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INNOVATION MANAGEMENT AND ENTERPRISE ARCHITECTURE:

HOW ENTERPRISE ARCHITECTURE CAN HELP IDENTIFY PATTERNS IN INNOVATION MANAGEMENT

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Abstract

Innovation is an impact driver for the development of organizations, which is why many of them have been implementing innovations into their business strategies. However, the success of implementation varies significantly from company to company. The purpose of this paper was to identify successful patterns of Innovation Management in the most innovative companies with the help of the Enterprise Architecture approach and the ArchiMate modelling language. This is an important contribution since modelling Innovation in a precise and comprehensive way allows comparing the models for different companies and finding gaps which prevent innovations from being successfully implemented in other companies.

Keywords: Innovation, Innovation Management, Innovation Strategy, Innovation Process, Organizational Structure, Enterprise Architecture, ArchiMate.

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1. Introduction

Innovation is an essential driving force for companies to stay competitive (Hamel, 1998). That is why many organisations devote much time and effort to developing capabilities to innovate. However, the way they configure Innovation in their processes may considerably differ.

Some companies consider the innovation process fickle, which is why the ideas appear in a spontaneous, very unstructured way there (Baer, 2012). Other companies construct well-developed innovative processes, which allow the creation of a more reliable approach to Innovation (Edmondson, 2012). That is why Innovation Management becomes an essential discipline of managing processes in Innovation and allows organizations to rapidly respond to external and internal opportunities (Kelly and Kranzberg, 1978).

However, the questions arise: why do some companies manage Innovation more successfully than others; and is there a curtain pattern of Innovation, that the most successful companies have in common? If such a pattern exists, how to capture and describe it?

Having its origins in Information System Research, Enterprise Architecture (EA) is a practice which helps represent an organization's processes, structure, and evolution in a holistic way (Lankhorst, 2013). And ArchiMate, an open and independent Enterprise Architecture modelling language, enables enterprise architects to do that unambiguously (The Open Group, 2019).

Previously, no attempts were made to model innovation processes using the Enterprise Architecture approach, however, we believe that EA has great potential for defining, visualising, and analysing Innovation across organizations. To prove that the following research question was formulated: "How Enterprise Architecture can help identify patterns in Innovation Management?"

To answer the stated question, a specific sequence of steps was conducted, which corresponds to the content of the work. **"Literature Review"** provides a theoretical background for the current research, covering the most relevant concepts related to the research question. **"Research Design"**

defines the existing problem in the studied field and states the main and supportive research questions. **"Proposal"** details the approach that was taken to answer the main research question. **"Demonstration"** implements the approach explained in previous steps and illustrates created Metamodels for key elements of innovation. **"Results"** demonstrates the outcomes of modelling Innovation for five innovative organizations and answers the research questions.

Finally, **"Conclusions"** summarizes all insights, provides considerations on limitations, and proposes directions for further research of the topic.

2. Literature review

2.1. Innovation Management

2.1.1. Definition

Innovation is an essential driving force for companies to grow. Under rapidly changing business environments and new emerging challenges, Innovation helps companies recreate themselves and their industries in a profound way to timely respond to those challenges and find new opportunities in the market (Hamel, 1998).

Technological changes and their ever-accelerated pace have even reinforced the need for enterprises to innovate to survive. Innovation helps to take advantage of new technologies and to improve the product or service that enterprises offer, to enhance performance, optimize costs, etc. Moreover, Innovation helps to stay ahead of the competitors by predicting the market and keeping up with customer needs (Nambisan et al. 2017). As successfully implemented Innovation brings additional value for the business, it also contributes to revenue growth. Thus, Innovation is the key to future success in business (Johnson, Christensen, and Kagermann, 2008).

Innovation process is the pathway which includes several steps, from new ideas generation to their development and further implementation and bringing to the market the final product or service (Tohidi and Jabbari, 2012).

In some enterprises, the innovation process is considered fickle and unstructured. However, like any business process, unstructured and uncontrolled Innovation will most likely result in disparate and unrelated initiatives that reflect the intentions and the culture of the teams involved rather than the strategic direction of the enterprises (Baer, 2012). Well-structured innovation process helps to increase the quality of the ideas, which are generated and selected, optimize the use of the resources of the Company, improve the internal cooperation among the teams involved, shorten the time for the development of innovative solutions and increase the success rate of the solutions which are brought to the market (Edmondson, 2012). Moreover, it aids in identifying potential development areas for the Company and determining the limitations of launching a new product or service.

Understanding that, managers are interested in establishing innovation processes in their companies and learning how to manage them efficiently, maximizing innovation output.

Innovation Management becomes an essential discipline of managing processes in Innovation and allows organizations to respond to external (customers, suppliers, competitors, etc.) or internal (technical divisions, marketing and sales, logistics, etc.) opportunities, and use its creative efforts to introduce new ideas, products, or services (Kelly and Kranzberg, 1978). Gartner, an international technology research and consulting firm, defines Innovation Management as a business discipline that aims to drive a repeatable, sustainable innovation process within an organization and focuses on changes that transform the business in a significant way (Gartner, 2022).

2.1.2. Key elements

Innovation strategy

Setting the *innovation strategy* and goals is the first step in the innovation management process. Many companies fail to build and maintain the capacity to innovate not only due to bad execution: many of them do not devote enough time and effort to develop an innovation strategy and align it to the overall business strategy. In its turn, innovation strategy shapes how the Company should

create value for potential customers, capture a share of that value and what type of Innovation it should pursue (Pisano, 2015).

The value for customers can be created in various ways. Innovation can increase the product's performance, provide new features, make it easier to use or have a more appealing design. Different resources and capabilities are generally needed depending on the chosen strategy, and it takes time to develop and accumulate them, so it is crucial to decide what sort of value the invention will provide and then stick with it (Spacek and Vacík, 2016). Moreover, it is not enough only to create value. It is also essential to capture it and protect it from rivals. To do so, companies must think about complementary assets, capabilities, products, or services, which can prevent customers from switching to competitors and help the innovator to keep its own position in the ecosystem.

