Architecting Innovative Engineering Organizations within Large Technology Enterprises Using a Systems Thinking Approach

by

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ABSTRACT

The technology industry has experienced significant transformations driven by rapid technological developments, changing market demands, and evolving business models. These changes have led to the creation of new products and services across various segments within the technology industry. With their substantial market value, large enterprises are crucial for driving innovation and boosting the economy. However, they face fierce competition from both established and emerging players, compounded by challenges such as economic uncertainty. Overcoming barriers to innovation is essential. Engineering organizations are the backbone of technology companies, making it vital for large enterprises to design innovative engineering organizations to remain competitive and create real value in the industry.

The primary objective of this thesis is to investigate key factors, strategies, and approaches that foster an innovative environment to drive organizational innovation. Additionally, it demonstrates how a systems thinking approach can holistically analyze an enterprise and generate crucial considerations for designing future organizational architecture. To achieve this goal, the study begins with a literature review on innovation barriers and generic strategies that might help cultivate an innovative environment. A discussion of approaches drawn from case studies to improve innovative environments is also presented. Based on these strategies and approaches, the study suggests several desired attributes to consider in transforming the organizational architecture for innovation. The study then employs an enterprise architecting framework to holistically analyze an engineering organization within a large technology enterprise. This analysis identifies the emerging stakeholder values the organization may embrace to remain competitive.

Building on this foundational analysis, the thesis proposes multiple alternative architectures. These architectures are then evaluated to determine their effectiveness, with detailed discussions on important considerations for various potential future scenarios. Finally, the thesis suggests an actionable plan for implementing the new architecture, aiming to create an innovative engineering organization and enhance the enterprise's competitive advantages in the technology industry.

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Chapter 1. Introduction

1.1. Background

The technology industry has undergone a dramatic transformation, shaped by technological advancements (Yaqub & Alsabban, 2023), changing consumer demands (Zhou et al., 2007), and evolving business models (J. Lee et al., 2019).

Technology advancements create new products and services. Improvements in Very-large-scale integration (VLSI) technology and multimedia significantly widened the range of desktop applications running on faster computers (Ramamoorthy & Tsai, 1996). Advancements in mobile devices, such as cell phones and tablets, have paved the way for new location-based services (Bellavista et al., 2011). In the past ten years, the emergence of cloud computing and 5G technology has increased computing power and network speeds, further enabling more interruptive innovations such as virtual reality and the metaverse (Kuiken, 2022). The latest developments in machine learning models and computer vision technologies have introduced new automation capabilities to various industries, such as manufacturing (Chui et al.,2023). These advancements have brought new products and services to the market, driving the industry forward.

There has also been a significant shift in customer demands and their engagements with technologies. In the consumer market, an increasing number of customers are adopting mobile devices and applications, leading to significant growth in their use (Smith, 2017). Customers now demand products with greater variety and more advanced technological features (Kovacs & Kot, 2016). Similarly, changes are occurring in the enterprise market. As shown in Figure 1-1, more enterprise customers now view technology not simply as a supplementary service but as a vital component of their business operations. Consequently, they demand proactive management of technology within their daily activities (Martinez, 2019). Additionally, enterprises are increasingly concerned about privacy and cybersecurity risks, striving to balance the introduction of new technologies with the management of these potential risks (Yeo et al., 2022). These changes are influencing how technology companies develop, market, and manage their products and services.

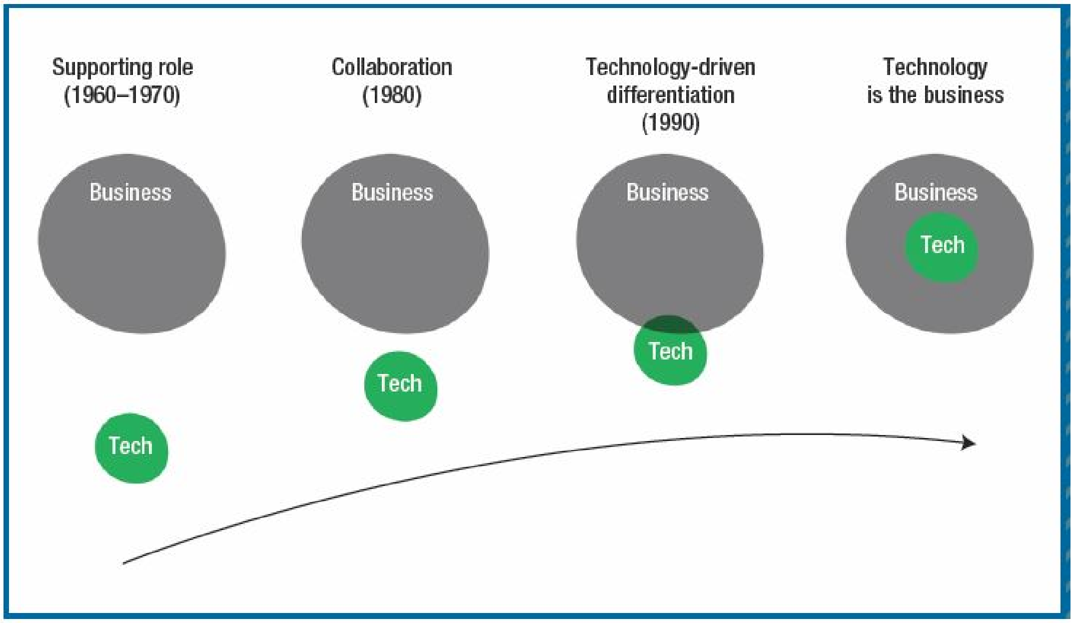

Figure 1-1 The changing role of technology for business customers (Martinez, 2019).

Business models for technology companies are continuously evolving. Established companies are increasingly shifting from selling products to providing services. For example, as Figure 1-2 illustrates, many software companies are adopting diverse business models. Traditional license sales have declined, with revenues shifting toward services such as annual fees and value-added technical support (Cusumano, 2008).

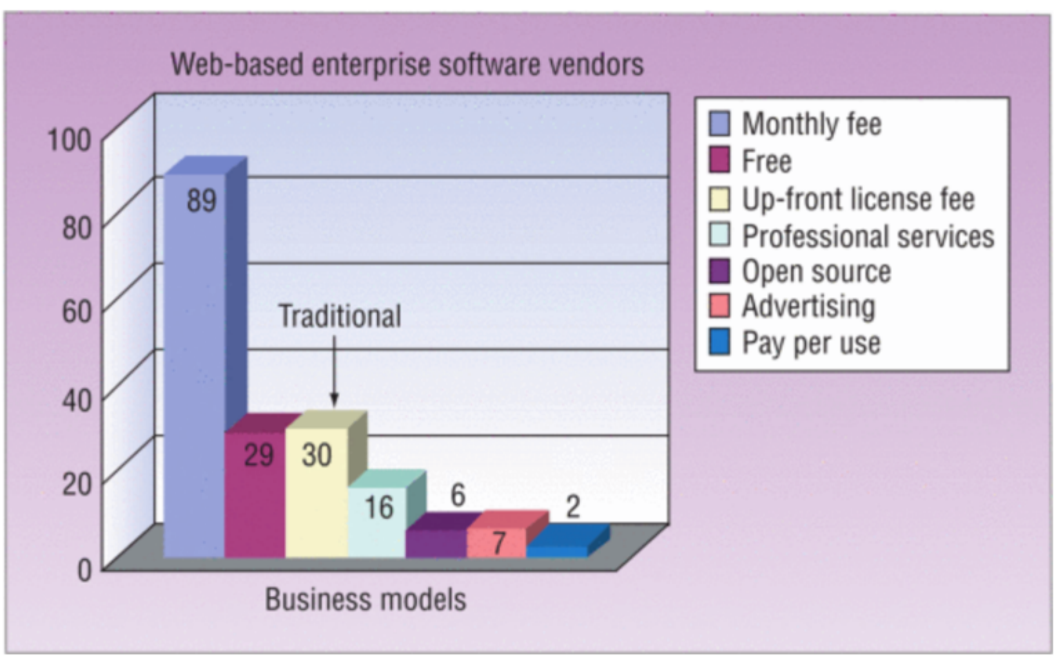

Figure 1-2 New business models for web-based software vendors (Cusumano, 2008)

Not only in software companies, but a McKinsey study suggests that hardware companies are also exploring new business models to capture market opportunities better. As shown in Figure 1-3, these companies are adopting cloud-like subscription models, where customers pay for actual usage of hardware on a recurring basis instead of a one-time payment (Agarwal et al., 2021).

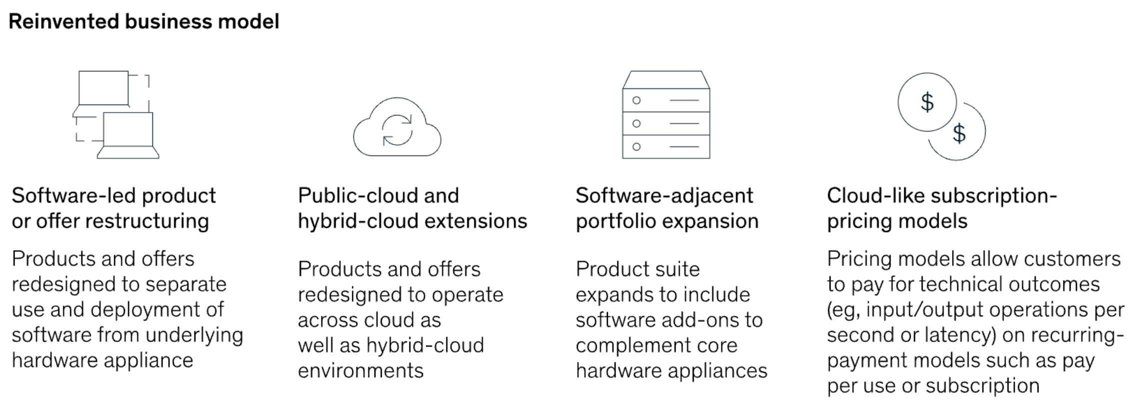

Figure 1-3 Reinvented business model for IT-infrastructure manufacturers (Agarwal et al., 2021)

In addition, digital technologies such as e-commerce and streaming have enabled some companies to completely transform traditional models to the online environment, as seen with Netflix's shift from DVD rentals to online streaming (Allegretti et al., 2021).

The technology industry is also a sector with significant market value (Precedence Research, 2023) and serves as a major contributor to the U.S. economy (U.S. Department of Commerce, 2024). However, the industry is characterized by intense competition, with an increasing number of competitors, including well-established corporations and emerging small-size companies (Rubin et al., 2002), all striving to secure their market share. An industry report shows that in the software and IT services sub-category alone, over 550,000 companies existed, and more than 13,400 technology startups (newly established companies) were created in 2019 (CompTIA, 2019). In addition to the growing number of competitors, companies also face challenges such as growth uncertainty and economic recessions (Ananthakrishnan et al., 2021). Finally, due to privacy and data security concerns, regulators are enforcing stricter regulations on technology companies worldwide, increasing their risks and operational costs (Comis et al., 2024).

In an industry as dynamic as technology, maintaining a competitive edge and fostering continual innovation is not merely a goal but a survival strategy for enterprises of all sizes.

1.2. Problem Definition

The technology industry is advancing at an unparalleled pace, forcing organizations to adapt or face obsolescence. A critical issue confronting today's well-established large technology enterprises, particularly in their engineering divisions, is a diminishing capacity for innovation (Meyer, 2022). This decline not only restricts growth but could also threaten the enterprise's competitive edge and long-term viability (Meyer, 2022).

Previous research has observed several manifestations of this diminishing performance, including slow adaptation to technological trends (Wolfe, 1994), innovation stagnation due to risk aversion (Netessine, 2013), and poorly designed but frequent organizational restructuring (Porter & Wilton, 2020). According to several earlier studies, some key factors could positively influence an organization's capacity for innovation. Some of the key factors are organizational structure and culture (Fahim et al., 2021; Ojochide et al., 2018), leadership styles (Fahim et al., 2021), knowledge management (Kim & Park, 2021; Hussain et al., 2022), and collaboration (Birch & Bronson, 2022).

Various techniques and approaches are utilized in organizational design to analyze, optimize, and enhance various aspects of organizational functioning. These methods include simulation-based approaches (Repenning, 2002), computational and mathematical organization theory (Carley, 1995), and qualitative research methods (Garcia & Gluesing, 2013). Additionally, techniques such as agent-based modeling (G. Lee et al., 2015) and system dynamics (Sanchez-Segura et al., 2018) are employed to study organizational structures, behaviors, and interactions.

Given the evolving challenges in the technology industry, large enterprises seek effective architectural strategies to support engineering organizations in enhancing and sustaining innovation. Drawing from theory and real business practices to incorporate them into organizational design and evaluating organizational architecture has become a key question for every large tech company aiming for innovation.

1.2.1. Research Objective

The objective of this study is to investigate factors, strategies, and approaches that contribute to cultivating an innovative environment to drive organizational innovation. Additionally, it demonstrates how a systems thinking approach can holistically analyze an existing enterprise and prioritize considerations for designing future organizational architecture. Specifically, the research addresses the following questions:

1. In large technology enterprises, what general strategies and practical approaches could facilitate the creation of a positive environment that drives organizational innovation?
2. In developing a future engineering organization, what considerations are important to ensure that the organization enables the large enterprise to gain competitive advantages in the technology industry?

1.2.2. Research Scope

This study focuses on the engineering organization within a hypothetical technology company modeled after several large U.S. technology enterprises.

1.2.3. Research Approaches

The study begins by conducting a literature review to understand the challenges faced by engineering organizations and to identify several barriers that diminish innovation capabilities within large enterprises. This review also identifies various general strategies to foster an innovative environment. Case studies are then examined to present some practical approaches large enterprises use to transform their organizations into more innovative entities. Next, the study synthesizes insights from the literature review and case studies to suggest some characteristics of innovative organizations. Recognizing the interconnected relationship among innovation strategies, approaches, innovation barriers, and the enterprise environment, the study employs the ARIES framework, a holistic enterprise architecting approach based on systems thinking, as a demonstration to analyze the current architecture and design a future architecture, generating key considerations throughout the entire architecting process.

1.3. Thesis Outline

Chapter 1: This chapter provides an overview of the evolving landscape of the technology industry. The objectives and scope of the thesis are also defined in this chapter.

Chapter 2: This chapter introduces large technical enterprises within the technology industry and explores the role of their engineering organizations. It also discusses the current barriers that these organizations face, providing a context for addressing these challenges in later chapters.

Chapter 3: Building on the previous discussions, this chapter examines some generic strategies that could positively influence organizational innovation, focusing primarily on leadership, organizational structure, and culture. Additionally, this chapter introduces the ARIES framework as a holistic approach to designing enterprise architecture.

Chapter 4: This chapter examines several case studies and discusses various companies and their specific approaches to fostering innovation. This chapter also links these approaches to generic strategies discussed in Chapter 3 and suggests several characteristics of innovative organizations.

Chapter 5: This chapter introduces the ARIES framework, a holistic approach to architecting future enterprises. This chapter also discusses the interrelationship between the enterprise environment, innovation barriers, and innovation strategies and approaches. It suggests using the ARIES framework as a systems thinking approach to holistically analyze the enterprise and guide the development of innovative engineering organizations in the technology industry.

Chapter 6: This chapter employs the ARIES framework to analyze the engineering organization architecture of a well-established large enterprise, M-Corp. It examines the external and internal landscapes of its engineering organization, identifying key stakeholders and describing their value exchanges. The chapter also highlights the emerging values of these stakeholders and suggests approaches for developing an innovative organization that can respond to emerging needs and rapid changes in the industry. The envisioned future of the organization is discussed as well.

Chapter 7: This chapter constructs alternative architectures incorporating insights from Chapters 2 and 3. Each potential architecture is evaluated against specific criteria to determine if it meets stakeholder needs and addresses changes in the landscape. Additionally, future-proofing evaluations are performed to discuss the potential risks of the selected architectures under different scenarios. An implementation plan is also proposed.

Chapter 8: The final chapter summarizes the study's conclusions, outlining key findings and insights from the research. It also discusses the study's limitations and suggests areas for future work.

Chapter 2. Large Enterprises and Innovation Barriers

This chapter begins by introducing large technical enterprises and explores the role of engineering organizations within these entities. It then delves into a literature review that identifies various barriers and challenges these organizations face.

2.1. Large Enterprises

Large tech enterprises, often referred to as *Big Tech* —such as Apple, Amazon, Microsoft, Google (Alphabet), and Facebook (Meta)—are dominant forces in the technology industry. They possess significant market power and are pivotal in the modern digital economy and society. These companies have revolutionized how people communicate, access information, shop, and conduct business. They have introduced innovative products and services that have transformed industries and shaped consumer behavior (Patel & Pavitt, 1990). For example, Apple's iPhone revolutionized the smartphone industry and enhanced user convenience (Goggin, 2009); Google's search engine dominates the online search and advertising market (Patterson, 2012); Amazon has revolutionized e-commerce, impacting various markets and retailers by providing a wide range of products and services (AI-Abri & Pandey, 2020); Microsoft's Windows operating system is widely used in personal computers (Microsoft, 2022); and Meta's social media platforms, Facebook and Instagram, have connected billions of people worldwide (Meta Platforms, 2022).

Large enterprises often operate under intense competitive pressure. The rapid development of information technology and global economic competition heighten the competitive pressure (Hsia & Tseng, 2015). These firms are also continually challenged by an evolving international competitive environment and high innovation demands, necessitating continuous adaptation and innovation to maintain their competitive edge (Guenther Schuh et al., 2016).

In their approach to innovation, large technical companies exhibit several key characteristics. Firstly, they often focus on independent innovation to enhance their technological capabilities and maintain a competitive edge (Zhu et al., 2020). They may be hesitant to disclose intellectual capital, technologies, and insights to safeguard their competitive advantage, fearing potential negative effects (Hsu & Chang, 2011). Furthermore, these companies aim to increase their innovation output through correction and risk-smoothing effects (Feng et al., 2023), and they are often reluctant to pursue high-risk innovations that might have negative impacts on their short-term operations and financial performance (Feng et al., 2023).

In conclusion, large tech companies are key players in the industry, driving innovation, product creation, and economic growth. However, they also face intense competition driven by technological advancements, global economic pressures, market dynamics, and the imperative for continuous innovation to uphold their competitive positions in the industry.

2.2. Engineering Organization

In this study, *engineering organizations* are defined as those responsible for technical product development, providing related services, and product support within large technology enterprises. Engineering organizations are crucial in tech companies. Externally, they play a significant role in developing cutting-edge technologies, designing innovative products, and ensuring successful continuous operations of products (Korte & Li, 2015). Internally, they tailor product development practices and ensure the delivery of valuable products within organizational constraints (Paternoster et al., 2014).

Engineering organizations have been adapting by embracing new technologies and methodologies to address the increasing complexities of products and emerging market needs (Brandon, 2008). Waterfall and Agile are two popular product development methodologies that have significantly influenced engineering organizations, and some organizations are now adopting hybrid approaches that combine elements from multiple methodologies to better meet their specific needs. (Vijayasarathy & Butler, 2016).

The traditional Waterfall model was one of the earliest product development methodologies, characterized by a linear and sequential approach to product development (Kuhrmann et al., 2017). As shown in Figure 2-1, the model has a very clear role definition and division in the origination for different purposes, such as design, implementation and test (Stober & Hansmann, 2010). The organization dominates requirements, design, and programming activities (Benediktsson et al., 2006), and there is no customer involvement during the development process (Halani & Jhajharia, 2022).

