrieved from https://www.scielo.br/j/tce/a/yfdGbT9DHyg5pdc3hxVvFMd/?lang=en&format=pdf

Manoukian, J.-G. (2016). Risk appetite and risk tolerance: what's the difference? Retrieved from https://www.wolterskluwer.com/en/expert-insights/risk-appetite-and-risk-tolerance-whats-the-difference

Manzano, S., Granizo, C., Velasteguí, H., Guilcapi, J., Benalcazar, F., & Gordón, C. (2020) Enabling Electronic System for Emergency Alerts. In*: Vol. 1078* (pp. 184-198).

Myers, W. (2022). How to Classify Your Processes to Structure Your Business Process Architecture. Retrieved from https://www.viewpoint.co.za/blog/how-to-identify-three-types-of-processes-in-your-organisation/

Naviza, A., Sehgal, T., Cherrington, M., & Mehdipour, F. (2021). *Assessing organisational climate change risk*: online.op.ac.nz.

Partida, D. (2021). Health Care Risk Classifications and How They Can Affect Your Practice. Retrieved from https://www.healthitanswers.net/health-care-risk-classifications-and-how-they-can-affect-your-practice/

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems, 24*. doi:https://doi.org/10.2753/MIS0742-1222240302

R, K. S., Kattumannil, D. K., & ... (2022). Enterprise Architecture. *Event-and Data-Centric …*. doi:10.1007/978-1-4842-7440-8_5

Rosa, E. A. (1998). Metatheoretical foundations for post-normal risk. *Journal of Risk Research, 1*, 15-44. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/136698798377303

Rosenfeld, J. (2021). The 10 Industries That Have Been Impacted the Most by COVID-19. Retrieved from https://www.gobankingrates.com/money/business/the-industries-that-have-changed-the-most-due-to-covid-19/?utm_campaign=1063597&utm_source=yahoo.com&utm_content=3

Stanislav, P. (2016). *Risk management in transportation companies: Russian and Finnish practices*: dspace.spbu.ru.

Suresh, N., Sanders, G. L., & Braunscheidel, M. J. (2020). Business Continuity Management for Supply Chains Facing Catastrophic Events. *IEEE Engineering Management Review, 48*(3), 129-138. doi:10.1109/EMR.2020.3005506

Tzanakakis, K. (2021) Risk assessment techniques. In*: Vol. 18. Springer Tracts on Transportation and Traffic* (pp. 113-146).

Veiligheidsprogramma, V. (2012). *Praktijkgids Prospectieve Risico-Inventarisatie (PRI)*.

Weske, M. (2007). *BUSINESS PROCESS MANAGEMENT: CONCEPTS, LANGUAGES, ARCHITECTURES*: Springer Science & Business Media, 2007.

WHO. (2009). Conceptual Framework for the International Classification for Patient Safety. *Final Technical Report January 2009*. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/70882/WHO_IER_PSP_2010.2_eng.pdf

Wieringa, R. J. (2014). *Design Science Methodology for Information Systems and Software Engineering*. Heidelberg: Springer Berlin.

Young, B., & Coleman, R. (2010). *Operational Risk Assessment: The Commercial Imperative of a more Forensic and Transparent Approach*: Wiley.

Enschede, The Netherlands
June 2023