Companies may pursue different innovations to create and capture value depending on the stated objectives and available resources and capabilities. Renowned experts in the field of Innovation from the Harvard Business School, such as Gary Pisano, William Abernathy, Clayton Christensen, Rebecca Henderson, and some others, developed the approach to characterize Innovation from two perspectives – the degree to which it involves a change in technology and in a business model. Based on these two dimensions, Innovation may fall into the following quadrants-categories: routine, disruptive, radical, or architectural innovation (Appendix 1) (Pisano, 2015).

Routine innovation leverages the existing technical competencies of a company and does not bring any changes to the current business model. Instead, this strategy helps to keep constantly developing existing products or services to offer customers new features and prevent competitors from copying successful solutions. Many companies implement this strategic approach, for instance, Apple, which regularly launches new versions of iOS, iPhones or its other products or Microsoft, which regularly updates its software.

Disruptive innovation, rather than solely enhancing existing products, requires new business model development. An example can be ride-sharing services which some companies started offering, which created competition for the traditional offer of taxi companies (Christensen, Raynor, and McDonald, 2015).

Radical innovation, on contrary, leverages the existing business model of a company but requires new technical competencies. An example of this type of Innovation is the new type of drug discovery, that emerged in the 1970s and 1980s – biotechnology. Established pharmaceutical companies which for decades had been developing medicines via the process of chemical synthesis, needed to develop new capabilities in molecular biology. Nevertheless, it perfectly fitted into the traditional business model of pharmaceutical companies to heavily invest in R&D, mainly funded by the revenues of a few high-margin products (McDermott and O'Connor, 2003).

Finally, *architectural innovation* requires both business model and technical competencies disruptions. One of the examples is digital photography. Entering the digital age required companies such as Kodak or Polaroid to develop new capabilities in electronics, software, display, and other technologies. To stay competitive, the companies tried to disrupt their business model and start making profits from cameras rather than "disposables" (such as film, paper, processing chemicals, and services) (Anthony, 2016).

In the studied literature, the scholars highlight that architectural type of Innovation is the most challenging for companies to realize. At the same time, routine innovation usually generates the most profits. That is why companies need to pursue different kinds of Innovation, which should complement each other (Pisano, 2015).

In addition to the above-mentioned innovation landscape map, other approaches to innovation strategy classification exist. Thus, a professor at UC Berkeley's Haas Business School, Henry Chesbrough, introduced his concept of open innovation as opposed to closed one, when a

company's internal team fully develops Innovation. Instead, open innovation is a decentralized approach to Innovation, which is based on the belief that valuable knowledge should be widely distributed and that no company could innovate effectively on its own, even giant enterprises with a wide range of resources and capabilities (Chesbrough, 2006). Chesbrough states that open innovation is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively". Companies benefit from open innovation as this approach can reduce costs, accelerate time to market and create new revenue streams for the Company (Chesbrough, 2011).

In recent years, many large companies started trying the open innovation approach and combine it with the traditional closed one, depending on the innovative goals. For example, General Electric (GE) launched an open innovation initiative to accelerate ultrasound research in 2012. This initiative aimed to facilitate collaboration between the research team of GE and independent researchers to develop new ultrasound diagnostic and treatment applications that could lead to innovative new therapy and diagnostic solutions in health care (GE, 2012).

Thus, innovation strategy is an essential part of Innovation Management that sets the direction of development to enable the evolution of the Company and enhance the capabilities to conquer new opportunities in the market.

Innovation practices

To effectively implement an innovation strategy, a company should use different *innovation practices* that materialize the organization's efforts and aid in transforming challenges into results. These innovation practices and processes contribute to organizing, structuring, and encouraging Innovation, which is generally complex and distributed throughout the whole Company.

McKinsey & Company, a global management consulting firm, researched over 300 companies in 2012, aiming to understand the strategic and organizational factors that distinguish successful big-

company innovators from the rest of the field. Based on the results of the interviews with more than 2,500 executives, they came up with two main groups of distinguishing factors.

The first set of factors are strategic and creative in nature and help create conditions under which Innovation will more likely appear and thrive. They include 1) *aspiration* or innovation target for growth, 2) a coherent time- and risk-balanced portfolio of initiatives to have options to *choose* from, 3) a differentiated business, market and technology *insight-discovery* process that translates into winning value proposition, 4) *evolvement* of insights and creation of new business models that provide defensible and scalable profit sources.

The second group of factors ensures a well-organized process to deliver valuable innovations repeatedly to contribute meaningfully to the overall performance of a company. They are characterized by 1) an *accelerated* innovation process, when innovations are quickly and effectively developed and launched to beat the competitors, 2) innovations, that are launched at the correct *scale* in the relevant markets and segments, 3) the creation of an *extended* network of external collaborators, and 4) *mobilized* people, who are motivated, rewarded, and organized to innovate repeatedly (De Jong, Marston, and Roth, 2015).

According to the research results, described attributes and behaviours underpin superior innovation performance. Moreover, within the next seven years after the initial research, the McKinsey team had validated the results through further research and observed them in action at hundreds of companies, proving their initial findings (Cohen, Quinn, and Roth, 2019).

For the development and implementation of innovations to be coherent and repetitive, it is necessary that innovation practices evolved into a specific process. Literature analysis showed up that there are numerous models, but many of the scholars mentioned an *innovation funnel,* which is used to describe the steps that take place in the process of innovation development (Appendix 2) (Cooper, Edgett, and Kleinschmidt, 2002; Chesbrough and Brunswicker, 2013).

In the analysed literature, the concept of the innovation funnel is used to illustrate the progress of innovation ideas and to highlight the fact of selection: at the beginning of the innovation process, there are many ideas generated, which after that, go through several selection gates. Ultimately, only the most successful ideas are brought to the market. Bringing only a few potentially successful ideas to the implementation phase helps to efficiently use a company's resources and avoid "boiling the ocean" (Chesbrough, 2004).