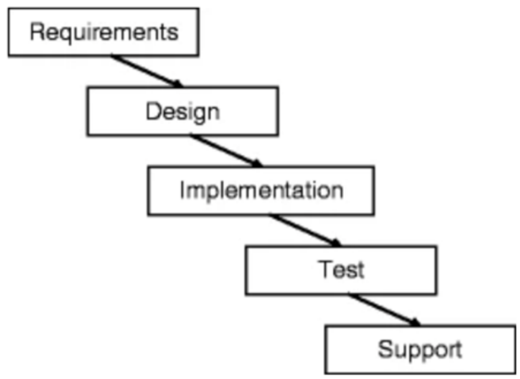

Figure 2-1 Traditional waterfall product development process (Stober & Hansmann, 2010)

On the other hand, as shown in Figure 2-2, Agile methodologies introduced a more iterative and flexible approach to product development. These methodologies emphasize collaboration, adaptability, and customer feedback, allowing incremental development and frequent iterations to deliver high-quality products (Abrahamsson et al., 2003; Kuhrmann et al., 2017). Agile organizations exhibit specific characteristics that distinguish them from traditional organizations. Instead of having fixed role assignments for all project teams, Agile team formation is influenced by project characteristics (Zainal et al., 2020). Furthermore, Agile organizations tend to have flatter hierarchies, which support self-organization, enable quicker decision-making, and foster an iterative work approach (Rietze & Zacher, 2022).

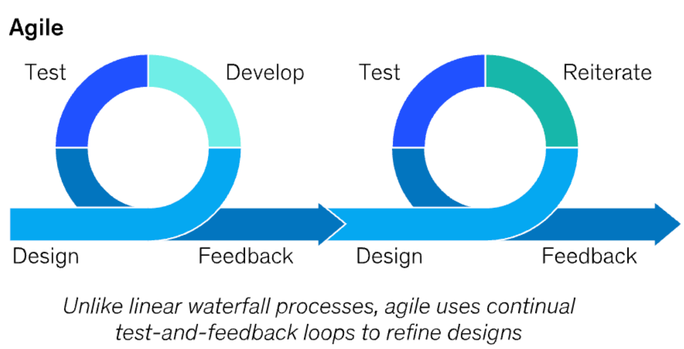

Figure 2-2 Agile product development process (McKinsey, 2023)

Several studies have suggested a link between organizational structure and an organization's capacity for innovation. Organizations with flexible, less hierarchical structures characterized by openness to external connectivity tend to have greater innovation capacity (De Mello et al., 2012). Such structures facilitate innovation processes by allowing for faster information sharing and quicker decision-making, and they are particularly effective in dynamic environments where rapid responses and continuous improvement are crucial (De Mello et al., 2012; François et al., 2002). In addition, structures that support continuous learning and adaptation are more likely to foster sustainable innovation (AI-Jayyousi, 2017). Furthermore, elements such as specialization, formalization, and informal social relations within an organizational structure can also positively influence innovation capability, which in turn enhances operational performance (Iranmanesh et al., 2021).

These studies collectively indicate that an organization’s innovative capacity is heavily influenced by its structure. Consequently, large technical enterprises would likely need to design their engineering organization structures strategically to maximize innovation capacity and maintain a competitive edge.

2.3. Barriers to Innovation

Real barriers exist in organizations to prevent them from delivering real innovations that create value. Barriers include a lack of capacity to spend on new things, resistance to change, and lack of innovation skills or infrastructure to implement new ideas (Anthony et al., 2019).

One barrier is the loss of innovation capability. The theory of the capability trap (Repenning & Sterman, 2001, 2002) suggests that organizations sometimes boost short-run process improvement at the expense of investment in improvement and learning. Research suggests that it is prevalent in various domains and organizations (Landry & Sterman, 2017). The organization enters a loop where the capacity goes down, and the performance goes down, leading to more short-run effort and, eventually, a greater performance shortfall and lack of capacity. The standard causal loop diagram for the capability trap is shown in the Figure 2-3.

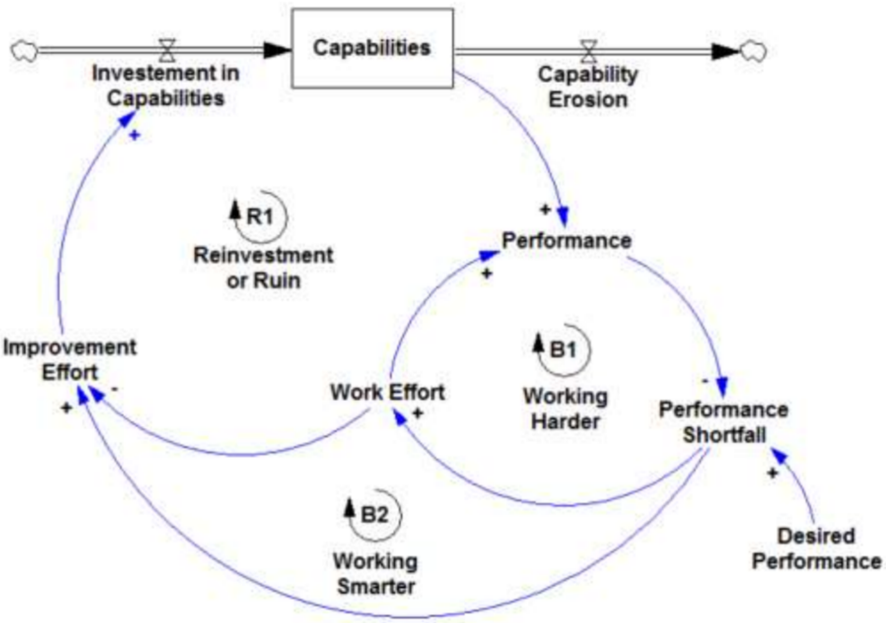

Figure 2-3 The capability trap causal loop diagram (Repenning & Sterman, 2001, 2002).

Another barrier is the organization's reluctance to change its existing processes. Large enterprises try to manage new business-like mature businesses by trying to fit the new business into existing organizations and processes (Watt & Abrams, 2019). For instance, a new business model may be evaluated through the existing lens, potentially underestimating its actual value. Additionally, there may be a perception that deviating from traditional methods offers no benefits, only additional costs. (Anthony et al., 2019).

The third barrier may be the organization's lack of skills (Anthony et al., 2019) and infrastructure, such as positive culture and management support, which are essential for implementing changes (Klein & Knight, 2005). For instance, implementing innovation often necessitates role changes (Holahan et al., 2004). One study found that doctors and nurses were unwilling to step out of their expert role during transformations due to insufficient management support (Edmondson et al., 2001). Therefore, an organization's skills, climate, and culture for innovation are crucial in driving change and successfully implementing transformative innovations. (Edmondson et al., 2001; Holahan et al., 2004).

This section discusses three significant barriers to innovation that large enterprises face: lack of capacity to spend on new things, resistance to change, and a lack of innovation skills or infrastructure to implement new ideas (Anthony et al., 2019). To unleash their innovative potential, large enterprises must recognize and overcome these obstacles. Notably, one of the biggest impediments is the organization itself. Without addressing this, efforts to tackle other barriers individually will likely be ineffective (Anthony et al., 2019). Therefore, it is crucial to approach these innovation barriers from an organizational perspective, identifying the desired attributes necessary for sustaining innovation.

Recognizing the barriers in today's organizations, the next question is: What does an innovative organization look like? The following chapter conducts a literature review to identify and suggest some strategies used for architecting an innovative organization.

Chapter 3. Innovation Strategies

A purposefully designed organization, incorporating roles, processes, rewards, and people practices, is more likely to generate innovations and overcome obstacles to innovation (Galbraith, 1982). Specific strategies could be crucial in enhancing an organization's innovative capabilities. This chapter discusses several strategies under three categories—leadership, organizational structure, and culture—identified in the literature as likely to foster continuous innovation within organizations.

3.1. Leadership

The actions of key individuals, such as leaders, are a crucial factor driving the pursuit of innovation because they strongly influence organizations in both direct and indirect ways (Jung et al., 2003). Recent research suggests that transformational leadership is a key factor influencing organizational innovation (Vaccaro et al., 2012). Transformational leaders continuously inspire and motivate their teams, fostering a culture of creativity, risk-taking, and continuous improvement. Some of their actions include articulating clear visions, exhibiting passion, emphasizing ethics and values (Bush, 2018), and motivating employees to engage in risk-involved innovations, thereby driving organizational innovation (Fang et al., 2019). They could also support innovation by encouraging information sharing and collaboration and ensuring political problems do not fester (Amabile, 2006). Furthermore, research shows that larger organizations could draw on transformational leaders to compensate for their complexity and allow management innovation to flourish (Bush, 2018).

Table 3-1 summarizes leadership strategies that can help cultivate an optimal organizational environment to enhance innovation.

Table 3-1 Leadership strategies that foster innovation

Category	General strategies
Leadership	• Articulate a clear vision. • Exhibit passion. • Emphasize ethics and value. • Motivate employees to engage in innovation. • Encourage information sharing and collaboration. • Ensure political problems do not fester.

3.2. Organization Structure

In the view of many scholars, the organizational structure is also an essential factor in driving organizational innovation. A less hierarchical organization generally means less restricted communication flows (Pierce & Delbecq, 1977), which can facilitate the rapid implementation of complex processes and new technologies (Rehman et al., 2022). Additionally, a flatter structure is likely to enhance the flow of new ideas both into and out of the organization (Amponsah, 2018), promoting an environment conducive to innovation and continuous improvement.

An open architecture to the public may encourage organizations to establish partnerships and engage with external stakeholders, potentially creating a collaborative ecosystem (Roldán Bravo et al., 2016). By building relationships with external entities, organizations might broaden their perspectives, access new markets, and develop innovative business models, and this approach could ultimately enhance innovation and competitiveness (Marques et al., 2016).

Furthermore, Darvishmotevali (2019) suggests that the existence of decentralization could influence innovative behavior among employees, as it allows for greater autonomy and quicker decision-making, which could contribute to innovation within the organization.

The role of cross-functional teams has been linked to organizational innovation. A study suggests that cross-functional teams, particularly in technical phases of innovation, could enhance the success rate of innovation initiatives. However, their effectiveness is not universal and depends on the right mix of support, collaboration, and organizational alignment (Blindenbach-Driessen, 2015). In other words, effective cross-functional teams are characterized by a strong shared identity, encouragement of risk-taking, customer involvement, and active senior management engagement.

Regarding organizational structure, features such as a flatter hierarchy, openness, and decentralization can facilitate knowledge and information exchange, encourage experimentation, empower employees, and foster collaboration with external partners. These are some of the considerations that promote organizational innovation. Regarding the cross-functional team, it could be beneficial in specific contexts. However, challenges such as internal conflict and communication barriers must be managed to realize the full benefits of these teams. The strategies under the organization structure category are summarized in Table 3-2.

Table 3-2 Organization structure strategies that foster innovation

Category	General strategies
Organization Structure	• Employ a less hierarchical structure to facilitate smoother communication flows. • Implement open architecture to enable external collaboration. • Adopt decentralization to enhance autonomy and expedite decision-making processes. • Utilize cross-functional teams, depending on the specific context.

3.3. Culture

According to earlier studies, culture could be a pivotal factor in driving innovation because it helps determine an organization's innovation strategy (Naranjo-Valencia et al., 2011). For instance, in new product development, a culture that fosters fast innovation and a willingness to embrace failure may encourage strategies to be the first to market rather than following a pioneer (Naranjo-Valencia et al., 2011). A culture that promotes creativity, risk-taking, and experimentation is more likely to drive successful innovation initiatives (Gaynor, 2013). Additional cultural traits, such as continuous learning, have also been shown to positively influence an organization's propensity for innovation (Kumar & Sharma, 2018).

A continuous learning culture could enable organizations to engage in sustained searching, experimentation, and embedding behaviors that support innovation. Research indicates that the continuous ability to acquire and exploit technology is a key driver of innovation in large-scale firms (Koc & Ceylan, 2007). Beyond new technologies, the renewal of business models and management strategies are also important elements of continued learning (Nisula & Kianto, 2013). A culture that supports continuous learning is likely to enable organizations to build core competitive advantages and exceed their initial capabilities (Hayes & Allinson, 1988), ultimately leading to enhanced performance and sustained growth.

Cultivating an organizational culture that values innovation and encourages experimentation could fuel the generation of new ideas and implementing innovative practices. This approach not only supports the immediate goals of innovation but may also contribute to long-term organizational resilience and adaptability (Petrakis et al., 2015).

The strategies under the culture category are summarized in Table 3-3.

Table 3-3 Cultural strategies that foster innovation

Category	General strategies
Culture	• Promote creativity to stimulate innovative ideas. • Promote risk-taking by taking calculated risks without fear of negative consequences for failures. • Promote experimentation and discover practical solutions and improvements. • Establish continues learning.

3.4. Summary

Table 3-4 presents a compilation of three categories and their associated general strategies for consideration when designing an innovative organizational architecture.

Table 3-4 Strategies in leadership, organizational structure, and culture that foster innovation

Category	General strategies
Leadership	• Articulate a clear vision. • Exhibit passion. • Emphasize ethics and value. • Motivate employees to engage in innovation. • Encourage information sharing and collaboration. • Ensure political problems do not fester.
Organization Structure	• Employ a less hierarchical structure to facilitate smoother communication flows. • Implement open architecture to enable external collaboration. • Adopt decentralization to enhance autonomy and expedite decision-making processes. • Utilize cross-functional teams, depending on the specific context.
Culture	• Promote creativity to stimulate innovative ideas. • Promote risk-taking by taking calculated risks without fear of negative consequences for failures. • Promote experimentation and discover effective solutions and improvements. • Establish continues learning.

Chapter 4. Approaches to Organization Innovation

Chapter 3 examines general strategies from the literature review that facilitate the creation of a conducive environment for organizational innovation. This chapter reviews the literature and analyzes several companies and their specific approaches to fostering innovation. For each company case, the approaches are identified and linked to one of three categories: Leadership, Organizational Structure, and Culture. This chapter concludes by suggesting several characteristics of innovative organizations that might be considered when transforming an organization into an innovative one.

4.1. Case analysis: IBM

IBM was founded in 1911 through the merger of three companies. By the mid-1980s, IBM's products were regarded as sound solutions to a range of business problems. However, in 1991, the company's earnings dropped to a negative $2.8 billion—a plummet of 146%. A case study suggests that at that time, IBM faced several key innovation issues: stifled innovation processes, making it difficult to develop new businesses that did not fit into any current category; poor commercialization of innovations and bringing them successfully to market; a fragmented organization with multiple strategic business units (SBUs) operating independently, leading to internal competition and inefficiencies; and a lack of sustained focus on emerging markets and new technologies due to a focus on short-term execution (Applegate et al., 2009).

In the late 1990s and early 2000s, under CEO Lou Gerstner, IBM began to take several approaches to overcome these issues. The *One IBM* initiative involved restructuring the company into larger business groups and creating centralized functions for global operations, ensuring unified execution across the company. IBM set up a special program, Emerging Business Opportunities (EBO), to identify and nurture new business opportunities with tailored management approaches and dedicated resource support for different maturity levels of innovations (Applegate, 2008). The company standardized and re-engineered core processes across all business units to improve efficiency and achieve cost savings. IBM also moved away from proprietary systems and embraced open standards, focusing on integration and services rather than competing in every product category. Additionally, the company created dedicated sales and service teams for key accounts to ensure better customer service and responsiveness (Applegate et al., 2009). These approaches helped IBM regain its innovation. Profits turned positive, and the EBO program successfully nurtured new high-growth businesses (Applegate et al., 2009).

Table 4-1 summarizes IBM's approaches to innovation, drawing from studies by Bjelland & Wood (2008) and Applegate et al. (2009).

Table 4-1 Case study summary - IBM's approaches to fostering innovation

Category	IBM's approaches
Leadership	• Created the One IBM Initiative as the core strategy. • Executed the core strategy unified execution across the company.
Organization Structure	• Created centralized functions for global operations. • Created Emerging Business Opportunities (EBO) with tailored management approaches and dedicated resources for different maturity levels of innovations. • Created dedicated sales and service teams for key accounts
Culture	• Moved away from proprietary systems and embraced open standards. • Organized large-scale hackathons that fostered collaboration across silos and promoted fast-paced problem-solving and innovation.

4.2. Case analysis: Microsoft

Microsoft is one of the largest technology companies in the world. Its products include operating systems, cross-device productivity and collaboration applications, server applications, business solution applications, desktop and server management tools, software development tools, and video games. The company's vision is to reinvent productivity and business processes, build an intelligent cloud and intelligent edge platform, and create more personal computing (Microsoft, 2023).

Despite its early dominance with the Windows operating system, the company faced increasing challenges and criticism around 2010. One major criticism is that Microsoft has not responded quickly enough to the threat posed by online productivity apps. As Salesforce CEO Marc Benioff noted, the software industry was moving online, and Microsoft had not kept pace with innovation (Hoover, 2007).

At the same time, user and usage volumes on mobile devices were increasing globally, leading to significant competition for Microsoft's Windows operating system from alternative platforms by Apple and Google. The company's cloud-based services also faced numerous competitors (Microsoft, 2010).

Tabrizi (2023) discusses the approaches Microsoft employed to regenerate its innovation capabilities under the new CEO Satya Nadella. Nadella initiated a cultural shift in 2014, emphasizing a mission to "empower every person and organization on the planet to achieve more." This marked a move from defensive strategies to bold investments in emerging technologies. Microsoft embraced partnerships and open platforms, supporting its rival Linux and iOS operating systems and acquiring key companies like LinkedIn, GitHub, and Activision Blizzard. These acquisitions expanded Microsoft's capabilities in social media, developer platforms, and gaming. Adopting a startup mindset, Microsoft focused on real-time customer usage data, reduced bureaucratic barriers, and organized large-scale hackathons to foster innovation and collaboration. Bold decisions, such as discontinuing Windows OS updates and eliminating the stack ranking system, also freed resources for new projects and promoted a supportive environment.

As of today, Microsoft is recognized by the industry as a leader in online productivity apps and the cloud computing market (Gartner, 2023).

Table 4-2 summarizes the approaches Microsoft took to innovation, drawing from studies by Dhillon & Gupta (2015), Ibarra et al. (2018), and Tabrizi (2023).

Table 4-2 Case study summary - Microsoft's approaches to fostering innovation

Category	Microsoft's approaches
Leadership	• CEO shifted the company's mission to *empowering every person and every organization on the planet to achieve more*. • Making bold investments in emerging technologies rather than just protecting its existing assets. • Eliminated the stack ranking system, which had fostered internal competition, in favor of a more collaborative and supportive environment.
Organization Structure	• Embracing partnerships and even collaboration with rivals in new products. • Acquired category leaders rather than pursuing me-too products. Key acquisitions included LinkedIn, GitHub, and Activision Blizzard. • Eliminated the stack ranking system, which had fostered internal competition, in favor of a more collaborative and supportive environment.
Culture	• Paying close attention to product usage and customer feedback. • Organized large-scale activities such as hackathons that fostered collaboration across silos and promoted fast-paced problem-solving and innovation.

4.3. Case analysis: Bosch

Bosch, founded in 1886 in Stuttgart, Germany, is a global enterprise operating in more than 60 countries. The company designs, manufactures, and sells products across various sectors, including industrial, energy, security, building-related, and consumer markets. (BOSCH, 2023).