Many organizations applied the concept of the innovation funnel but adapted it to their needs. That is why versions can vary from company to company. Nevertheless, developing innovations through the funnel can be organized into three significant steps: discovery, exploration, and execution (Wheelwright and Clark, 1992).

In the first stage, an organization collects as many ideas as possible from various sources: employees, partners, customers, competitors, academia, etc. As the ideas are collected, they need to be explored and related to the company's innovation goals. Only those ideas, which meet the Company's innovation strategy and create new business opportunities, proceed to the next stage. In the second stage, the pre-selected ideas are evaluated and tested, and only the best opportunities are selected to be evolved to the execution phase. Finally, the third phase is responsible for the controlled launching of the concept in the market (Cooper, 2008).

This process is generally not linear, as sometimes some iterations repeat themself until all challenges are tackled and the developed innovation concept fits the initially stated innovation goal.

Organizational structure

A specific organizational structure is needed to root innovation practices, which will contribute to a more robust innovation culture and ensure efficient and continuous execution of those practices. Several researchers agree that less hierarchical organizational structures foster an innovation culture more than traditional structures. Organizations, which implement a less hierarchical

structure, generally have a more integral environment in which all employees have a chance to impact the innovation process and develop advanced communication mechanisms that encourage interactions and exchange of information among different departments. Such structure supports innovative thinking and behaviours across all organizations, not only in specialized teams responsible for innovations (Keathley, 2020).

In 2012, McKinsey surveyed executives aiming to find out what are organizational innovation structures at their companies. According to the results, 62% of executives reported using multiple structural models to execute innovations in their organizations. Nearly 50% of executives said that their organizations use separate innovation functions, which focus on developing different business opportunities and report to the CEO (Capozzi, Kellen, and Somers, 2012).

Nowadays, more and more companies rely on a structure that centres on functional expertise to create innovations. Such an approach concentrates employees with the most expertise in one domain, so they can take decisions for the function they are responsible for.

Thus, having a defined innovation goal, an organized innovation process and a specific organizational structure, which helps Innovation thrive, are the critical elements of successful Innovation Management. These elements shape how the Company searches for novel solutions, synthesizes ideas into a business concept, and selects which ones get funded.

2.2. Enterprise Architecture

2.2.1. Definition

Enterprise Architecture (EA) is a relatively young discipline that appeared in the 1980s, mainly after the publication of Zachman's work "A Framework for Information System Architecture" in 1987. Even if the researcher did not use the exact wording "enterprise architecture", his insights created a basement for further developments of the concept (The Open Group, 2015).

Academics and organizations have offered various interpretations of the concept "Enterprise Architecture". However, an explicit definition has not yet been established (Mentz, Kotzé, and Van der Merwe, 2012). Marc Lankhorst, a leader of the Service Architectures expertise group at the research institute Novay and experienced practitioner and manager of Enterprise Architecture projects, published a book where he accumulated all his practical experience. He defined Enterprise Architecture as "a coherent whole of principles, methods, and models used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure" (Lankhorst, 2013). Hence, Enterprise Architecture combines information from different, even non-related, domains into one plane, providing a holistic view of an enterprise.

2.2.2. Applications

The concept of Enterprise Architecture was mainly rooted in the Information System environment. However, it often starts appearing in a broader scope (Lankhorst, 2013).

Enterprise Architecture is generally applied to capture the essentials of the business, IT and its evolution. At the same time, it leaves much room for flexibility and adaptivity, to determine how an organization can effectively achieve its objectives. It provides insight into how to bridge the gaps between optimizations at the level of individual domains and a company as a whole, to balance corporate strategy and daily operations (Bernard, 2012).

The literature on Enterprise Architecture uncovers various applications of the concept. Thus, Enterprise Architecture assists in modelling a blueprint of the organizational structure of an enterprise and its business processes to reach various business goals, as follows (Janssen, 2016):

- to grasp the broader business model of an organization, its challenges, and risks,
- to help an organization go through the digital transformation process,
- to align the work of different teams of an organization, etc.

In other words, Enterprise Architecture represents an organization's processes and structure and has the potential for business transformation and creating a foundation for business execution (Ross, Weill, and Robertson, 2006).

2.2.3. Modelling language

There can be many different domains, or distinct areas of influence, activity, and decision-making, within an organization. And generally, each domain has its description techniques: they can be textual, graphical, informal, or precise. Different domains use their techniques and tools, speak their languages, and draw their models. It impairs the communication and decision-making process among those domains (Lankhorst, 2013).

To overcome the limitations, enterprise architects generally choose one of the established description languages and use it for modelling the domains. Many different modelling languages were developed; *ArchiMate*, an open and independent Enterprise Architecture modelling language, was chosen as the most relevant one in the scope of the current research.

In 2009, The Open Group launched the first version of ArchiMate as a formal technical standard, which provides instruments for the description, analysis, and visualization of the "different architecture domains and their underlying relations and dependencies" in a precise manner (Jonkers, Proper, and Turner, 2009). The language has been constantly updated since then.

ArchiMate has a hierarchical structure, and its models are composed of three main concepts: elements, relationships, or relationship connectors. In turn, elements can be behaviour, structure, motivation, or composite elements (Appendix 3) (The Open Group, 2019).

The framework of the language is made up of two dimensions: layers and aspects (Appendix 4). In ArchiMate, an organization can be modelled at four levels: Business, Application, Technology (including Physical), and Implementation and Migration. The aspects dimension includes Passive Structure, Behaviour, Active Structure, and Motivation (The Open Group 2019).

The language structure enables modelling an enterprise from different viewpoints, while the position within the cells emphasizes the interests of different stakeholders.

So, Enterprise Architecture is a powerful practice to describe, analyse and visualize an organization's structure, processes, applications, systems, and technologies in an integrated way. And ArchiMate enables enterprise architects to do that unambiguously.

3. Research design

3.1. Problem

As it was highlighted in the literature review, Innovation is an impact driver for the development of organizations. Innovation can distinguish a company from rivalry in a competitive environment by providing a competitive advantage. It adds value to the business and contributes to revenue growth. Hence, many companies have been implementing innovations into their business strategies. At the same time, the success of implementing innovations varies significantly among different companies.

There is plenty of literature covering the topic of Innovation and describing successful practices implemented in innovative companies. However, all this information is most often descriptive, and the critical success elements of Innovation are considered in isolation.

Implementation of successful practices, brought in from outside, without their alignment with internal structure and processes, will probably not bring much value but can even harm the current business model of an organization.

Enterprise Architecture, in its turn, is a practice that integrates different aspects of organizations: their structure, processes, applications, systems, and technology. Hence, it might be a handy tool for modelling Innovation in companies in a precise and comprehensive way, comparing the models for different companies and finding gaps which prevent innovations from being successfully implemented in some companies.

While analysing the literature on Innovation and Enterprise Architecture, no studies were found connecting both concepts, namely the exercise of modelling Innovation based on EA principles and using ArchiMate language.

3.2. Research questions

Considering the above, the main research question was formulated: "How Enterprise Architecture can help identify patterns in Innovation Management?"

To answer the main research questions, a set of supportive objectives were formulated:

Q1. How Innovation Management can be modelled, using EA practice and ArchiMate language?

Q2. Does a common pattern of Innovation Management exist among successful innovation companies?

4. Proposal

A mix of qualitative analysis and empirical approach was used to answer the research questions.

First, to understand how Innovation Management can be formulated using EA practice by ArchiMate language, the main Innovation Management dimensions were defined (Appendix 5). During the literature review analysis, it was found that organizations develop innovations through *an innovative process*. This process can be composed of different steps or have different degrees of openness from company to company. However, the process is a key element in Innovation Management (Wheelwright and Clark, 1992; Cooper, 2008; Chesbrough and Brunswicker, 2013). A strategy is needed for this process to function well and facilitate the development of new ideas and bring them to market. *Innovation strategy* helps organizations to build and maintain the capacity to innovate and align the innovation goals of a company with its resources and capabilities (Pisano, 2015; Spacek and Vacík, 2016). The last but not least element of Innovation Management is organizational structure. It can help create and root innovation practices, contributing to a more

robust innovation culture in which executing practices continuously improves efficiency and effectiveness (Keathley, 2020).

After, each of the three components was decomposed into the concepts: elements and relationships are modelled in the visual-modelling and design tool Archi, using ArchiMate modelling language. While modelling innovation strategy, the Strategy layer and Motivation aspect of ArchiMate language was used. The innovation process, as well as the organization structure, was modelled mainly with the Business layer. Since technologies more often acted as a driver for the development of innovations in the modelling process, but not as an element of Innovation Management, the Technology and the Application layers were taken out of the scope of the current study. At the same time, all aspects were involved in the construction of models: Passive Structure, Behaviour, and Active Structure.

Thus, at this stage, three models were created: 1) the model which represents innovation strategy, 2) the model which illustrates the innovation process, and 3) the model for organizational structure. In the course of further analysis, these models were applied as Metamodels, provided an abstract representation for innovation management elements and acted as templates in modelling innovation practices in companies.

To analyse how Innovation is structured and develop a successful pattern if it exists, it was considered to choose the top-5 innovative companies as a reference. A global consulting firm BCG (Boston Consulting Group) has been conducting annual research on Innovation to identify the world's most innovative companies. According to the 2022 ranking, the most innovative companies are Apple, Microsoft, Amazon, Alphabet (Google) and Tesla. Moreover, according to the BCG rating, these companies have been occupying leading positions for over a decade (Appendix 6). Thus, these companies are good benchmarks, as innovation processes have already taken shape and demonstrated their effectiveness in these companies. The availability of information sources

on these companies is also essential for modelling innovation concepts. The sources of information for the creation of the models for the selected companies are available in Appendix 7.

When the list of benchmark companies was defined, three main innovation management blocks – innovation strategy, innovation process, and organizational structure, were modelled for each of the selected companies.

Finally, the models were analysed and compared across companies to understand if a common "successful" pattern of Innovation Management exists among innovation companies, which can be implemented in other companies and successfully drives Innovation there.

5. Demonstration

5.1. Innovation strategy

In Figure 1, the results of the modelling innovation strategy are shown. As it was previously mentioned, the Strategy Metamodel was developed with the elements of the Motivation aspect and Strategy layer.

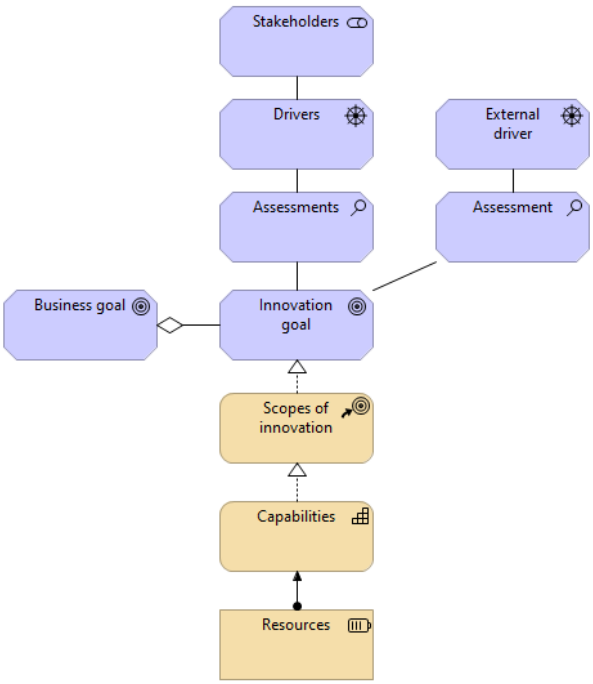

Figure 1. Innovation strategy Metamodel

Developing an innovation strategy starts with a clear and specific innovation goal, related to the business goal of an organization and helping this organization achieve a sustainable competitive advantage. The aggregation relationship was used in Archi to connect innovation and business goals, as business strategy generally aggregates several goals.