In recent years, Bosch faced rapid changes in the sectors it serves, particularly in the automotive industry. To address these challenges, Bosch's CEO in 2014 emphasized the need to invest in new business models alongside the company's traditional strengths in technology and products. This approach aimed to ensure Bosch's continued success amid market disruptions (Marquis et al., 2020).

To implement this strategy, Bosch established the Corporate Business Model Innovation (C/BM) group in 2016. This team of five experts from different parts of the organization reported directly to the senior vice president. Bosch also partnered with UC Berkeley to create the Bosch Accelerator Program (BAP), which focused on early customer validation, rigorous testing, and evidence-based decision-making. Additionally, Bosch embraced open innovation by collaborating with external startups and other companies to access new technologies and create new market paths. By early 2020, the Bosch Accelerator Program had become a global standard for validating new business ideas, earning high praise from participants and significantly contributing to Bosch's innovation goals (Marquis et al., 2020).

Table 4-3 summarizes the approaches Bosch took to innovation, drawing from studies by Denner (2017), Schwager (2018) and Marquis et al. (2020).

Table 4-3 Case study summary - Bosch’s approaches to innovation

Category	Bosch’s approaches
Leadership	• CEO shifted the company's strategy to *invest in new business models*.
Organization Structure	• Formed a new group with innovation experts from various parts of the organization. • Partnered with the Innovation Acceleration Group at UC Berkeley to develop the Bosch Accelerator Program (BAP). • Started the Program from a pilot team, then applied to all teams.
Culture	• Embraced open innovation by collaborating with external startups and other large companies. • Emphasized early customer validation, rigorous testing, and evidence-based decision-making.

4.4. Characteristics of Innovative Organizations

Chapter 2 discusses several barriers to innovation, while Chapter 3 reviews the literature on general strategies that facilitate the creation of an environment conducive to organizational innovation. This chapter presents various companies and their approaches to fostering innovation. This section summarizes and suggests some of the key characteristics of innovative organizations from both the literature and real business cases.

First, innovative organizations are often attributed to factors such as a shared vision, leadership, effective organizational structures, high involvement in innovation, and motivation systems (Cebáková, 2019). In IBM's case, the clear vision is *One IBM*, and the organizational structure includes centralized operation teams. At Bosch, all teams participated in the innovation program.

Effective organizational structures and an innovation culture, including good cooperation between employees and management, are also key characteristics of innovative companies (Ernawati & Hamid, 2021). This means employees receive enough support from the management team regarding resources needed for innovation. In Microsoft's case, the CEO created a cooperative environment by eliminating the stack ranking system and fostering collaboration across silos. In IBM's case, a dedicated team with specific resources and management ensured continuous support and execution of the innovation initiatives.

Furthermore, innovative companies are known for their ability to engage in radical product innovations that offer significant customer benefits, cost reductions, and new business opportunities, ultimately leading to superior performance (Slater et al., 2014). Listening to current customers is key to creating new products and improving processes (Norena-Chavez & Guevara, 2020). Successful enterprises find a problem that many customers are trying to solve and provide a solution that customers are willing to purchase. For well-established enterprises with existing products, these products generate revenue from existing customers, and listening to them provides insights for improvement. In Microsoft's case, the team continuously listened to customer feedback to refine their product.

Additionally, listening to future customers is perhaps even more important. As Steve Jobs, the founder of Apple, said, *some people say to give customers what they want, but* *that is not my approach. Our job is to figure out what they are going to want before they do* (D. Smith, 2019). For Steve Jobs and Apple, capturing the desires of tomorrow's customers is crucial, leading to innovative products like the iPhone, which he described as *five years ahead of any phone* at its launch.

Overall, innovative organizations are characterized by their commitment to long-term innovative capabilities, effective organizational structures, radical product innovations, strong leadership, a culture that fosters innovation, and effective cooperation between employees and management. These organizations prioritize innovation in various operations, leading to their success and sustainability in the dynamic business environment.

The next chapter introduces the ARIES framework. This study later demonstrates using the ARIES framework as a systems thinking approach to design an innovative engineering organization within a well-established enterprise in the technology industry. As the architecting processes progress, the characteristics identified in this chapter are utilized as guiding principles for developing alternative architectures.

Chapter 5. ARIES Framework

This chapter introduces the ARIES framework, a holistic approach for architecting future enterprises that leverage systems thinking. Chapter 3 and Chapter 4 explore several general strategies and practical approaches that may assist the organization in fostering a conducive environment for innovation, drawing insights from a literature review. This chapter then discusses how these strategies and approaches could be incorporated into the ARIES framework to guide the concept design of the future enterprise. Later in this study, the ARIES framework is used as a demonstration of how a holistic approach can drive architectural design and generate important considerations for building innovative organizations within well-established large enterprises in the technology industry.

5.1. The ARIES framework

The ARIES framework, an acronym for ARchitecting Innovative Enterprise Strategy, is a holistic approach to developing future enterprise architecture (Nightingale & Rhodes, 2015). As illustrated in Figure 5-1, the ARIES framework has three key components: Elements, Process, and Techniques. The framework suggests ten view elements to comprehensively analyze an enterprise. It features an architecting process with seven activities that guide the architecting efforts. Additionally, various techniques are introduced to assist the analysis and evaluate the design of the enterprise architecture throughout the architecting process.

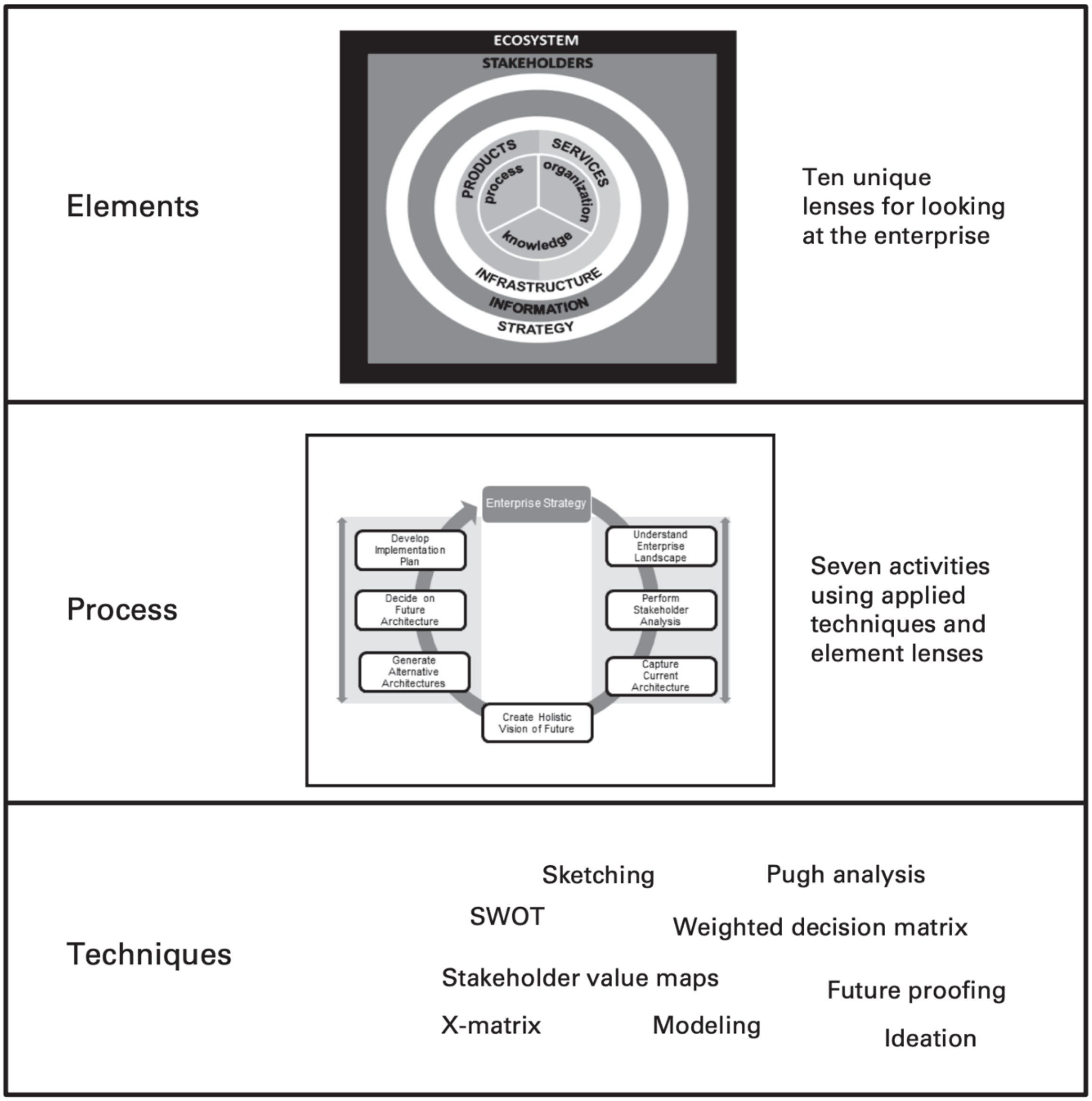

Figure 5-1 The concept of the ARIES framework (Nightingale & Rhodes, 2015)

5.1.1. Elements

The ARIES framework comprises ten essential elements for examining an enterprise: Products, Services, Infrastructure, Information, Strategy, Ecosystem, Stakeholders, Processes, Organization, and Knowledge. These elements provide a holistic view of the enterprise's current status, offering clear insights into what should be considered in the architecting process before initiating any transformation (Nightingale & Rhodes, 2015).

5.1.2. Process

The ARIES framework also includes an architecting process that utilizes several analysis techniques and *ten elements* to design future enterprise architecture.

The architecting process comprises seven activities. It begins with understanding the enterprise landscape from the perspective of enterprise view elements. This is followed by performing a stakeholder analysis to understand their needs, prioritize stakeholders, and identify emerging values. Next, the current architecture of the enterprise is captured. Subsequently, a holistic vision of the future is created, leading to the generation of alternative architectural concepts. The process then involves deciding on the future architecture, leveraging various analysis techniques. Finally, an implementation plan is developed.

The architecting process, along with some of the artifacts it produces—such as architecture concepts, stakeholder prioritization, and evaluation criteria— facilitates the description of the enterprise and its potential transformation. It enhances communication among system stakeholders and supports the evaluation and comparison of architectures. Additionally, it aids in the planning, managing, and executing organizational transformation activities while expressing the persistent characteristics and supporting principles that guide those proposed changes. The comprehensive architecting process introduced in the ARIES framework ensures that all aspects of organizational transformation are addressed, aligning with current needs and future visions (Nightingale & Rhodes, 2015).

5.1.3. Techniques

The ARIES framework incorporates various techniques to support the architecting process. Analytical techniques, such as Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis and a weighted decision matrix, are applied at different stages to complete the process model.

5.2. Applying Systems Thinking to Organization Innovation

Chapters 3 and 4 examine various general strategies and practical approaches that may facilitate the organization in creating an environment conducive to innovation. Nevertheless, the selection of these strategies, the practical application of approaches, and their potential combinations pose significant challenges in organizational design due to the extensive range of available options.

According to Galbraith (1982), merely implementing one or two of these strategies or approaches in isolation is likely to fail and may reinforce the misconception that such strategies and approaches are ineffective. Instead, a consistent and integrated application of these practices is more likely to create an innovative organization (Galbraith, 1982). Additionally, the effectiveness of a particular strategy or approach can vary depending on the diverse environments, unique cultures, resources, and challenges each organization faces, which further poses challenges in organizational design (Mathar et al., 2020). Therefore, a holistic approach is suggested to incorporate these strategies and approaches into the design of the future organization architecture.

As shown in Figure 5-2, three elements—competing environment, innovation barriers, and strategies and approaches influencing innovation—interact, impacting overall organizational performance and innovation capability. Due to this interrelationship, this study suggests that adopting a holistic approach that considers all three elements as part of a system might be beneficial. Systems thinking is a potentially effective method for addressing these issues by viewing them as interconnected systems.

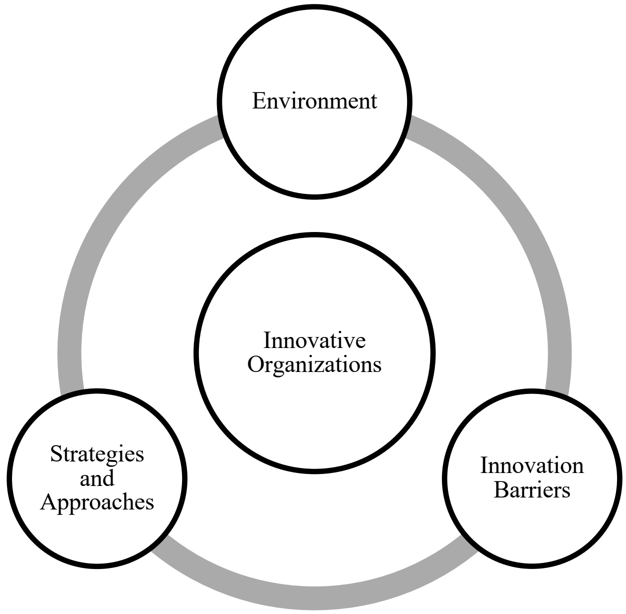

Figure 5-2 Interrelationship between the Environment, Innovation Barriers, and Strategies and Approaches

Systems thinking emphasizes understanding the interconnections between the components of a system and integrating them into a unified view of the whole (Assaraf & Orion, 2005). It enables the formulation of insightful questions, the recognition of significant relationships, the interrelation of components, and the consideration of different perspectives (Taylor et al., 2020).

In the following chapters, this study demonstrates using the ARIES framework as a systems thinking approach to design future architectures for innovation. The rapidly changing competitive environment and complex barriers are discussed in Chapters 1 and 2. Chapters 3 and 4 explore multiple strategies and approaches that could contribute to an innovative organization. Under the ARIES framework, these innovation strategies and approaches could potentially serve as guiding principles in the future architecture concept generation process. Each concept might be evaluated against existing innovation barriers to assess its effectiveness. The framework also includes a future-proof analysis in the *Decide on Future Architecture* process, allowing for testing architectures under various external scenarios. Barriers and environmental challenges could facilitate the design of such scenarios, fostering deeper conversations and understanding about potential outcomes.

Chapter 6. Application of the ARIES Framework to the Current Architecture

This chapter applies the ARIES framework to the engineering organization of a large hypothetical company in the technology industry and discusses the organization's current architecture. First, this chapter examines the internal and external landscapes of the organization, followed by presenting its stakeholders and their needs. The organization's current architecture is also discussed, and finally, this chapter suggests the envisioned future of the organization.

6.1. Enterprise Landscape

This section examines the internal and external landscape of the engineering organization within M-Corp, a hypothetical technology company modeled after several large U.S. technology enterprises. The objective is to gain an understanding of its operational contexts and identify shifts that may trigger enterprise transformation.

6.1.1. The Scope

M-Corp, a hypothetical enterprise in this study inspired by large technology companies, including Microsoft, Google, IBM, and Amazon, is a global technology company headquartered in the United States. M-Corp has diverse business lines, including software, hardware, and business consulting services. The company comprises various departments, each with distinct responsibilities. The scope of this study is limited to the engineering organization within M-Corp's software business line.

The engineering organization at M-Corp is primarily responsible for interpreting user needs, coding software products, providing technical services, and ensuring their ongoing operational stability. Within this organization, various roles exist, including engineering management, research, development, operations, design, and product management. Beyond engineering, M-Corp's Software business features additional divisions such as Sales and Marketing. Other corporate functions—human resources, legal, and finance—also play a vital role in M-Corp's operations.

Figure 6-1 shows M-Corp's organizational chart, illustrating the boundary of the engineering organization being studied and its relationships with other divisions.

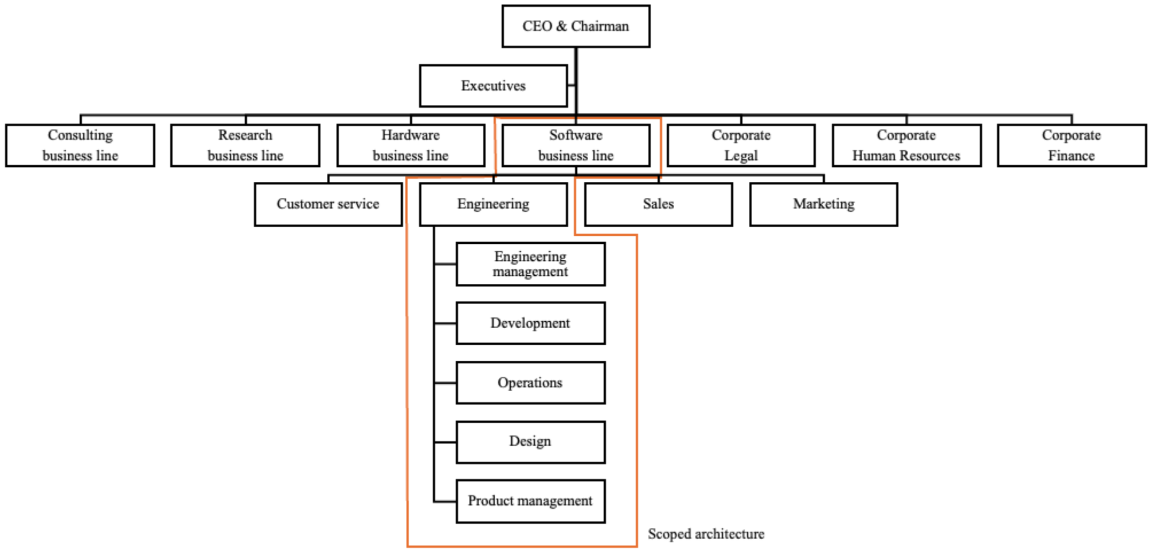

Figure 6-1 M-Corp organizational chart and the boundary of the enterprise being studies

This analysis focuses on the engineering organization for several reasons. The engineering organization tends to be crucial in creating products for M-Corp. These products not only potentially attract new customers and generate revenue but also help M-Corp to establish competitive advantages and differentiate itself in the market. Continuous innovation within the engineering organization could potentially lead to technological breakthroughs, positioning the company as a leader in its field. Additionally, the engineering organization plays a central role in capturing new business opportunities by swiftly responding to market changes, listening to customer needs, and integrating emerging technologies and trends into their products and services to maintain competitiveness. Furthermore, improvements and innovations in the development processes of the engineering organization could lead to more efficient and cost-effective operations, likely impacting corporate finance significantly.

6.1.2. External Landscape

After defining the enterprise scope, the next activity in the ARIES framework involves understanding the external landscape in which M-Corp operates. This activity presents the enterprise's external landscape by examining seven key ecosystem factors. Results are shown in the Table 6-1.

Table 6-1 External landscape analysis of M-Corp

Ecosystem factor	Shifts that may trigger enterprise transformation	Level of change	Pace of change	Impact to enterprise
Economy	• Fluctuations in the economic environment and global currencies add more uncertainty	Medium	Medium	Medium
Market	• Increase in technology demand and client spending budgets. • Rapidly changing customer preferences and demands, varying by region and customer sectors. • Uncertain client adoption rates and viability of business models in the high-value market.	Medium	Medium	High
Regulatory	• New country regulations increase operational challenges. • Data privacy and labor laws impact products and operations. • Tariffs and sanctions may restrict sales or add costs	Medium	Low	High
Technology	• Disruptive innovations challenge the enterprise's market share. • Rapid technology adoption and a successful developer ecosystem are key to innovation	High	High	High
Workforce	• Heavy reliance on skilled technical, marketing, and staff resources. • Intense competition for talent due to high demand for skilled personnel. • Potential decrease in equity compensation for employees due to stock market volatility.	High	Medium	Medium
Competition	• Highly competitive in both local and international markets • Several principal competitors in the global market • Many smaller niche competitors in specific segments and markets	High	High	High
Environment	• Potential climate-related risks. • Increased environmental disclosures required	Low	Low	Low

Economy

The global economy is dynamic and varies significantly across regions, areas, and countries. M-Corp operates in more than 120 countries worldwide and has developed operational strategies tailored to each economy. The company has also implemented measures to mitigate economic impacts, such as fluctuations between the U.S. dollar and non-U.S. currencies, recessions and inflation.

Market

M-Corp is a globally integrated entity with many business and government clients worldwide. The company has expanded into areas including hybrid cloud, artificial intelligence, quantum computing, and other disruptive technologies. While demand and customer spending are increasing in these areas, the presence of more competitors in the market requires the company to quickly commercialize innovations and expand and scale them with sufficient speed and versatility.

Regulatory

M-Corp's global operations are subject to potential impacts from cybersecurity and privacy laws, tax regulations, tariffs, international trade sanctions, and labor relations laws. Specific laws may prevent M-Corp from conducting business or selling goods and services across borders or could impose additional costs on these activities.

Technology

Disruptive innovations are challenging the market share of the enterprise's products. The speed of technology adoption and a thriving developer ecosystem are crucial to fostering innovation. Rapid advancements in areas such as artificial intelligence, big data, and cloud computing are setting a trend for continuous learning and adaptation. Staying technologically ahead is essential for maintaining a competitive advantage. However, M Corp's intellectual property may not prevent competitors from independently developing products and services that are similar to or duplicate the company's offerings.

Workforce

M-Corp’s future success relies heavily on skilled technical, marketing, and staff employees. These skilled workers are highly sought after, creating intense competition for talent. Changes in demographics and workforce trends could lead to a scarcity of essential skills and knowledge. Additionally, the need to realign, train, and scale these resources may not keep pace with global opportunities and industry demands. Furthermore, key employees at Corp’s are compensated partly with equity awards. Factors like new regulations or stock market volatility could reduce the attractiveness or value of these equity incentives, potentially placing the company at a competitive disadvantage.

Competition

M-Corp's methods of competition include technology innovation, performance, price, quality, brand, breadth of capabilities, products and services, talent, and client relationships and support. In the software segment, competition is intensifying not only from established companies such as Amazon, Microsoft, Oracle, and SAP globally but also from smaller, niche competitors in specific geographic regions or product segments.

Environment

M-Corp faces potential climate-related risks and costs due to increased severe weather events, temperature changes, and new regulations affecting hardware and data centers, alongside carbon taxes and heightened environmental disclosures required by clients and regulators. Violations or liabilities under these laws could result in significant costs, fines, sanctions, and third-party claims for damages. Despite these challenges, M-Corp does not anticipate that climate change or related compliance will disproportionately affect its financial health or competitive stance.

6.1.3. Internal Landscape

M-Corp's strategy centers on leveraging its extensive breadth and depth of expertise to integrate various technologies and address the most pressing business issues its clients face. Combining knowledge from multiple domains allows M-Corp to develop comprehensive and innovative solutions tailored to specific client needs. Through this strategic focus, M-Corp aims to deliver exceptional value, foster long-term client relationships, and maintain a competitive edge in the technology industry.

The core values of M-Corp are reflected in its code of conduct, which emphasizes providing innovative products with trust and security and creating a broad ecosystem of partners and alliances. The internal landscape analysis is presented from the perspective of several capabilities in the Table 6-2.

Table 6-2 Enterprise capabilities of the engineering organization in M-Corp

Capability	Observations	Current performance
Flexibility	The organization evolves slowly due to its large size, long history, and widespread geographical operations, making it less agile than startups.	Insufficient
Adaptability	The organization can adapt to external changes, but the process is slow and requires improvement.	Insufficient
Agility	Decision-making is hindered by hierarchical structure and corporate control over budgets and priorities, causing delays in urgent initiatives.	Insufficient
Scalability	The organization has the capability to adjust its size based on business needs.	Sufficient
Competitiveness	The organization's competitiveness has declined in recent years due to the lack of standout products and the inability to attract the best talents in the market	Insufficient
Robustness	The organization is robust, with risk management and business continuity policies to handle extreme situations	Sufficient

M-Corp has established a robust ecosystem and relationships with major Fortune 500 companies, offering numerous opportunities to build and sell software products to these clients. M-Corp’s software customers are primarily enterprise clients. Some M-Corp products, such as security and mainframe software, have a lock-in mechanism that generates stable revenue for the company. These core values are unlikely to change dramatically due to the company’s reputation and long-term commitment to its clients.

However, challenges exist within the current enterprise capabilities. For instance, M-Corp is not competitive enough in its key areas, particularly in cloud computing. M-Corp's product is not recognized as the leader and is ranked behind its major competitors' products in industry reports (Gartner, 2023).

The company has a well-defined architecture, and business processes that have been proven to work over a long period, making it difficult to challenge the status quo, even with external competitive pressures. Additionally, due to its organizational structure and solution-oriented approach to engaging with enterprise customers, product development and market introduction can be lengthy, resulting in low agility. Furthermore, many employees have been with M-Corp for an extended period and are accustomed to the existing processes. This can limit exposure to new experiences from outside the company, decreasing the enterprise's adaptability.

6.1.4. Force-field Analysis

In the ARIES framework, Force-field analysis is one of the analysis techniques that could be used to identify the driving forces in the enterprise landscape for the current architecture of the engineering organization. Table 6-3 shows the force-field analysis result, highlighting the drivers for change and the forces against change.

Table 6-3 Internal and external factors that drive changes

Drivers for changes	Drivers against changes
• Technological Advancements: New technologies enable new work patterns and increase productivity. • Shifts in Customer Behavior and Preferences: Adopting new product development methodologies requires organizational changes. • Competitive Pressure: Requires M-Corp to stay ahead of competitors and meet evolving market expectations. • New Laws or Standards: Require organizational changes to meet complex compliance requirements. • High Competition for Skilled Professionals: Also involves access to key technologies.	• Lack of Competitiveness: Due to slow product development. • Low agility due to the risk-avert due to existing large business and operations. • Regulatory Constraints: Strict labor laws and the extensive approval processes required for changes. • Low Flexibility and Adaptability: due to the established hierarchy and employees staying long. There might also be a skill gap due to not having enough capacity to learn new skills. • Resource Constraints: Limited budgets, staff, or time can impede the ability to implement change.

The analysis in previous sections indicates that both internal and external forces drive and resist changes in architecture. M-Corp's external environment is rapidly evolving, prompting the organization to adapt to operate more efficiently, seize new business opportunities, and maintain innovation speed. However, the company faces challenges due to internal and external factors such as low agility from hierarchical structures, inconsistent policies and systems, entrenched processes, and a lack of competitiveness.

6.2. Stakeholder Analysis

The stakeholder analysis represents the second activity in applying the ARIES framework. This section starts by identifying key stakeholders relevant to the engineering organization. After that, salience analysis is used to prioritize stakeholders. A stakeholder relationship map is introduced for internal and external stakeholders, and value exchange between stakeholders and the enterprise is also discussed. Finally, this section discusses the emerging needs of these stakeholders.

6.2.1. Internal Stakeholders

Internal stakeholders work together on product development and operations in the engineering organization, and there are two relationships among stakeholders – managing and collaborating. Three major internal stakeholders, including executives, managers, and individual contributors, are identified, and their relationships are illustrated in Figure 6-2.

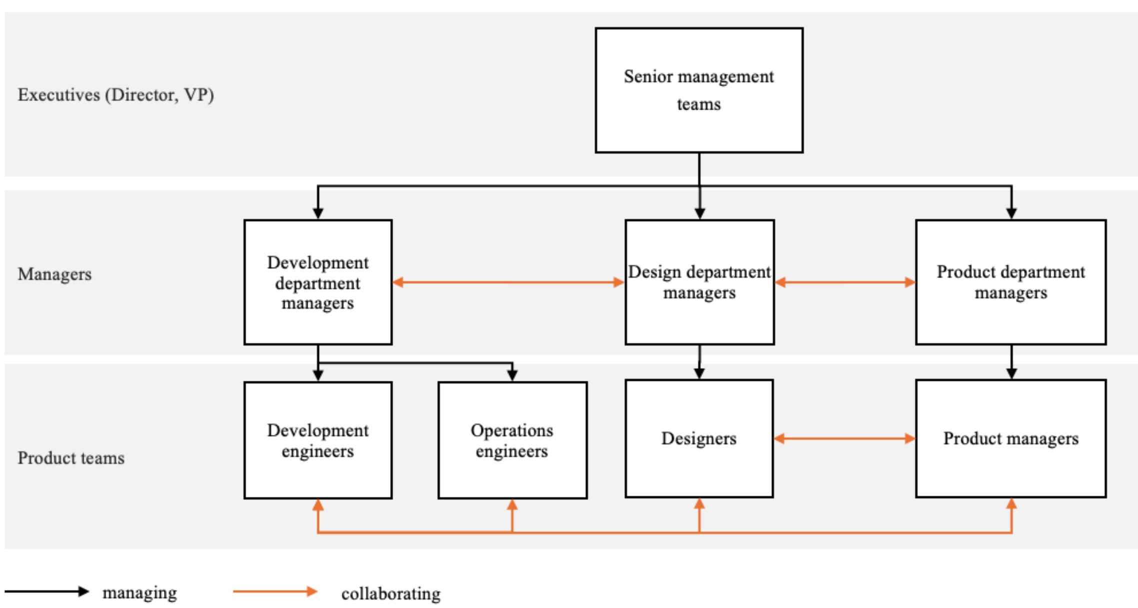

Figure 6-2 Internal stakeholders map of the engineering organization

The primary goal of the engineering organization at M-Corp is to develop new software products that meet market needs and provide operational support. At the highest level, executive stakeholders guide the organization by developing growth strategies, setting policies, defining yearly goals, managing budgets, and determining team structures. They ensure strategic alignment and coordination across the company.

Middle stakeholders, who are managers, act as the link between executives and front-line teams. They translate strategic goals into actionable plans, manage day-to-day operations, assess team performance, resolve resource conflicts, and empower employees. They also manage timelines, oversee risks, and communicate team feedback to executives.

On the front lines, individual contributors execute the plans and apply their professional skills in their daily jobs. Various roles exist within this group: Product managers initiate new products by defining requirements from the roadmap; designers create visuals for these new products; and engineers develop these designs into functional software. Together, engineers, designers, and product managers collaborate to ensure the software meets product specifications. After the product launch, operations engineers take over routine maintenance throughout the product's lifecycle.

6.2.2. External Stakeholders

This section examines the external stakeholders. Figure 6-3 shows external stakeholders around the engineering organization.

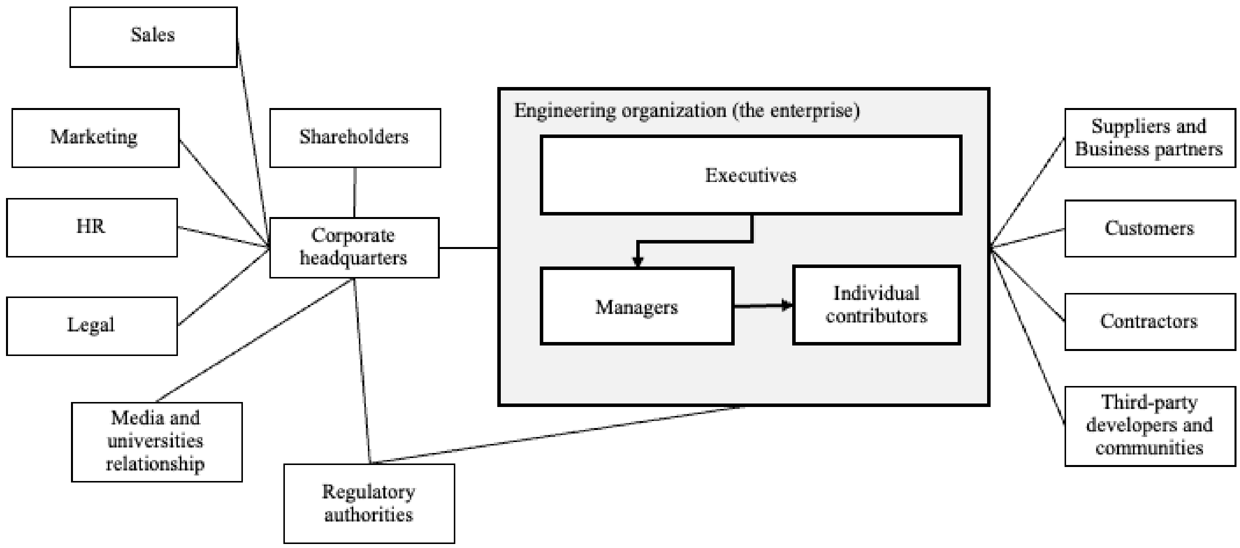

Figure 6-3 External stakeholders of the engineering organization

Certain stakeholders, such as the sales, marketing, Human Resources (HR), legal, and public relations departments, supply essential resources the engineering organizations need. Other stakeholders rely on the engineering organization's collaboration. Suppliers and business partners, for example, business partners and suppliers seek business opportunities from the engineering team. Additionally, partnerships with third-party developers, communities, and contractors help expand the engineering organization's capabilities and product adoption.

6.2.3. Stakeholder Prioritization

After mapping out the key stakeholders, it is recommended that they be prioritized. Creating value is the fundamental purpose of the enterprise; therefore, one approach to designing the enterprise is to adopt a value-driven perspective (Nightingale & Rhodes, 2015). To design a new architecture, it is beneficial to understand the most important values that the engineering organization needs to create for its stakeholders.

The salience stakeholder analysis framework, originating from business management, is employed to prioritize stakeholders based on three criteria: power, legitimacy, and urgency (Mitchell et al., 1997). A stakeholder with power has significant influence over the organization's decisions and can affect its strategic direction and focus areas. Legitimacy refers to a stakeholder's justified position or action, grounded in their reputation, credibility, or authority. Urgency indicates the time-sensitive nature of the stakeholder's relationship to the enterprise. Using the above three attributes, each stakeholder—internal and external—is evaluated and classified into one category. The analysis result is shown in the Figure 6-4 and Table 6-4.

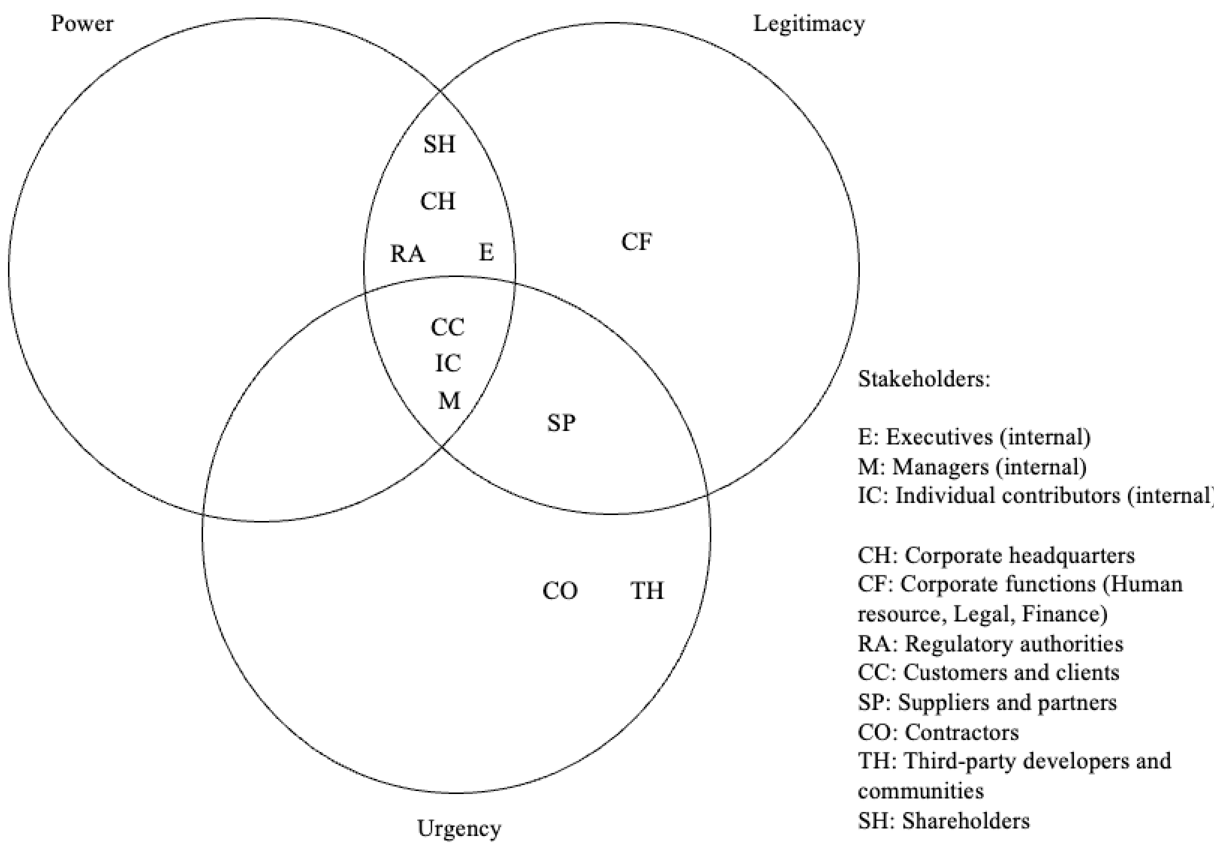

Figure 6-4 Stakeholder typology of the engineering organization

Table 6-4 Stakeholder salience analysis of the engineering organization

Stakeholder		Salience	Power	Legitimacy	Urgency
Internal	Executives	Dominant	Yes	Yes	No
	Managers	Definitive	Yes	Yes	Yes
	Individual contributors	Definitive	Yes	Yes	Yes
External	Customers	Definitive	Yes	Yes	Yes
	Contractors	Dependent	No	Yes	Yes
	Partners and suppliers	Dependent	No	Yes	Yes
	Regulatory authorities	Dominant	Yes	Yes	No
	Third-party developers and communities	Demanding	No	No	Yes
	Corporate functions (HR, Legal, Finance)	Discretionary	No	Yes	No
	Corporate headquarter	Dominant	Yes	Yes	No
	Shareholders	Dominant	Yes	Yes	No

Stakeholders are grouped into three priority groups based on their salience category:

Priority 1: Managers, Individual contributors, and Customers.

Priority 2: Executives, Contractors, Partners and suppliers, Regulatory authorities, Corporate headquarter, and Shareholders.

Priority 3: Third-party developers and communities and other corporate functions.