Motivation layer states that stakeholders define drivers which promote management questions (named as assessments in the model) that should be answered by innovation goals achievement. Additionally, the innovation goals are influenced by external drivers that require response and reflection. In turn, the innovation goal can be decomposed into different courses of action – "Scopes of innovation", realized by several capabilities and relevant resources.

5.2. Innovation process

The innovation process was modelled with the elements of the Business layer, such as Business Event, Business Interaction, Business Collaboration, Business Role, and Business Process.

The innovation process generally starts when a business challenge occurs. In ArchiMate language, it was defined as a "Business Event", as it is an event, which changes an organizational state. Besides, a business challenge may occur due to external factors (e.g., customers), and internal events generated by, for example, other processes within the organization. After that, different stakeholders, represented in the model as "Business Role", conduct brainstorming, or "Business Collaboration", to generate new ideas, a "Business Interaction".

After new ideas are generated, a "Business Process" of refining value propositions of those ideas starts. This is a Discovery step in the innovation process.

The next phase of the process is the Explore Phase, responsible for assessing the best opportunities and selecting only the best bets to evolve to an Execution Phase to de-risk the launching of not-viable product. After evaluating and selecting the most promising business concepts, the realization

of the experimentation goes with the development of sample prototyping (if applicable) to understand if the proposed solution should be a more significant investment.

The final stage is the execute phase, which is responsible for the controlled launching of the concept in the market through two main steps – concepts industrialization, where the concept will be tested on a small scale first to understand and address remaining issues to scale bigger in the next stage, and the launch of the product (Figure 2).

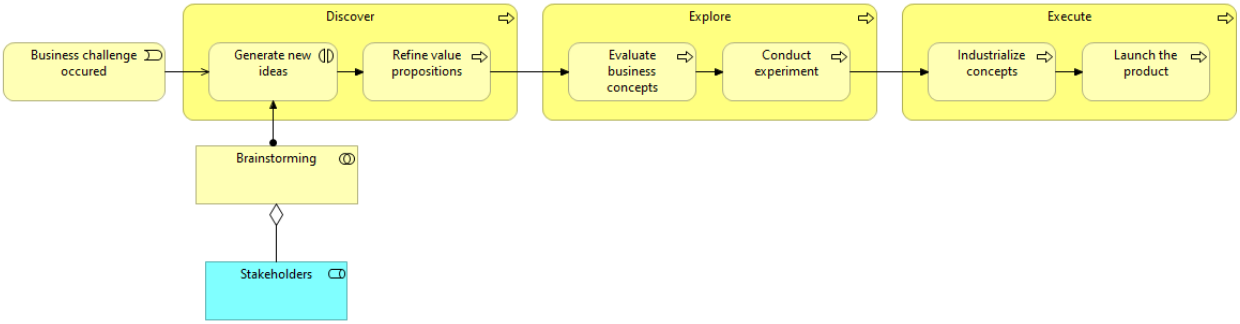

Figure 2. Innovation process Metamodel

All the steps in the process were modelled as "Business Process" elements to represent a sequence of business behaviours that brings the most promising innovation idea into the market.

5.3. Organizational structure

The organizational structure was modelled with the "Business Actor" and "Business Function" elements of the Business layer.

As it was discovered from the literature analysis, innovative organizations generally have a flat organizational structure, where areas divide expertise, or functions, which are reported directly to the CEO of an organization. In Appendix 8, a Metamodel of the organizational structure is illustrated.

6. Results

6.1. Innovation strategy

Modelling the innovation strategy of the selected five most innovative companies in Archi showed that all companies have a clearly defined innovation strategy, which generally fits into the modelled Metamodel, no substantial deviations from the pattern were found. At the same time, a number of insights were discovered.

Thus, the *innovation goal* in the analysed organizations follows from the *business goal* and is aimed at contributing to the achievement of the business goal. This contributes to the fact that innovation is not a third-party process but is integrated into the overall business process of companies and contributes to business growth. It was also found that most companies are customer-centric. For instance, Apple as innovation goal states: "to bring the best user experience" (Figure 3). Amazon aims to create products and services that will improve customers' lives. Tesla "brings new innovations to the market to make them affordable" for people. And Alphabet "continually innovates in areas where technology can have an impact on people's lives" (Appendix 9, 10, 11).

The main stakeholders that drive the change to innovate are generally customers, competitors, or employees of the organizations. *Customers* generally have certain expectations. To meet their expectations and preserve loyalty, companies need to innovate to offer best-in-class products and experiences. *Competitors* drive a fastly evolving competitive landscape, which requires dedication to innovations to provide a better experience than competitors. *Employees* are also an important part of the innovation driving force, which is why companies such as Google or Microsoft (Appendix 12) encourage their employees to be curious, experiment, and contribute their best ideas. Besides, innovation is embedded into the corporate culture in all analysed organizations.

In addition, the main external driver of Innovation is *technological progress*. High rates of technological change and disruption enable further development of organizations.

Modelling the innovation strategy of organizations allowed capturing that the most innovative companies have more than one course of action to reach their innovation goal. This division of the *scope of innovations* is associated with the diversification of types of innovations: routine, disruptive, radical, etc. For instance, continuous innovation of Apple's products or constant advancement of the Microsoft software versions is an example of routine innovation, which accounts for most of the company's profits, allowing for investment in more transformational innovations. At the same time, the organizations put their bets on disruptive, radical, or architectural innovation. For instance, Microsoft set the objective to create more personal computing, Tesla gains innovation capital by introducing such products as Cybertruck. Moreover, there is a trend of creating an ecosystem of the products and services the companies provide, which is an additional source of monetization and a way of protection against innovation being copied by competitors.

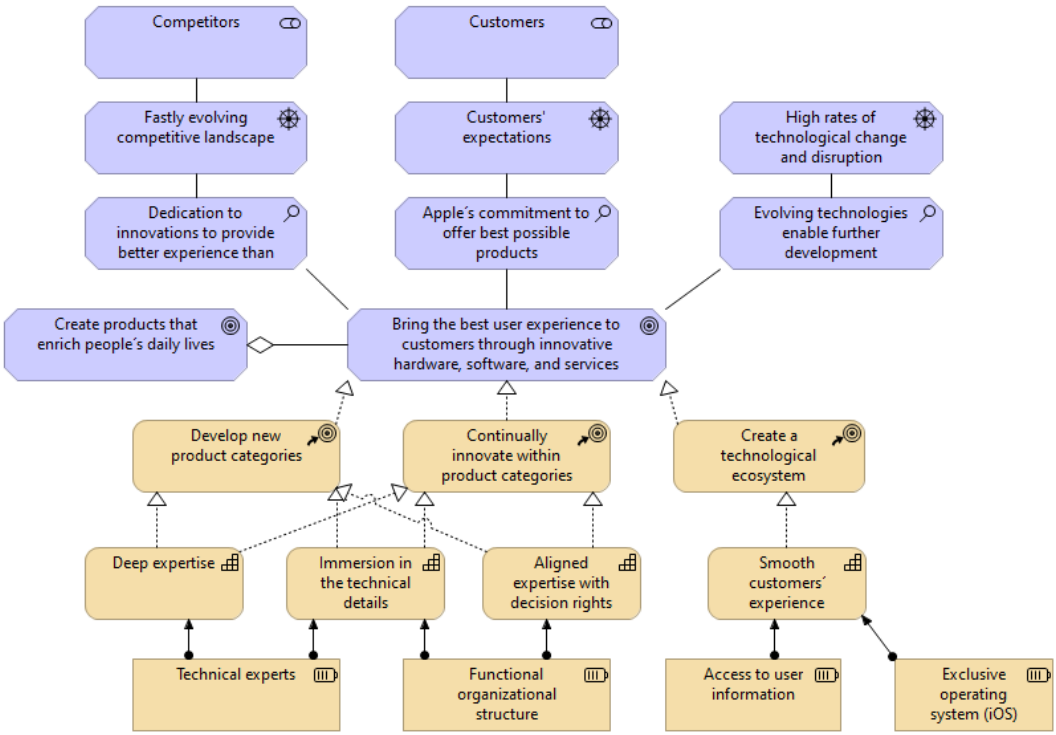

Figure 3. Innovation strategy of Apple

To successfully realize defined courses of innovative actions, the companies develop supportive *resources* and *capabilities*, which give them some competitive advantage. Generally, the resources are technologies, experts, and software, but they can also be unique. For instance, the exclusive operating system of Apple (Figure 3), iOS, is a resource assigned the capability to provide a smooth customer experience, which is in line with the creation of a technological ecosystem course of action. Another example is the marketplace of Amazon, which can be considered as a resource which is assigned to two different capabilities: traffic, product variety and dynamic pricing, which, in their turn, are in line with providing a large selection of products and ensuring low prices courses of action respectively.

6.2. Innovation process

In the process of modelling the innovation process in Archi, it was found that, despite the apparent similarity, there are specific differences between the analysed companies.

Thus, the *stages of the innovation process* differ across companies. Some analysed organizations initiate the process with the development of ideas. For instance, in Microsoft, the ideas are generated and collected through "The Garage", a program that encourages employees to work on projects about which they are passionate, even if it is not directly related to their primary job function (Appendix 13). Google has been well-known for its "20% Project" practice. This is how much time the company allocates to employees to work on their projects. This practice ensures the constant generation of new ideas. To support generated ideas, the company has its in-house incubator (Appendix 14). The following steps to develop those ideas in these companies are generally similar: after the most successful ideas are selected, they form the basis of potential future products, projects, or services. After evaluating and piloting these projects, the most successful ones are launched. The process is not always straightforward: the ideas can be refined if they are not promising enough, or a pilot can be reviewed due to underperforming at the testing phase.

Amazon has a different approach to innovation. Usually, the process of innovation begins with the identification of a specific customer problem that needs to be solved. Then, instead of generating many ideas and choosing the most promising one, a draft solution is developed and described with a high level of detail. After that, the idea is challenged. And if any technical, legal, financial or partnership issues are identified, the idea is sent for revision (Figure 4).

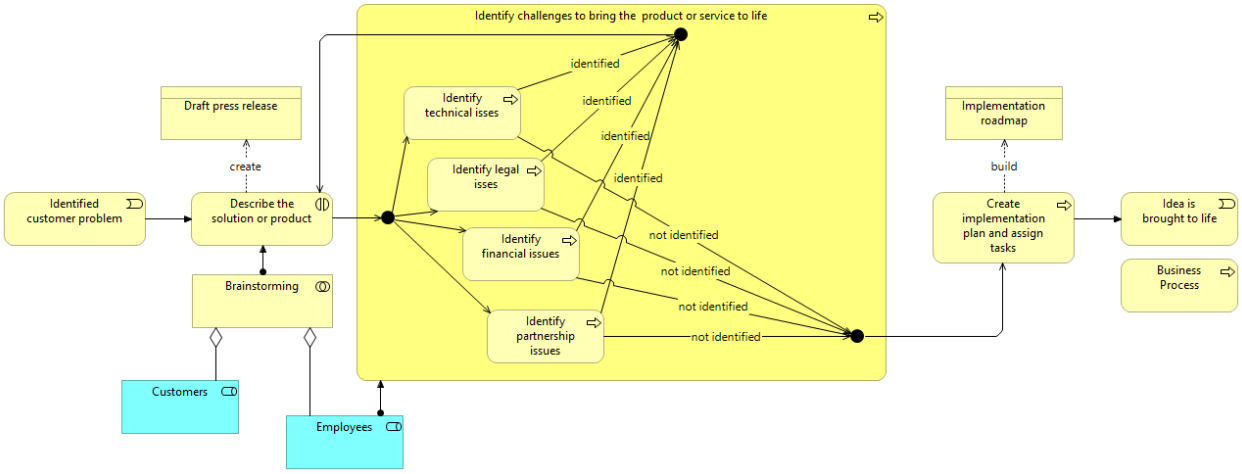

Figure 4. Innovation process in Amazon

Another distinctive feature is the *degree of openness* of the innovation process in organizations. For instance, Apple has features of closed innovation. Internal teams conduct all stages of the innovation process. Only manufacturing is delegated, but the manufacturing company is obliged not to disclose the innovative product details (Appendix 15). Amazon is also characterized by closed innovation, as they protect all their inventions with patents and keep the developments' details secret. The main reason for that is Amazon's competitive advantage with its innovations. However, there are some elements of openness at the initial phase of the innovation process, as Amazon actively involve customers to identify their main challenges (Figure 4).