6.2.4. Stakeholder Value Exchange

Table 6-5 describes all stakeholders and the value exchanges between stakeholders and the enterprise. Each stakeholder provides a particular value to the enterprise, and, in exchange, they anticipate receiving specific benefits or outputs from the enterprise

Table 6-5 Stakeholder and value identification

Stakeholder	Description	Value delivered to the enterprise (+ emerging value)	Value received from the enterprise (+ emerging value)
Executives (internal)	Top management positions in the organization	Strategy Budget	Compensation Reputation and recognition
Managers (internal)	Managing different departments	Project management People management Team management + Product owner role	Compensation Career growth + Ownership
Individual contributors (internal)	Complete individual tasks	Skills Experience and knowledge + Product owner role	Compensation Career growth + Ownership
Customers	Business and governments that purchase products and services	Revenue Market feedback Loyalty Reputation Advocation Usage data	Reliable products Customer support Regular product updates + More diverse and customizable products
Partners and Suppliers	Businesses that provide necessary infrastructure and services to support engineering organization	Resources Professional Services Access to key technology	Business growth opportunities + Closer partnership and alliance
Contractors	External workers and entities that are hired for specific projects. Usually for a fixed term, hire from third-party companies	Specialized skills at a lower cost Scalability Flexibility Usage data	Clear requirement Potential for future work Quick payment
Regulatory authorities	Government of industry bodies that enforce compliance standards, such as the Privacy Protection Act	Guidance Approval	Reporting and auditing +New compliance requirement
Third-party developers/communities	Independent developers who might use the enterprise's platforms or products to build complementary products	Revenue Ecosystem expansion + Collaboration on developing new products	Developer tools + Support and incentive from the ecosystem
Corporate function (HR, Legal, Finance)	Internal departments that support business operations	Recruitment Financial planning and management Media/Branding resources	Strategic alignment Partnership and coordination Commitment
Corporate headquarter	Central management office that oversees the organization's operations and evaluates performance	Strategic direction Central resources	Performance results Market share Satisfactory return on investment (ROI)
Shareholders	Stockholders: individual investors or institutions	Capital investment Financial relationship	Dividends, Stock price, Transparent governance

The stakeholder value exchange analysis shows that, as a company with a long history, the engineering organization has largely met the needs and values of its stakeholders. However, as the external and internal landscapes evolve, stakeholders' needs and values are changing, with new values emerging. Stakeholders now expect the enterprise to capitalize on these emerging values. Several of these evolving stakeholder values are described in the sections that follow.

Customers

M-Corp focuses on the enterprise Business-to-Business (B2B) market, and its products are primarily used by business and government customers. A McKinsey study suggests that in the B2B market, customers exhibit a positive investment outlook and show clear signals of intent to purchase various products, ranging from cloud services to security to business applications (McKinsey, 2024). The study also indicates a shift toward products that can be conveniently integrated and customized to best fit their needs (McKinsey, 2024).

The emerging value of more diverse and customizable products from customers indicates that the enterprise needs to act quickly, expand its portfolio, and provide flexibility in combining technologies to meet customers' dynamic business needs while managing risks effectively.

Managers and Individual contributors

Industry analysis indicates a persistent shortage of engineers in the U.S. and globally, with intense competition among companies for skilled professionals with STEM (science, technology, engineering, and mathematics) backgrounds (Kodey et al., 2023). Engineering organizations depend on professional and experienced managers and skilled employees to deliver high-quality products, making retaining experienced employees essential (Kodey et al., 2023). Research by Bain & Company suggests a potential way to achieve this is by making employees feel that their work is meaningful, involving them in key phases or projects from start to completion, thereby quickly fostering a sense of satisfaction and allowing them to see the impact of their work (Suter et al., 2023).

Due to role division and specialization, M-Corp's employees only participate in one phase of product development and typically do not witness the product's progression from inception to launch. They usually work on a specific area for multiple products, such as designing a particular user interface, which results in a lack of ownership of the products among employees.

Third-party developers and communities

As discussed in Chapter 1, product development was previously predominantly an in-house activity using waterfall methodologies. M-Corp recognizes the necessity of enhancing its connections with third-party developers to accelerate technology adoption, create a product ecosystem, and establish a reputation in the industry. The emerging values are that third-party developers and communities wish to provide requests and suggestions for product development while expecting to receive support and incentives from the enterprise. Third-party developers are eager to collaborate on new platform capabilities and share the benefits of the ecosystems they contribute to.

Partners and Suppliers

Partners and suppliers are seeking more collaborative relationships with M-Corp. Ecosystem partners, distributors, and third-party vendors are crucial channels for M-Corp to sell its products. Given that clients are now facing more complex business challenges and engaging with various technologies, suppliers, and vendors, it is likely that M-Corp and its partners need to forge closer partnerships. This collaboration would enable them to work together to deliver comprehensive, end-to-end solutions in specific areas.

Regulatory authorities

Regulatory authorities are introducing new laws, regulations, standards, and policies to govern new technologies and data usage and protect user privacy. For instance, the European Union introduced the General Data Protection Regulation (GDPR) to protect data privacy and security (European Union, 2018). This law mandates the creation of new company roles, establishes standard procedures for collecting, handling, and destroying data, and sets reporting requirements in the event of a breach. Additionally, numerous legislative processes are ongoing in emerging technology areas, such as artificial intelligence (NCSL, 2024). All these developments will require M-Corp and its engineering organization to comply with an increasing number of regulations.

This section provides a holistic view of how the enterprise creates value by identifying stakeholders, prioritizing them, and discussing their value exchanges. It also presents several emerging values that the new architecture aims to capture. The next section will detail the current architecture of the engineering organization at M-Corp.

6.3. Current Architecture

This section provides a comprehensive analysis of the current architecture of M-Corp's engineering organization. It first outlines the current enterprise architecture of M-Corp through the lens of ten distinct elements. It then conducts a SWOT analysis to evaluate the current architecture in terms of its Strengths, Weaknesses, Opportunities, and Threats.

6.3.1. Ten-element Model

The ten-element model is a helpful tool that allows us to analyze enterprises by focusing on one area at a time, thereby reducing complexity so that the entire enterprise can be examined (Nightingale & Rhodes, 2015). Table 6-6 shows the results of the analysis using the ten-element model for the engineering organization at M-Corp.

Table 6-6 Ten element model for M-Corp's engineering organization

Element	Description
Ecosystem	M-Corp faces fierce competition, regulatory challenges, economic fluctuations, and geopolitical tensions that impact supplier relationships. The company's engineering organization needs to innovate and diversify its portfolio while maintaining quality.
Stakeholders	The organization has successfully met existing stakeholder values to varying degrees. New values emerging from stakeholders have appeared and are not yet being addressed.
Strategy	The enterprise aims to create the most innovative products and deliver high value to clients, focusing on investing in highly complex technical area such hybrid cloud and advanced artificial intelligence technologies. Platform capabilities are also a priority.
Information	M-Corp has a good grasp of market and technology trends. Needs to improve internal transparency and communicate the vision and roadmap clearly within the organization.
Infrastructure	The infrastructure supporting product development is stable and evolving, yet its full potential is not realized due to internal complexity and disparate systems.
Products	Product innovation needs enhancement, with few new products making significant inroads in emerging market segments. There is an overabundance of ongoing products, traditional sales channel reliance, and onboard difficulty, indicating a need for quality improvement.
Service	Services are designed around product lines rather than customer needs, resulting in duplications from overlapping product functionalities. Legacy services continue with reduced support.
Process	Standard processes exist, but some are complex and time-consuming.
Organization	The hierarchical organization and existing policies have bred past successes, but cross-department collaboration is rare due to the organization's size. There is a minimal risk culture and a low appetite for innovation.
Knowledge	Departments hold specialized knowledge, but internal sharing is challenging without established processes. External knowledge sharing and contributions to open-source or academic communities are limited.

Ecosystem

M-Corp operates in a highly competitive technology industry. Chapters 1 and 2 suggest that challenges arise from technological advancements, market shifts, increasing competition from various competitors, and internal challenges within the organization. M-Corp also faces risks from its ecosystem, such as risks related to laws and regulations, downturns in the economic environment, client spending budgets, and potential geopolitical impacts on its relationships with critical suppliers. M-Corp's engineering organization spans globally and has multiple products and services in its portfolio. They are challenged to develop new products and services more quickly to meet the increasingly diverse needs of customers while maintaining high quality, which adds a significant burden to the organization.

Stakeholder

As discussed in the stakeholder analysis section, emerging stakeholder values have not been met.

Strategy

The organization strives to develop innovative products and maximize client value, emphasizing investments in complex technical domains like advanced cloud computing and cutting-edge artificial intelligence technologies.

Information

M-Corp has a strong understanding of market and technology trends. However, there is a need to enhance internal transparency and communicate the vision and roadmap throughout the organization. Additionally, conflicting sources of information within the organization delay the retrieval of useful information.

Infrastructure

The organization has established common infrastructure elements, such as central storage and document management facilities, for product development and is leveraging automation to handle repetitive tasks. This allows professionals to focus on true innovations. However, certain aspects of the infrastructure, particularly technical tools and platforms, vary from team to team and product to product. This variability leads to challenges in maintenance and improvements.

Products

Shifting market trends and evolving client requirements necessitate M-Corp diversifying its portfolio with customizable capabilities. Additionally, M-Corp lacks leading products in key competitive areas such as cloud computing and artificial intelligence (Gartner, 2023).

Services

Services are designed around product lines, sometimes resulting in duplicated services or insufficient staffing for products that are not actively maintained. Furthermore, the departure of experienced employees can lead to losing key knowledge about services, decreasing service quality and knowledge retention.

Processes

Standard processes exist for key areas such as client engagement, product development, and risk and incident management. However, some processes are complex and time-consuming due to the multiple levels of approval required. Additionally, certain processes may be outdated and not reflective of the latest best practices in the industry.

Organization

The hierarchical structure and established policies of the organization have facilitated past successes. However, due to the organization's size, cross-departmental collaboration is infrequent. Additionally, there is a prevailing culture of minimal risk-taking.

Knowledge

Departments possess specialized knowledge, but the absence of established processes hinders internal sharing. Some products suffer from a lack of formal documentation, with key knowledge retained by long-term employees. External knowledge sharing and contributions to open-source or academic communities are also limited.

6.3.2. SWOT Analysis

SWOT Analysis is a tool that originated in the business world and has become a widely used strategic management tool, with its use extending beyond companies to countries and industries, and its application in business cases has increased (Helms & Nixon, 2010).

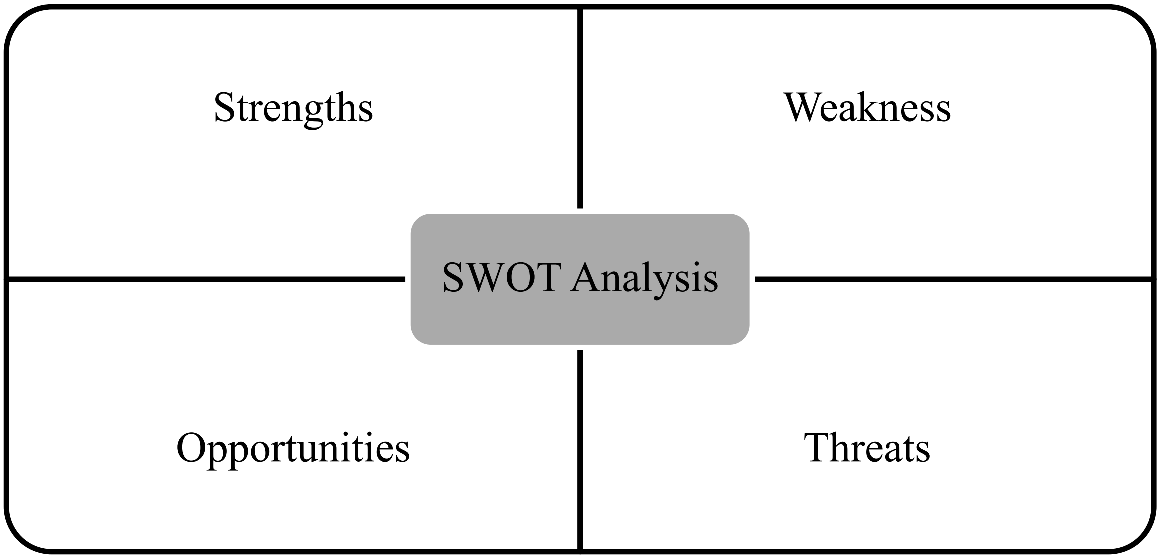

Figure 6-5 SWOT analysis: Strengths, Weaknesses, Opportunities, and Threats

A SWOT analysis is used to identify the Strengths, Weaknesses, Opportunities, and Threats of the as-is architecture of M-Corp's engineering organization.

Strengths:

- Stability and Predictability: Established procedures and hierarchies enable consistent outcomes and clear lines of authority.
- Experienced Leadership: Leaders often have deep industry experience and a strong understanding of traditional markets.

Weaknesses:

- Resistance to Innovation: Aversion to risk can hinder innovation and adaptation to new market demands or technologies.
- Slow Decision-Making: Hierarchical structures can slow down decision-making processes, affecting responsiveness.

Opportunities:

- Leveraging Expertise: There is potential to leverage deep institutional knowledge and expertise to refine and improve existing products.
- Partnerships: Collaborations with external firms, third-party developers, and communities could introduce innovation while maintaining the organization's core strengths
- Strategic Acquisitions: Acquiring smaller tech companies can enhance an organization's technological capabilities and market reach.

Threats:

- Market Evolution: Rapid technological changes and innovative competitors could outpace the organization's ability to adapt.
- Talent Drain: Younger or more dynamic talent may be deterred by the slow pace and conservative nature, preferring more flexible environments.
- Economic downturns: Global economic instabilities can affect customers' investments in technical services and product purchases, forcing the organization to reduce its product and service lines for cost savings.
- Regulatory Challenges: Compliance with global regulations can be complex and costly.

6.4. Envisioned Future

In the ARIES framework, the next step is to create an envisioned future after analyzing the enterprise landscape, stakeholders, and current architecture. This envisioned future describes the future enterprise from a high level, aiming to capture emerging stakeholder values with the new architecture. Given that M-Corp is a hypothetical company in this study, this section first discusses a future scenario drawn from the strategic directions of M-Corp's competitors, including Microsoft, Google, Amazon, and IBM. At the end of this section, several desired attributes are extracted from the future scenario, and the characteristics of innovative organizations are discussed in Chapter 4. These attributes guide the concept generation in the next chapter.

6.4.1. Future Story

In the future, M-Corp will be a pioneering technology organization characterized by a flattened hierarchy and rapid decision-making capabilities. This structural agility allows

M-Corp to swiftly adapt to market changes, consistently creating winning products and services tailored to client needs. Renowned as a leader in key technological areas, M-Corp garners trust from clients and technology communities. M-Corp's thriving ecosystem, which includes numerous partners and individual developers, fosters innovation and creates value for all involved. This collaborative environment encourages continuous improvement and breakthroughs in technology. Governance at M-Corp is notably transparent, ensuring full compliance with industry standards and regulations. The organization is committed to responsible risk management and maintaining stability while pushing the boundaries of innovation. Through these practices, M-Corp not only leads in technology but also sets the standard for corporate responsibility and ethical business practices.

6.4.2. Stakeholders Vignette

Customers

M-Corp is recognized as a trusted long-term partner, offering a wide range of high-quality products across multiple key areas essential for supporting digital transformations. These products incorporate the latest technologies and provide significant flexibility and integration capabilities. This enhances ease of use and management for customers, positioning M-Corp as a leader in facilitating technological integration and operational efficiency. Through its comprehensive solutions, M-Corp empowers organizations to seamlessly navigate their digital journeys, reinforcing its reputation as a dependable and innovative partner in the tech industry.

Individual Contributor

M-Corp adopts the latest product development methodologies in its innovation process, ensuring that every product is crafted with precision by dedicated professionals. These experts care deeply not only about the products themselves but also about every detail surrounding them, including support and services. Each team member feels a strong sense of ownership over their work and takes pride in their contributions. They actively seek feedback from customers, working alongside them to tackle some of the most challenging issues. This collaborative approach allows M-Corp to continuously improve its offerings and maintain high standards of quality and customer satisfaction.

Third-party developers and communities

M-Corp is an open organization that actively encourages collaboration and mutual learning among its members. It demonstrates a strong commitment to building developer communities, providing timely feedback, and facilitating opportunities for knowledge sharing, documentation, and collaboration. The culture at M-Corp is one that respects diverse opinions and fosters an environment open to continual learning and improvement. Additionally, third-party developers and communities benefit from various incentives within the ecosystem, further enhancing collaboration and innovation within M-Corp.

6.4.3. Desired Future Attributes

Chapter 4 discusses several characteristics of innovative organizations. Based on the discussion in Chapter 4 and combined with the desired future scenario, Table 6-7 presents desired attributes that could be used to guide the concept generation in the next chapter.

Table 6-7 Desired attributes of the engineering organization in the elemental view

Element	**Description**
Ecosystem	Quickly react to market trends and emerging technologies and build winning products.
Stakeholders	Capture emerging value from stakeholders.
Strategy	Continuous investment in highly complex technical areas such as hybrid cloud and advanced artificial intelligence technologies. Continuously increase the organization's innovation capabilities.
Information	Communicate vision and strategies within the organization. Share information with partners and suppliers to foster collaboration
Infrastructure	Simplify infrastructure management and increase reliability.
Products	Offer a wide range of products with customizable features.
Service	Provide a wide range of services with customizable features.
Process	Continuously improve processes and retire out-of-date processes. Processes are focused on delivering outcomes, not on the format and procedure.
Organization	Open organization that supports innovation with third parties. Flexible structure allowing adoption of new product development methodologies.
Knowledge	Well-documented knowledge shared across the organization.

The above analysis suggests that the transformation of the engineering organization would need to strike a balance between maintaining the existing operations of the products and extending its core capabilities to deliver innovations. It also aims to maintain relationships with critical external stakeholders, such as key customers, vendors, and regulators, while establishing new and closer connections with business partners, third-party developers, and communities.

Based on the desired attributes and insights from Chapters 3 and 4 regarding general strategies and practical approaches leading to an innovative organization, the next chapter generates alternative architectures and evaluates their effectiveness within the enterprise's evolving landscape.

Chapter 7. Generating Alternative Architectures

The last chapter describes emerging values from stakeholders and introduces the desired attributes for alternative architectures to capture these emerging values. Chapters 3 and 4 also present several general strategies and practical approaches for the enterprise to establish a positive environment for innovation. This chapter continues applying the ARIES framework to M-Corp by generating alternative architectures and drawing on insights from previous chapters. First, it presents several concepts integrating desired attributes introduced in Chapter 6. Subsequently, an alternative architecture for each concept is discussed and evaluated, and a selected architecture is introduced and then further examined under various future scenarios. Finally, the chapter outlines an implementation plan for the chosen architecture.

7.1. Evaluation Methods

Two evaluation approaches are utilized in this section. In addition to a SWOT analysis, a weighted decision matrix is used to evaluate each architecture based on several criteria. Table 7-1 defines a set of criteria against which each alternative architecture is assessed. Each architecture is scored for every criterion, and scores range from 1 to 5, with 1 indicating the worst performance and 5 indicating the best performance in that criterion.

Each criterion item carries a different weight. Chapter 4 discusses the capabilities of the current enterprise and identifies that flexibility, adaptability, agility, and competitiveness would need to be improved. Additionally, M-Corp would need to maintain its global operations and customer relationships and is likely to consider robustness. Each criterion carries a 20% weight in the evaluation process.

Table 7-1 Weighted decision matrix used to evaluate alternative architectures

Criteria	Weight	Description
Flexibility (20%)	10%	Can the organization quickly shift resources between projects or priorities in response to priority changes?
	10%	Does the organization easily facilitate reconfiguration or scaling up to seize new opportunities in the landscape?
Adaptability (20%)	10%	Does this organization allow learning and incorporate new trends from the external landscape
	10%	Does this organization support ongoing learning and improve internally
Agility (20%)	10%	Can the organization quickly make and implement decisions?
	10%	Does it rapidly adopt new technologies and develop new products in response to market needs?
Competitiveness (20%)	5%	Is this organization effective in developing competitive products?
	5%	Is the organization effective at retaining top talent?
	5%	Is the organization efficient in its operations?
	5%	Is the organization effective in attracting partners and building ecosystems?
Robustness (20%)	10%	Does the new architecture increase organizational risk? (A higher score means less risk in the organization)
	10%	Could the transformation and new architecture disrupt ongoing operations? (A higher score means less likely to cause disruption)

7.2. Generation of Alternative architectures

This section first discusses the current (as-is) enterprise and then presents three concepts of alternative architectures, along with three different organizational architectures.