An opposite example is Tesla. The company not only involves customers and partners in developing the ideas stage but also discloses the information from the patents the company gains. It makes the innovation available to other market players (Appendix 16). Microsoft and Google

also actively embrace open innovation in their processes, especially at the stage of ideas generation. In the case of these companies, the co-creation of innovation with customers, partners, and matter experts, on the opposite, enriches their value proposition and competitive advantage.

6.3. Organizational structure

The organizational structure is built around functions in the analysed organizations and is characterized by effective horizontal collaboration. The heads of each of those functions generally report to the CEO. This structure provides flexibility and allows a company to take decisions faster, which is essential in a highly competitive world where the pace of change has constantly been increasing. Apple is a prime example of the functional structure of an organization (Appendix 17). Nevertheless, some differences were captured among the companies. Thus, Microsoft separately distinguishes its engineering group, which is directly linked with the organisation's core business (Appendix 18). For Amazon (Appendix 19), a distinctive feature is the importance of the executive chairman in the organizational structure. After leaving the post of CEO, Jeff Bezos became an executive chairman. Although he is the company's employee now, he plays a huge role in supporting the current CEO, sharing his vast industry knowledge. Tesla, in its turn, does not have such a variety of functions as Apple, which keeps its organizational structure simple (Appendix 20). In Alphabet, the organization structure, instead of the functions, is divided into products: the "Google" stream (which includes Android, YouTube, etc.) and the "Other bets" stream. In addition, the supportive business functions are also distinguished (such as HR, Finance, etc.) (Appendix 21). This is mainly related to the variety of different markets where Alphabet is functioning at.

7. Conclusions

The main goal of this paper was to investigate if Enterprise Architecture can help identify patterns in Innovation Management and if yes, how. A preliminary literature analysis demonstrated that there are three main elements of Innovation Management – innovation strategy, innovation process

and organizational structure. During a thorough review of the literature, the main components of these elements were identified. The use of a universal modelling language, ArchiMate, with built-in layers and aspects, made it possible to capture various elements, and relationships, and model Innovation Management.

The second research question aimed at investigating if a common pattern of Innovation Management exists among successful innovation companies. To answer this question, five of the most innovative companies over the past decade were selected. The models for these companies have demonstrated that common patterns are present. Thus, innovative companies have a formulated innovation strategy, which is generally customer-centric and follows the business strategy. The most innovative companies have more than one course of action, which is supported by accumulated relevant resources and capabilities. The innovation process to some extent has openness, and the organizational structure is formed from functions. However, the differences have also been captured.

The value of this study is that for the first time an attempt was made to model Innovation Management using the Enterprise Architecture approach. However, there are also limitations.

First, the results obtained could be biased due to the small number of analyzed cases and the adjacency of the industries of the analyzed companies. Second, in the process of modelling, we stayed at the upper level of the analysis of innovative elements of companies. Perhaps, with more detail, we could form additional insights.

To validate the results of this study, additional studies on this topic are needed. Thus, the analysis can be carried out for a larger number of companies and from more diverse areas (for example, pharmaceuticals). In addition, innovation management can be modelled at other layers, such as "Technology" or "Application" and using additional viewpoints.

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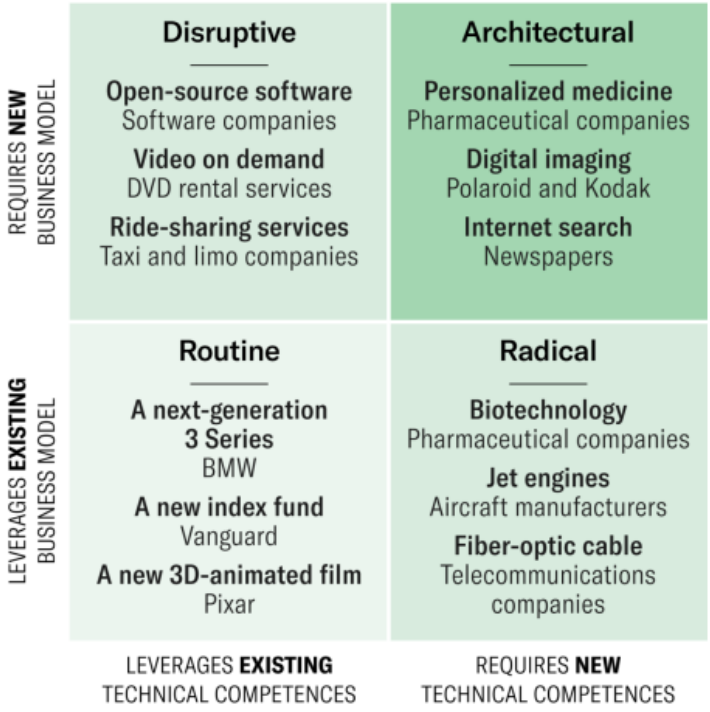
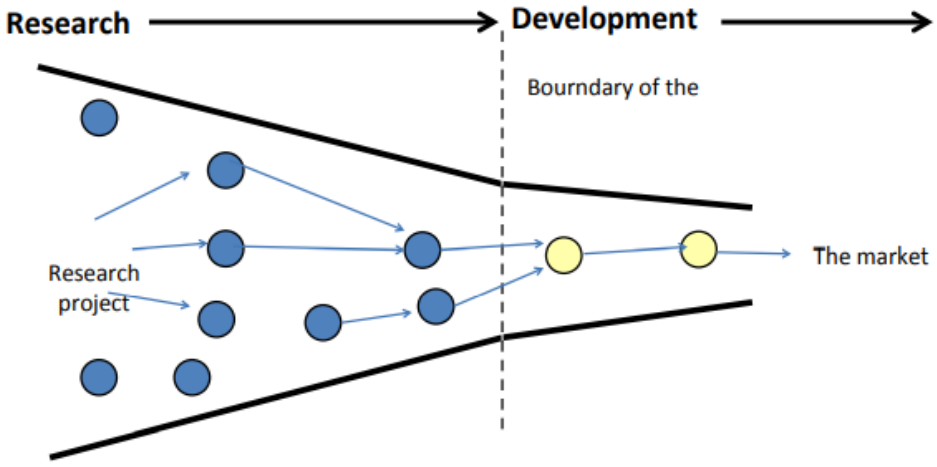
Appendix