7.2.1. As-is Enterprise (baseline)

Figure 7-1 shows the as-is hierarchical structure with clear lines of management authority. Corporate headquarters sits at the top, overseeing the entire engineering organization and other corporate functions. Encircled by a dashed blue line, the engineering organization is managed by executives who set strategic goals, define budget spending plans, and allocate resources across all projects.

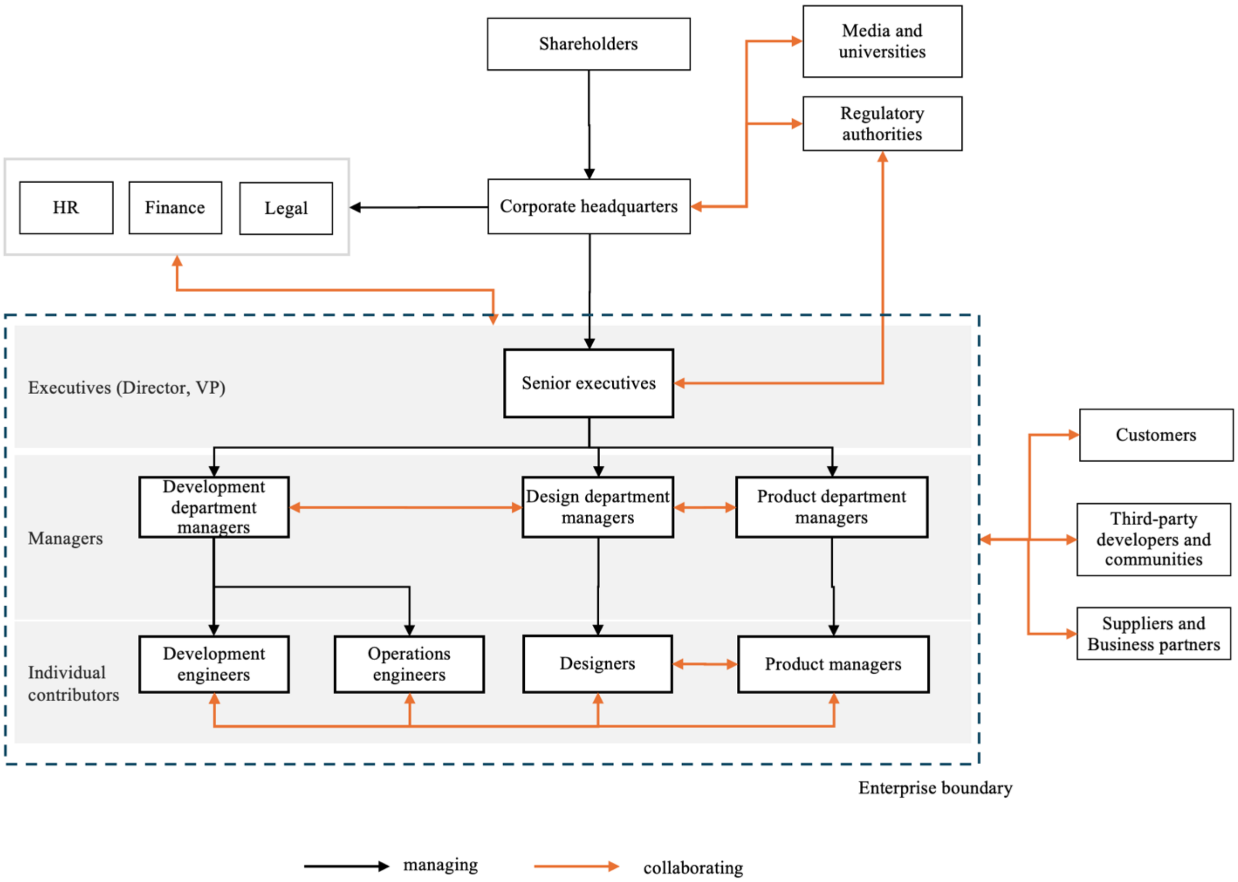

Figure 7-1 The overview of the “as-is” engineering organization architecture

Each department within the engineering organization has its managers. These managers oversee individual contributors, coordinate among departments to resolve conflicts and collaborate on project planning and timelines. Individual contributors are grouped based on functional departments and report to their respective managers, collaborating on specific tasks for implementation.

External stakeholders, including corporate functions, provide necessary resources to the engineering organization. Suppliers, partners, third-party developers, and regulators also coordinate with the engineering organization.

From a task completion perspective, each task is assigned to a specific department, added to that department’s backlog, and then prioritized based on staffing levels, productivity, and project priorities. This architecture indicates a clear separation of roles, with most coordination and planning occurring at the top management level.

7.2.2. Concept and Design of Architecture I

Concept generation is the initial step prior to developing the actual alternative architectures. Each concept incorporates certain desired attributes introduced in previous chapters, aiming to capture the emerging value of stakeholders.

Concept I emphasizes enhancing adaptability and competitiveness by increasing the ownership roles of individual contributors and managers without dramatically changing the existing architecture. Details of Concept I are shown in Table 7-2.

Table 7-2 Concepts for alternative architecture I

Element	Description
Strategy	Emphasis is placed on adaptability and competitiveness. Teams are product-focused, with each team having full flexibility and dedicated resources for their specific product.
Information	Communication within teams is swift, and transparency is prioritized. Strategic directives come from senior management.
Infrastructure	Teams select their own tools and infrastructure to best support their products.
Products	Teams are assigned to continuously work on the same product.
Service	Services are tailored to product lines and customer needs and delivered by the respective product teams.
Process	Each team handles all requests for one product.
Organization	Two-tier management structure: Executives handle overarching strategy and goals, while team managers have the final say on their products.
Knowledge	Common knowledge sharing could be challenging due to team segregation; domain-specific knowledge may remain within teams.

Figure 7-2 shows an architecture diagram of the alternative architecture I, highlighted by the blue-colored box, illustrating that individuals are organized into small squads. Each squad is led by a squad manager who reports directly to an executive and oversees all squad members. Squad managers also coordinate with other squad managers regarding staffing and resource planning.

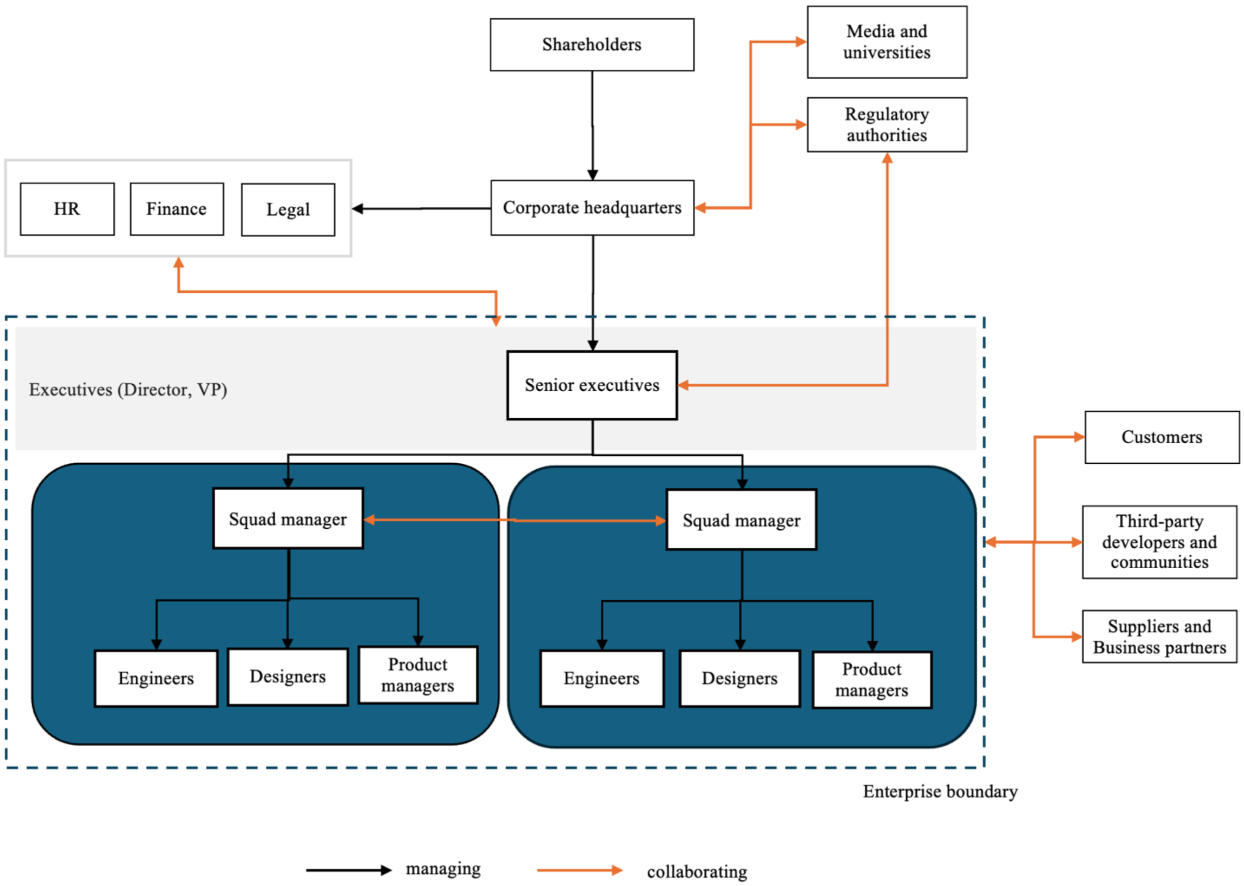

Figure 7-2 Alternative architecture I – small squads

Each squad has various roles, including engineers, designers, and product managers, who all work collaboratively on the same set of products. The squad would handle all requests and questions related to their products, prioritizing them internally. All members in one squad participate and are responsible for the entire product lifecycle, starting from initial user research and design phases, moving through the development process, and continuing into operational management. This structure grants each squad complete ownership over its product and its services. Such autonomy would also empower them to effectively manage and direct support from external contractors and partners. With a comprehensive understanding of their products, squad members are likely to ensure high-quality development and maintenance, fostering innovation and responsiveness to market changes.

The SWOT analysis for the alternative architecture I is as follows:

Strengths

Dedicated teams for each product simplify capacity planning and product scheduling. This specialization also enables a single point of contact for support and customer service, eliminating communication rerouting and ensuring consistent and timely communication.

Weaknesses

Each individual works on different products that may require a completely different set of technologies. This specialization makes it challenging to find replacements should a team member become unavailable, potentially interrupting business continuity. Additionally, if a team member leaves, significant knowledge gaps could arise.

Opportunities

The flexible team formation fosters internal innovation and experimentation with new projects. Employees with innovative ideas are likely to collaborate to validate concepts and develop prototypes. This approach also allows for quick allocation of dedicated resources to address urgent customer requests or specific requirements.

Threats

The squad's overall productivity may vary depending on its members, and the unique composition of each squad makes their successes challenging to replicate across the organization. Even squads working on different products under the same umbrella may experience varying levels of performance, complicating standardization and scaling of successful practices.

7.2.3. Concept and Design of Architecture II

Concept II aims to boost adaptability and maximize flexibility by outsourcing the bulk of engineering tasks and maintaining a core in-house team for essential coordination and management. Details of Concept II from the perspective of various elements are presented in Table 7-3.

Table 7-3 Concepts for alternative architecture II

Element	Description
Strategy	Focus on maximum flexibility and agility by retaining only the minimum number of in-house employees and outsourcing most of the work.
Information	The free flow of information is crucial, especially when outsourcing. Knowledge transfer and confidentiality are needed.
Infrastructure	The technology and systems need to support both in-house teams and outsourced contractors.
Products	In-house only for key phases of products, while most of the product features. Auxiliary products or features, and operations could be outsourced.
Service	In-house teams manage core services, while outsourced services could be used for scalable, non-critical services, or new tasks.
Process	Requires careful management to ensure that quality and consistency are maintained.
Organization	Individuals within the organization need to have clear roles and responsibilities. A point of contact is needed to ensure smooth communication with external contractors.
Knowledge	Core knowledge is likely to be preserved in-house, with an effective strategy for leveraging external knowledge through outsourcing.

Figure 7-3 shows the second architecture - Minimum In-House and Outsourcing. This architecture emphasizes flexibility and agility, focusing on maintaining a core team of in-house employees who possess critical skills and knowledge essential for the central functions of the business. Simultaneously, it outsources specific tasks, encompassing both development and operational activities, to contractors. This approach allows the organization to adapt quickly by scaling the number of contractors up or down based on the evolving needs of product development and operational demands.

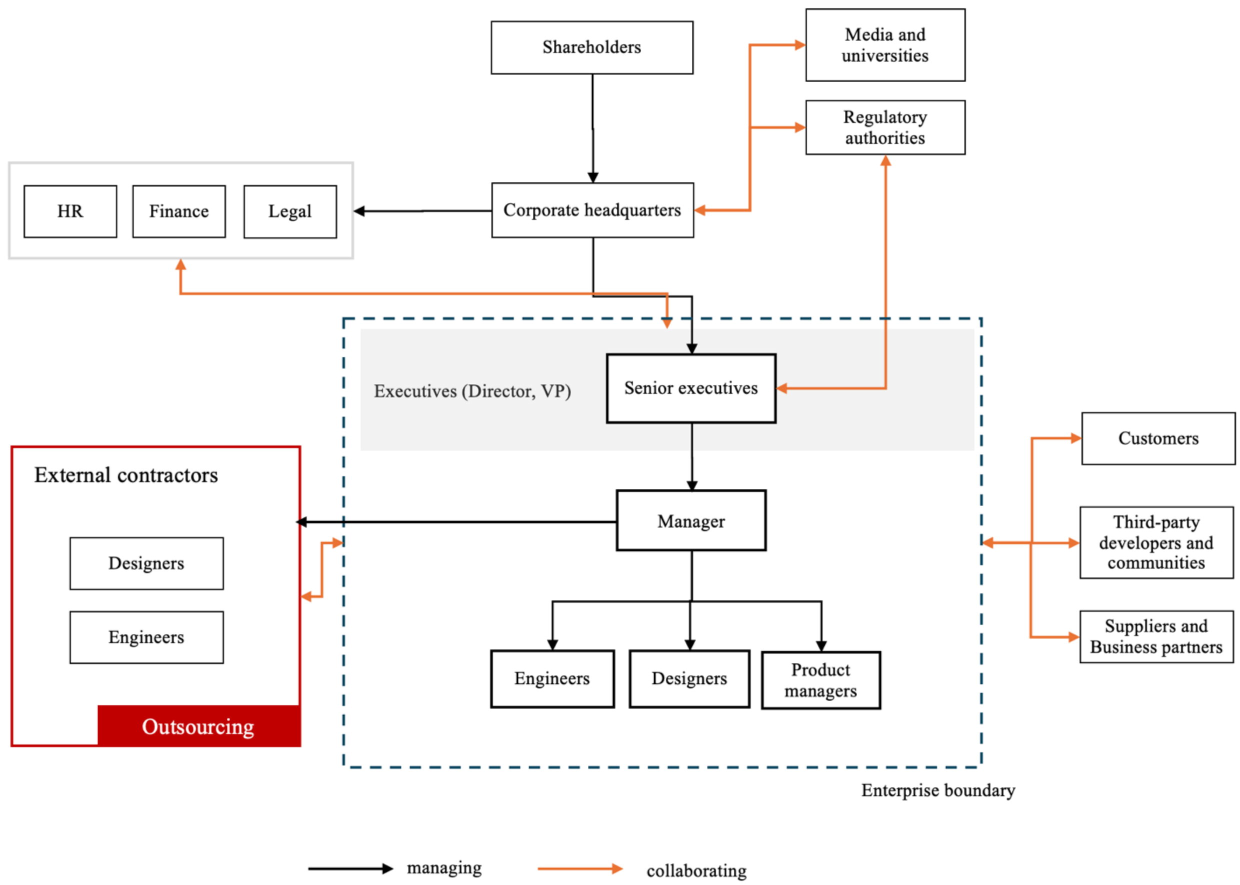

Figure 7-3 Alternative architecture II - minimum in-house

In this architecture, in-house managers oversee both internal employees and external contractors, reporting directly to the executive level. In-house employees coordinate with external contractors to complete tasks across all product lines, ensuring seamless integration and execution. These in-house team members also serve as primary contacts for each product, collaborating closely with their external counterparts on project planning and implementation, thereby ensuring that all project milestones are met efficiently and effectively.

The SWOT analysis for the alternative architecture II is as follows:

<u>Strengths</u>

Outsourcing could potentially support rapid response to market demands by quickly mobilizing external teams for new product development, which might enhance organizational agility and adaptability to some extent. Additionally, it potentially offers cost-effectiveness by reducing overhead and possibly eliminating many fixed operational costs. This flexibility in managing resources allows the organization to scale operations up or down based on current needs without the constraints of maintaining a large permanent workforce.

Weaknesses

A major downside to full outsourcing could be the lack of full ownership over projects, as employees continuously work with different outsourcing teams. This might lead to inconsistencies and dilute the sense of project ownership among internal staff. Moreover, geopolitical restrictions could also limit the pool of outsourcing options, potentially affecting the efficiency and quality of outsourced work. Another significant risk involves intellectual property; contractors might leverage the insights and knowledge gained from their work to develop competing products, posing a direct threat to the organization.

Opportunities

Outsourcing opens significant opportunities for incorporating the latest technologies and innovations into the organization. By collaborating with a diverse range of contractors who may bring specialized skills and contemporary technological advancements, the organization has a higher chance to stay at the cutting edge of technology without directly investing in extensive research and development. This model not only has the potential to enhance the innovative capacity but also possibly inject fresh perspectives and ideas into the organization's operations.

Threats

The reliance on external contractors comes with its set of risks, notably the potential loss of core competencies within the organization. If key contractors are lost, this might result in a significant knowledge gap, potentially negatively impacting product quality and operational continuity. Additionally, this dependency on external entities introduces vulnerability, as the organization might struggle to meet its operational requirements during periods when quality contractors are scarce or if existing contractors fail to deliver as expected.

7.2.4. Concept and Design of Architecture III

Concept III focuses on achieving a balance among adaptability, flexibility, and robustness by forming internal squads for different product developments while outsourcing many of its operational responsibilities to external resources. Details of Concept III can be found in Table 7-4.

Table 7-4 Concepts for alternative architecture III

Element	**Description**
Strategy	Prioritizes rapid innovation and strategic execution by using in-house development resources. Uses professional skills from outsourcing for operational excellence.
Information	Internal product squads handle development projects and maintain consistent communication between internal and external engineering teams.
Infrastructure	The technology and systems need to support both in-house teams and outsourced contractors.
Products	A product-centric approach focuses on quickly delivering value to customers with in-house resources.
Service	Services are performed by contractors specialized in operational tasks.
Process	Development and operational processes are distinct. A handover process between internal and external teams is likely to be established.
Organization	The architecture involves a mix of internal and external resources.
Knowledge	Departments hold specialized knowledge. Operational knowledge is shared with external teams for communication.

Figure 7-4 suggests that the engineering organization forms squads (depicted in blue boxes) for new product development, aligning with executive strategies.

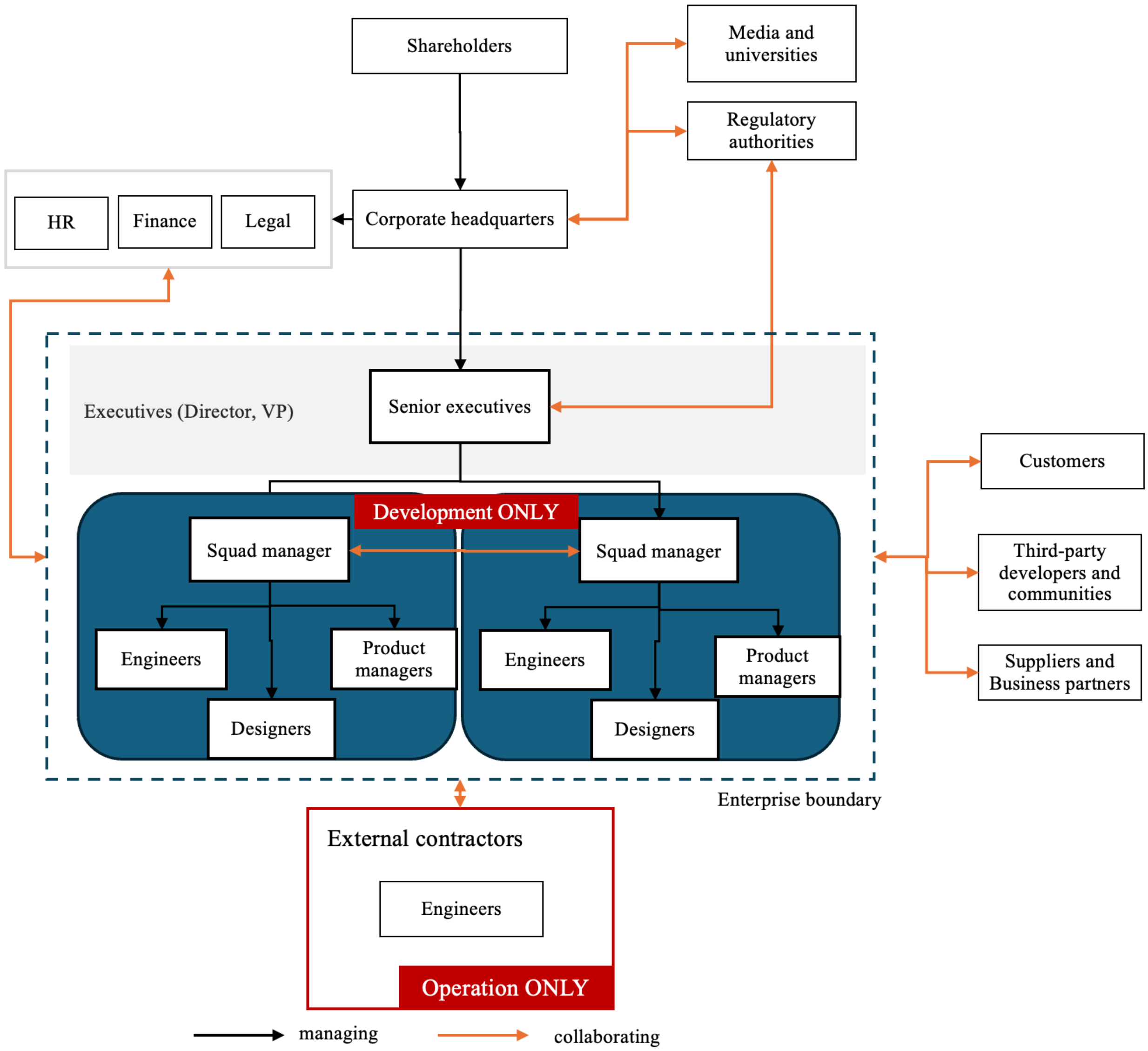

Figure 7-4 Alternative architecture III - in-house development only

Tasks consistently go to the dedicated squad for prioritization and implementation for new product development. Once the development phase concludes, operational tasks are generally delegated to proficient contractors, potentially optimizing the process with a focus on efficiency and specialization. This transition usually occurs when the product enters its routine operational phase, aiming to ensure continuity through regular communication between internal and external engineering teams. The goal is to optimize resource allocation, allowing internal teams to concentrate on developing new products.

The SWOT analysis for the alternative architecture III is as follows:

Strengths

The organization benefits from a focused approach by maintaining dedicated squads specifically for new product development, allowing for deep specialization and an intensive focus on innovation. This structure ensures that resources are utilized efficiently, with operational tasks typically transferred to dedicated teams and external contractors' post-development phase to optimize workload distribution and maintain focus on new initiatives. The streamlined division between development and operational tasks allows each team to specialize in their respective areas, improving efficiency and effectiveness in handling their specific roles.

Weaknesses

The organization's reliance on external contractors for operational tasks could introduce risks related to quality control and dependency, which might lead to consistency in service delivery. Communication between internal and external teams needs to be managed carefully to potentially prevent information silos or miscommunications, which are inherent challenges in this model. Additionally, the handover process from internal development squads to operational teams and contractors is crucial; any missteps in this transition could potentially adversely affect product quality and customer satisfaction.

Opportunities

This operational model provides scalability, enabling the organization to adjust operations based on product success and market demand without significantly increasing internal staffing levels. By allocating internal resources primarily to new product development, the organization can accelerate innovation cycles and maintain a competitive edge in the market. Furthermore, collaboration with external contractors opens avenues for strategic partnerships, offering potential access to new markets and technologies that can enhance the organization's market position.

Threats

The organization’s operational success is closely tied to the reliability and performance of external contractors. Disruptions in contractor services can directly impact the organization's operational capabilities. There is also an inherent risk of losing control over operational quality and timelines when outsourcing critical tasks. Moreover, increased collaboration with external parties raises concerns about the security of intellectual property, as exposure to external contractors might lead to potential theft or leakage of proprietary information.

7.3. Determining Future Architecture

This section first evaluates each architecture using the weighted decision matrix defined in the previous section, and the evaluation result is presented in Table 7-5. Based on the evaluation results, a selected architecture is presented. The total score for each architecture is calculated by summing the scores for each item, each multiplied by its weight.

Table 7-5 Weighted decision matrix for different alternative architectures

Criteria	Weight	Description	As-is	ACI	ACII	ACIII
Flexibility (20%)	10%	Can the organization quickly shift resources between projects or priorities in response to priority changes?	2	3	5	4
	10%	Does the organization easily facilitate reconfiguration or scaling up to seize new opportunities in the landscape?	1	1	5	3
Adaptability (20%)	10%	Does this organization allow learning and incorporate new trends from the external landscape	1	4	4	3
	10%	Does this organization support ongoing learning and improve internally	3	4	1	3
Agility (20%)	10%	Can the organization quickly make and implement decisions?	1	3	5	3
	10%	Does it rapidly adopt new technologies and develop new products in response to market needs?	2	2	5	4
Competitiveness (20%)	5%	Is this organization effective in developing competitive products?	2	5	4	5
	5%	Is the organization effective at retaining top talent?	2	5	1	3
	5%	Is the organization efficient in its operations?	2	3	5	5
	5%	Is the organization effective in attracting partners and building ecosystems?	2	4	4	4
Robustness (20%)	10%	Does the new architecture increase organizational risk? (A higher score means less risk in the organization)	3	3	1	3
	10%	Could the transformation and new architecture disrupt ongoing operations? (A higher score means less likely to cause disruption)	3	2	1	3
		Total score	2	3.05	3.4	3.45
		Overall implementability level	-	ESAY	HARD	MEDIUM

The current "as-is" architecture scores the lowest due to its shortcomings in flexibility, adaptability, and competitiveness. However, it receives a total score in robustness since maintaining the status quo means no change in risk levels and no disruption to existing operations.

Architecture I (ACI) excels in competitiveness, particularly in developing competitive products and retaining top talent. ACI operates with small squads that allow employees to take full ownership of the product from end to end, enhancing their sense of achievement upon product release. These squads focus on a limited number of products, allowing for dedicated product research, design, and integration of the latest technologies based on real customer feedback. This focus also facilitates continuous improvement in products and processes. However, this structure introduces risks such as disparities in squad skill levels affecting product quality and knowledge being confined within small groups. Additionally, squads handle both development and operations, which can be challenging if development demands overshadow operational capabilities.

Architecture II (ACII) emphasizes ultimate flexibility through its outsourcing model. This architecture allows the organization to dynamically scale its workforce by hiring contractors with specific skill sets as needed for new products. It also adapts staffing levels based on project progress, market feedback, and investment levels. The smaller in-house team focuses on product strategy, high-level architecture, and core technology design, while contractors handle most of the development work, bringing in the industry's latest technologies. Operations are also outsourced to skilled contractors. However, this architecture carries significant risks due to heavy reliance on external resources, including potential geopolitical issues that might restrict access to necessary contractors. Additionally, transferring existing development and operations to external teams could cause disruptions during the transition process.

Architecture III (ACIII) scores balanced marks across all criteria. It retains the squad system from Architecture I for new product development, offering flexibility in grouping employees into new product teams. While it may not scale as rapidly as Architecture II, it allows for in-house development, retaining knowledge and enabling continuous improvement. Operations are efficiently outsourced to external contractors, freeing in-house staff from routine tasks to focus on product development, ecosystem building, and employee retention. Risks associated with outsourcing and the need for internal staff to transition operations to external teams may cause operational interruptions. ACIII has the highest weighted score among the three architectures and is, therefore the selected architecture.

The following section examines Architecture III under different future scenarios to assess if it can still produce an innovative engineering organization with increased flexibility, adaptability, agility, and competitiveness while managing risks at an acceptable level

7.4. Future Proofing

This section utilizes scenario analysis as a future-proofing technique to assess the suitability of the preferred architecture. Chapter 1 introduces the rapidly changing technology industry and the challenges faced by large enterprises. Chapter 2 outlines the barriers to innovation that engineering organizations typically encounter in this context. Building on these insights, three epochs are created, each representing a potential scenario that M-Corp might face over the next five years. As a global company, M-Corp is concerned about several key factors:

- Geo-political shifts could impact its staff and global supply chain.
- Market Demand Fluctuations could impact customers' buying power.
- Competitive pressure could challenge its core competitiveness in product innovation, service quality, and ecosystems.

Table 7-6 shows three epochs. For each epoch, the weight in the decision matrix changes to reflect the concerns from M-Corp, and the score remains unchanged.

Table 7-6 Three epochs of M-Corp's future landscape

Epoch 1 – bad time	Epoch 2 – big players	Epoch 3 – heated competition
• Increased geo-politic tension • Decreased market demand • Many competitors	• Similar geo-politic tension • Similar market demand • Few large enterprises	• Decreased geo-politic tension • Increased market demand • Many smaller competitors

Epoch 1 – bad time

Under this scenario, an economic recession could lead customers to reduce their technology spending and become more selective in choosing products. Additionally, geo-political factors may impact global staff mobility, creating challenges in hiring or necessitating a complete withdrawal from specific markets (Yale Chief Executive Leadership Institute, 2024). Consequently, cautious investment becomes a priority for the company, with an increased focus on the organization's robustness. To address these concerns, the weight assigned to robustness in the decision matrix is adjusted to 40%, reflecting its heightened importance in this scenario. The updated evaluation result is shown in Table 7-7.

Table 7-7 Updated weighted decision matrix under Epoch 1

Criteria	Weight	Description	As-is	ACI	ACII	ACIII
Flexibility (15%)	7.50%	Can the organization quickly shift resources between projects or priorities in response to priority changes?	2	3	5	4
	7.50%	Does the organization easily facilitate reconfiguration or scaling up to seize new opportunities in the landscape?	1	1	5	3
Adaptability (15%)	7.50%	Does this organization allow learning and incorporate new trends from the external landscape	1	4	4	3
	7.50%	Does this organization support ongoing learning and improve internally	3	4	1	3
Agility (15%)	7.50%	Can the organization quickly make and implement decisions?	1	3	5	3
	7.50%	Does it rapidly adopt new technologies and develop new products in response to market needs?	2	2	5	4
Competitiveness (15%)	3.75%	Is this organization effective in developing competitive products?	2	5	4	5
	3.75%	Is the organization effective at retaining top talent?	2	5	1	3
	3.75%	Is the organization efficient in its operations?	2	3	5	5
	3.75%	Is the organization effective in attracting partners and building ecosystems?	2	4	4	4
Robustness (40%)	20.00%	Does the new architecture increase organizational risk? (A higher score means less risk in the organization)	5	3	1	3
	20.00%	Could the transformation and new architecture disrupt ongoing operations? (A higher score means less likely to cause disruption)	5	2	1	3

Epoch 2 – big players

In this scenario, persistent geo-political tensions continue to shape the business landscape, affecting international trade and global market operations. These tensions lead to similar market demands as companies and consumers become cautious, opting for proven, reliable technology solutions. Within this environment, a few large enterprises dominate the market. The key to winning competition is to launch new products ahead of other large enterprises while maintaining high quality and robust operations to win trust. In this scenario, weight for robustness increases to 30%, and agility and competitiveness increases to 20%. The result is shown in Table 7-8.

Table 7-8 Updated weighted decision matrix under Epoch 2

Flexibility (15%)	7.50%	Can the organization quickly shift resources between projects or priorities in response to priority changes?	2	3	5	4
	7.50%	Does the organization easily facilitate reconfiguration or scaling up to seize new opportunities in the landscape?	1	1	5	3
Adaptability (15%)	7.50%	Does this organization allow learning and incorporate new trends from the external landscape	1	4	4	3
	7.50%	Does this organization support ongoing learning and improve internally	3	4	1	3
Agility (20%)	10.00%	Can the organization quickly make and implement decisions?	1	3	5	3
	10.00%	Does it rapidly adopt new technologies and develop new products in response to market needs?	2	2	5	4
Competitiveness (20%)	5.00%	Is this organization effective in developing competitive products?	2	5	4	5
	5.00%	Is the organization effective at retaining top talent?	2	5	1	3
	5.00%	Is the organization efficient in its operations?	2	3	5	5
	5.00%	Is the organization effective in attracting partners and building ecosystems?	2	4	4	4
Robustness (30%)	15.00%	Does the new architecture increase organizational risk? (A higher score means less risk in the organization)	5	3	1	3
	15.00%	Could the transformation and new architecture disrupt ongoing operations? (A higher score means less likely to cause disruption)	5	2	1	3

Epoch 3 – heated competition

In this scenario, a decrease in geo-political tensions fosters a more stable global business environment, increasing market demand. This expansion attracts numerous smaller competitors, intensifying the competitive landscape. To capitalize on these opportunities, organizations must rapidly adapt to market trends, prompting an increase in the flexibility weight to 15%. Additionally, there is a pressing need to launch new products swiftly to secure a market-leading position, which also increases the weight for agility to 15%. To build core competitiveness—characterized by robust products, top talent retention, and enhanced operational efficiency—the weight for competitiveness is significantly raised to

50%. This strategic adjustment aims to optimize performance and leverage emerging market opportunities effectively. The result is shown in Table 7-9.

Table 7-9 Updated weighted decision matrix under Epoch 3

Criteria	Weight	Description	As-is	ACI	ACII	ACIII
Flexibility (15%)	7.50%	Can the organization quickly shift resources between projects or priorities in response to priority changes?	2	3	5	4
	7.50%	Does the organization easily facilitate reconfiguration or scaling up to seize new opportunities in the landscape?	1	1	5	3
Adaptability (15%)	7.50%	Does this organization allow learning and incorporate new trends from the external landscape	1	4	4	3
	7.50%	Does this organization support ongoing learning and improve internally	3	4	1	3
Agility (15%)	7.50%	Can the organization quickly make and implement decisions?	1	3	5	3
	7.50%	Does it rapidly adopt new technologies and develop new products in response to market needs?	2	2	5	4
Competitiveness (50%)	12.50%	Is this organization effective in developing competitive products?	2	5	4	5
	12.50%	Is the organization effective at retaining top talent?	2	5	1	3
	12.50%	Is the organization efficient in its operations?	2	3	5	5
	12.50%	Is the organization effective in attracting partners and building ecosystems?	2	4	4	4
Robustness (5%)	2.50%	Does the new architecture increase organizational risk? (A higher score means less risk in the organization)	3	3	1	3
	2.50%	Could the transformation and new architecture disrupt ongoing operations? (A higher score means less likely to cause disruption)	3	2	1	3

Table 7-10 shows that, when aggregating the scores from the table across the three different epochs, Architecture III consistently scores the highest among the alternatives. Therefore, this study recommends Architecture III as the innovative engineering organization architecture for M-Corp. This architecture is positioned to better capture stakeholders' emerging values better while aligning with the organization's strategic goals.

Table 7-10 Weighted scores of all architectures under various scenarios

Scenario	As-is	Architecture I	Architecture II	Architecture III
Original	2	3.05	3.4	3.45
Epoch 1 – bad time	3.05	2.9125	2.8	3.3375
Epoch 2 – big players	2.725	3	3.125	3.425
Epoch 3 – heated competition	1.9	3.525	3.675	3.775

7.5. Developing Implementation Plan

In the ARIES framework, the final step involves developing a plan for the enterprise to implement the new architecture. The X-matrix is an effective technique for describing and analyzing the alignment of strategic objectives, metrics, processes, and stakeholder values (Nightingale & Rhodes, 2015). Furthermore, the anatomy of eight view elements is utilized to outline key strategies in the new architecture. A comparison of these elements between the current and the new architecture is also provided. At the end of this section, a high-level plan is outlined to implement these key strategies, with several considerations being discussed.

7.5.1. Validation of Future Architecture

The Enterprise X-matrix within the ARIES Framework is divided into four quadrants: Strategic Objectives, Metrics, Processes, and Stakeholder Values (Nightingale & Rhodes, 2015). The intersecting quadrants represent potential interactions between a column and a row. Each cell in the matrix indicates the level of interaction between the row and column items, using colors: blue for strong, yellow for weak, and white for none.

Strategic objects are transformation goals that an enterprise wants to achieve. For M-Corp, these strategic goals are:

- Maintain healthy cash flow and achieve financial objectives.
- Strengthen partnerships and ecosystems to enhance global reach.
- Ensure responsible and transparent governance to maintain trust and reputation.
- Foster a culture of diversity and inclusion.
- Develop employee skills and expertise.
- Invest in advanced research to lead the industry and drive innovation for competitive advantage.
- Expand the product portfolio in emerging technologies to deliver value to clients.

The metrics and key processes designed to address issues in the existing enterprise architecture are shown in Figure 7-5. Each cell in the matrix indicates the level of interaction between the row and column items, using colors: blue for strong, yellow for weak, and white for none.

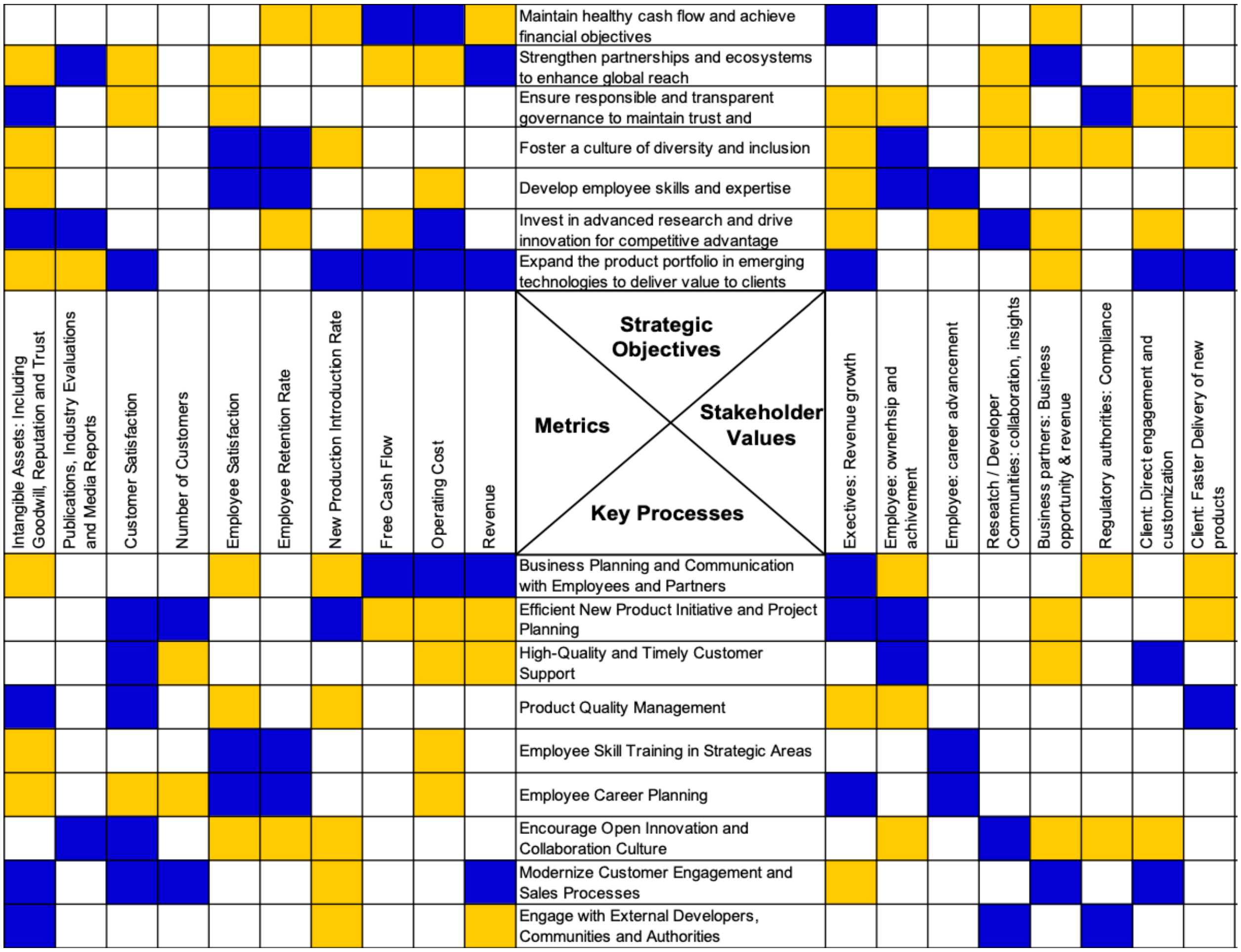

Figure 7-5 X-matrix for the engineering organization's future architecture

The preferred future architecture prioritizes rapid product development by forming small squads that take ownership of the entire product development lifecycle. It also encourages collaboration with external developers, communities and direct client communications. This future architecture enables the enterprise to accelerate new product development while maintaining high-quality support for existing customers.

For example, the new strategic objective, *Expand the product portfolio* in emerging technologies, will now deliver value in terms of ownership and achievement for employees. This is because employees working in small squads can make decisions more quickly. They will have a voice in new processes, such as the *New Product Initiative* and the *Project Planning Process*. With expertise from the external operations team, they will be able to redesign high-quality customer support programs. These improvements could be reflected in the *New Product Introduction Rate* and the *Customer Satisfaction Reports*.

In another example, the objectives *Foster a culture of diversity and inclusion* and *Strengthen partnerships and ecosystems* together capture value from M-Corp's business partners and third-party communities. In the new architecture, the organization establishes direct connections with third parties through processes like the *Open Innovation and Collaboration Program*, and engagement with external developer communities and authorities. Metrics such as the number of customers, publications, and media reports could be used to measure the effects of these processes.

The X-matrix illustrates the necessary key processes and metrics the enterprise needs to include in the implementation plan to achieve its envisioned future.

7.5.2. Element Anatomy for the Future Architecture

X-matrix provides a high-level overview of the relationship among strategic objects, stakeholder values, key processes, and evaluation metrics, demonstrating that future enterprise architecture delivers emerging values and addresses existing issues. The *element anatomy* is useful to present some detailed implementation ideas for future architecture (Nightingale & Rhodes, 2015). The following discussion captures the anatomy of view elements for both the future and current architectures to facilitate comparison.

Table 7-11 shows the strategic shift in the future architecture, which aims to attract new customers of all sizes, not just large companies, through investment in numerous new products. Both the measures and evaluation periods have also been adjusted.

Table 7-11 Strategy element anatomy for M-Corp

Anatomy	As-is architecture	To-be architecture
Structure	Focus mainly on large enterprise customers	Focus on various sizes of companies
Behavior	Focus on a few heavily invested products	Smaller investment in more new products
Artifacts	Strategic plan Annual report	Strategic plan Annual report
Measures	Customer satisfaction	New product introduction rate Customer satisfaction Number of new customers
Periodicity	Bi-annually	New product evaluation will be ongoing. Product roadmap reviewed monthly

Table 7-12 shows the process element anatomy. The most significant change in the future architecture involves each squad's self-improved process. Squads merge existing organizational processes and industry best practices into their development and operating procedures. They also collaborate with external contractors to swiftly adjust these processes as needed. In the future architecture, behavior reflects collaborative project planning among in-house employees, third-party community members, and external contractors.

Table 7-12 Process element anatomy for M-Corp

Anatomy	As-is architecture	To-be architecture
Structure	Mature process employed by the entire organization	Self-improved process used by product squads and external contractors
Behavior	Top-down project planning	Collaborative project planning
Artifacts	Policy, best practice	Policy, best practice
Measures	Total completed tasks Employee satisfaction	Total completed tasks Employee satisfaction
Periodicity	Processes update happens usually during re-org	Processes updated more frequently as squads can act swiftly

Table 7-13 shows the organization element anatomy. On the structure and behavior side, the future architecture introduces contractors to do all operational tasks and a flatter in-house team structure. By collaborating with contractors, in-house employees can free up time to focus on new product development and make decisions faster. In addition, the future architecture also has direct connections with external parties such as industry experts, community developers, and researchers. Therefore, new artifacts such as community engagement policy are needed. Finally, the new measures are introduced for the new architecture and will be evaluated more frequently.

Table 7-13 Organization element anatomy for M-Corp

Anatomy	As-is architecture	To-be architecture
Structure	Functional team with clear hierarchy; no external teams	Product squads and flat management with contractors and communities
Behavior	Collaboration mainly within the organization	Collaboration among different roles and with external teams
Artifacts	Organization charter, mission statement	Organization charter, mission statement Contractor agreement Communication engagement policy
Measures	Revenue, budget, employee satisfaction	Revenue, budget, employee satisfaction
Periodicity	Annual	Quarterly

Table 7-14 displays the knowledge, information, and infrastructure elements anatomy, focusing on product-specific knowledge and engineering technical skills. In the future architecture, this knowledge will be collaboratively documented by M-Corp's employees, contractors, and community members due to their close collaboration. Additionally, documentation will be produced in various formats such as demos, blogs, news articles, and publications. These formats will aid M-Corp in establishing a strong industry reputation and trust.

Table 7-14 Knowledge, Information & Infrastructure elements anatomy for M-Corp

Anatomy	As-is architecture	To-be architecture
Structure	Product knowledge; Development knowledge	Product knowledge; Development knowledge
Behavior	Employees write all documentation	Collaboration between employees, contractors, and communities
Artifacts	Product and process documentation	Product and process documentation: Demos, articles, publications
Measures	Customer satisfaction report; Employee satisfaction report	Customer satisfaction report; Employee satisfaction report; Industry reputation
Periodicity	Annual	Annual

Table 7-15 shows the product and service element anatomy, demonstrating how the future architecture will allow the organization to develop an increased number of products, starting from simple bases and then progressively adding more features. Each product's roadmap will incorporate inputs not only from M-Corp's employees but also from direct feedback from customers and communities. Additionally, the number of products will be introduced as a new measure in the future architecture.

Table 7-15 Product and Service elements anatomy for M-Corp

Anatomy	As-is architecture	To-be architecture
Structure	A few products with many features	Smaller products that could potentially add more features
Behavior	Develop plan based on several large customers	More inputs from all types of customers and communities
Artifacts	A few products	More products
Measures	Revenue from a single product	Revenue from a single product Number of new products
Periodicity	Annual	Annual

7.5.3. Implementation Plan

A phased transformation helps ensure business continuity while allowing the organization time to implement the new architecture effectively, and considering the *Role of Leadership and Governance* and *Communicating the Plan* are two key aspects (Nightingale & Rhodes, 2015). Figure 7-6 shows a phased implementation plan for M-Corp to implement the future architecture within its engineering organization.

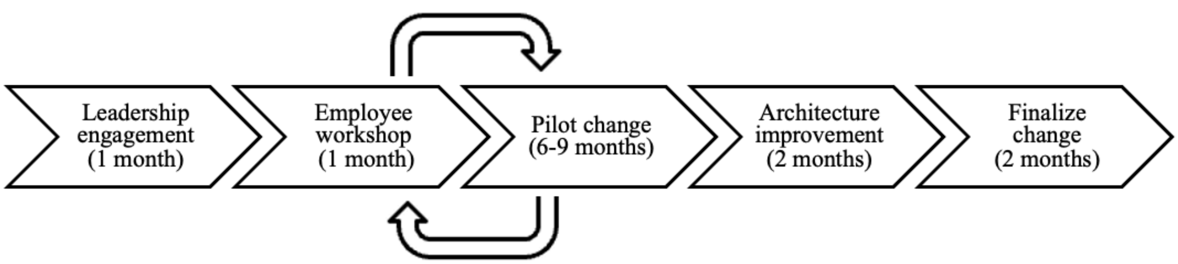

Figure 7-6 A phased implementation plan for the future architecture

With the M-matrix providing a high-level overview and detailed discussion in element anatomy, the implementation plan begins with leadership engagement. This phase focuses on discussing the vision, objectives, and expected outcomes of transitioning to the future architecture. Key strategic objectives highlighted in the M-matrix, such as strengthening partnerships and ecosystems to enhance global reach, will also be addressed.

Following this, the plan moves into the employee workshop phase to communicate the purpose and explain how the changes will affect each team and individual. A primary goal of this phase is to solicit feedback and ideas from employees to foster inclusivity and address any reservations. A small group of employees is expected to participate in the pilot change in waves, as their existing projects allow.

As employees join the pilot change, they will integrate into new organizational structures and begin utilizing new processes such as open innovation and collaborating with third parties. They will also work alongside contractors. It is management's role to closely monitor the pilot, gathering data on key metrics and employee adaptation.

Crucially, the pilot change and employee workshop phases are part of a spiral process. This means that pilot outcomes and feedback will likely lead to changes in our strategies and processes for the future architecture, making it essential to communicate these updates to employees to sustain the pilot program.

Once the pilot change phase concludes, it is time to reflect from a high-level perspective and adjust and optimize organizational structures and processes. This is also the moment to engage with process experts and organizational design consultants, using accurate metrics from the pilot program to ensure that organizational configurations facilitate effective workflow and communication.

The final step involves implementing the future architecture and integrating new processes across the organization. During this phase, it is imperative to conduct comprehensive training and provide transition support for all employees, ensuring a sustained transformation.

7.6. Summary

This chapter begins by establishing the evaluation criteria based on the needs of emerging stakeholders and the envisioned future. Three alternative architectures are assessed using two evaluation approaches, and Architecture III is selected as the preferred future architecture considering M-Corp’s existing enterprise landscape. To test the effectiveness and resiliency of this chosen architecture, it undergoes testing through several epochs, which represent potential future changes; associated risks are also discussed. This chapter further validates the preferred architecture by checking strategic alignments using the X-matrix and elaborates on implementation details using element anatomy. Alongside these details, a phased implementation plan is introduced for M-Corp to guide the transformation of its engineering organization towards the envisioned future enterprise architecture.

Chapter 8. Conclusion and Future Work

As discussed previously, large enterprises, such as M-Corp, are well-established in the technology industry. They have built a strong reputation with a long history of pioneering innovations, developing renowned products, and attracting prestigious customers. However, these large technology companies are now experiencing rapid changes in their operating environment and facing intense competition from more disruptive players. Cultivating an environment that fosters innovation seems to be essential for them to stay innovative. This study identifies general strategies and practical approaches to foster a positive environment. Drawing from these insights, the study demonstrates the use of systems thinking and a holistic approach to transform an engineering organization's architecture, making it innovative and adaptable to changes. Several considerations are also discussed regarding the transformation of such organizational architecture.

8.1. Conclusion

Chapter 1 introduces the background of the technology industry, which has experienced significant transformations due to technological advancements, changing customer demands, and evolving business models. Challenges arise for large enterprises in this industry, primarily due to a diminishing capacity for innovation. These enterprises need to regain their innovative capabilities within their engineering organizations. The research questions addressed in this study are:

1. In large technology enterprises, what general strategies and practical approaches could facilitate the creation of a positive environment that drives organizational innovation?
2. In developing a future engineering organization, what considerations are important to ensure that the organization enables the large enterprise to gain competitive advantages in the technology industry?

Chapter 2 delves into engineering organizations within large technology companies. These organizations are adapting to new product development methodologies. Research indicates that organizational structure can positively influence innovation capacity. Three significant barriers to innovation are discussed, including capability traps, the organization's reluctance to change its existing processes, and a lack of necessary skills and infrastructure. This chapter suggests that to unlock innovation potential fully, barriers should be tackled organization-wide using a holistic approach.

Chapters 3 and 4 present several generic strategies that could foster a positive innovation environment within organizations. These strategies fall into three categories: leadership, organizational structure, and culture. Specific approaches used in various companies to encourage innovation are also summarized from case studies. Approaches such as creating dedicated innovation teams, implementing innovation programs, establishing partnerships, and embracing openness are found to be beneficial in cultivating a healthy environment that encourages innovation. These chapters also suggest that these strategies and approaches to innovation could be incorporated into a holistic approach to designing an innovative engineering organization.

Chapter 5 introduces the ARIES framework, a holistic approach to enterprise architecture design using systems thinking. Key components of the ARIES framework, including its view elements, modeling processes, and analysis techniques, are also discussed.

Chapter 6 uses the ARIES framework to analyze the existing enterprise architecture of a hypothetical company, M-Corp, which is modeled after several large technology companies. The analysis identifies M-Corp's external and internal landscapes, stakeholders and their priorities, and value exchanges, as well as emerging values from stakeholders. The analysis indicates that improving flexibility, adaptability, agility, and competitiveness are some of the prioritized considerations for M-Corp in establishing an innovative engineering organization. Finally, this chapter discusses the enterprise's future vision, which incorporates these prioritized considerations and captures emerging values from stakeholders.

Chapter 7 first defines evaluation criteria to assess alternative architectures. SWOT analysis and weighted matrix analysis are performed for each alternative architecture to assess its alignment with the envisioned future. Architecture III, which incorporates small squads for product development and combines external contractors for operations, is most likely to drive the innovative organization under different scenarios. Finally, the X-matrix further examines this selected architecture for validity, and an implementation plan is developed.

This study presents three barriers to innovation within the engineering organizations of large enterprises. It also summarizes several generic strategies and approaches that could establish a positive environment for innovation within large enterprises. These strategies are categorized into three groups: leadership, organizational structures, and culture. The study further suggests that using a systems thinking approach would provide a holistic view of enterprises and be beneficial for designing innovative organizations using these strategies and approaches.

This study uses the ARIES, an enterprise architecting framework, to demonstrate how a systems thinking approach can be used to transform organizational architecture for innovation. By applying the ARIES framework to a large hypothetical technology company, M-Corp, specific considerations for an innovative organization are identified as crucial for generating the future vision of M-Corp's engineering organization. These considerations include stakeholder emerging values and envisioned futures.

In the evaluation phase, three alternative scenarios are presented to assess the selected architecture and demonstrate how it could positively impact innovation within M-Corp's engineering organization. Key considerations include different epochs under which the organization could operate and the implementation plan to deliver the transformation.

8.2. Recommendations and Considerations

Based on the findings of this study, the following recommendations are proposed to foster a positive and innovative environment within engineering organizations of large enterprises.

Transformative leadership seems to play a crucial role in creating a positive environment for innovation. Leaders could adopt a mindset that embraces change, cultivates a supportive culture, and motivates employees. Case studies suggest that approaches such as establishing a clear vision and implementing special programs might be practical. Well-established innovation project teams could complement leadership with dedicated support and resource allocation from management. Additionally, developing a reward mechanism for innovation and implementing talent management strategies could support and motivate employees effectively.

Flatter organizations and smaller squads working on products might contribute to a more innovative environment. Landscape and stakeholder analyses indicate that competition in the technology industry is not only about adopting new technologies but also about the speed of introducing new products. Flatter organizational structures may provide more autonomy and result in quicker decision-making processes. However, it is essential to recognize that this structure might hinder the establishment of a joint knowledge base, as teams may operate differently. Regular knowledge-sharing sessions or dedicated teams and processes could be created to foster knowledge sharing across the organization.

Organizations with an open architecture that allows collaboration with contractors and third parties might achieve greater flexibility and agility in product development and service maintenance. The future-proof analysis under different scenarios suggests that open architecture supports rapid scaling by integrating contractors with in-house teams in a rapidly evolving and competitive environment. This approach might enable external partners to take on dedicated responsibilities, freeing up in-house team resources. However, challenges may arise in communication and increased risks from external entities. Companies are suggested to evaluate their operating environment carefully before adopting this approach in scenarios where external hiring might not feasible due to strict labor laws or geopolitical conflicts.

Finally, the hypothetical enterprise M-Corp could potentially adapt these recommendations for its other divisions or the organization operating in other countries. In such cases, prioritized considerations include the external landscape, particularly local regulations and laws, which could lead to different preferred architectures. Some of these considerations when architecting M-Corp's engineering organization might also be useful for other large technology companies facing similar challenges.

8.3. Limitation and Future Work

At the time of writing, the author is employed by a large technology company. The author may introduce unintentional biases into the study. Familiarity with the existing engineering organization architecture and its challenges might influence the analysis, resulting in a non-zero-based design approach. This perspective could skew the development of new architectural concepts toward incremental rather than radical changes.

The study is conducted within the time limitations of a master's thesis, which may restrict the depth and scope of research. Certain essential aspects such as stakeholder analysis were not thoroughly conducted; interviews with real stakeholders such as M-Corp's potential customers and other related entities were not included. Consequently, the values and concerns reflected in the study might not fully capture these groups' real sentiments and priorities. Further modifications and more comprehensive studies are needed to refine the proposed concepts and ensure they align more closely with the actual needs of M-Corp.

The current architecture remains at a high level and lacks detailed specifications necessary for effective implementation. To bridge this gap, detailed architectural plans and step-by-step implementation strategies need to be developed. Additionally, architecture validation could benefit from model-based simulations to gather empirical data, or initiating pilot testing could provide practical insights. If other companies are to adapt this framework, modifications will be necessary to tailor the architecture to fit their specific organizational contexts and challenges.

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