Appendix 1. The innovation landscape map



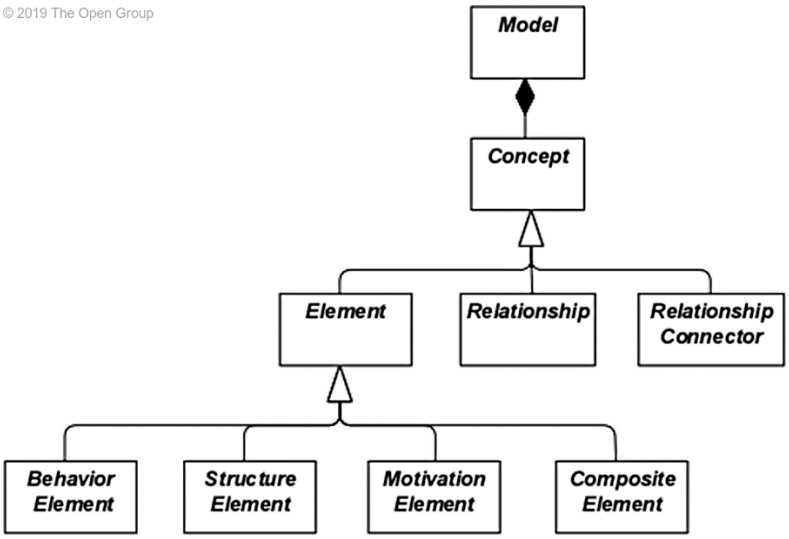
Different types of innovations (Source: Pisano, 2015)

Appendix 2. Innovation funnel



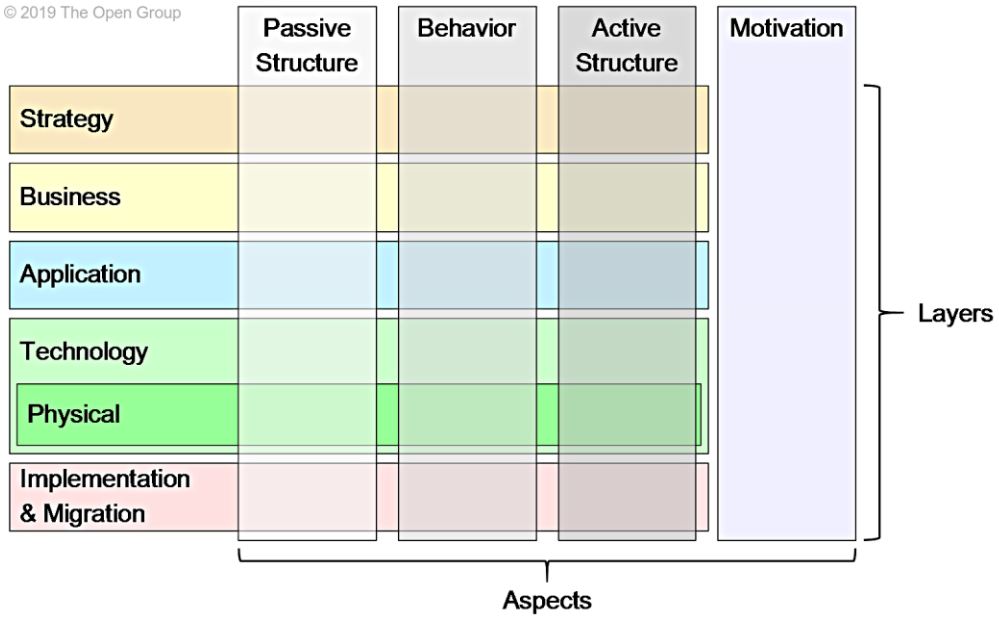
Time-based funnel (Source: Chesbrough, 2004)

Appendix 3. ArchiMate language structure



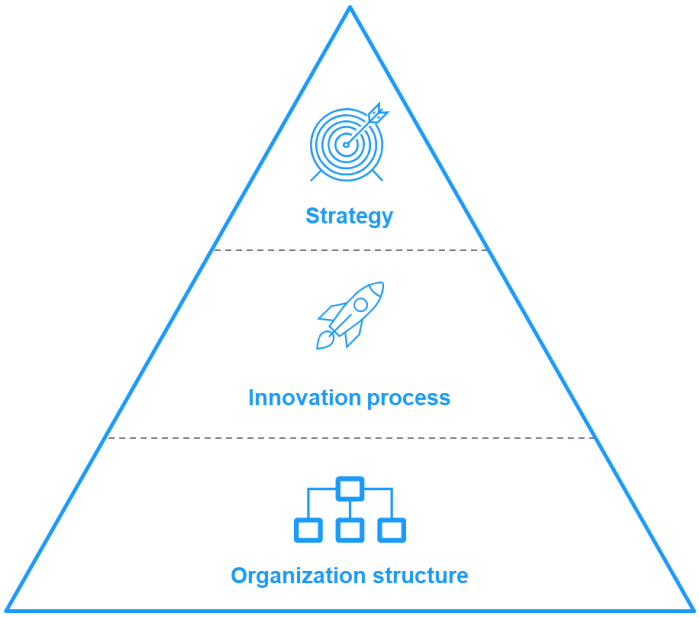
Top-Level Hierarchy of ArchiMate Concepts (Source: The Open Group, 2019)

Appendix 4. Layering of the ArchiMate Language



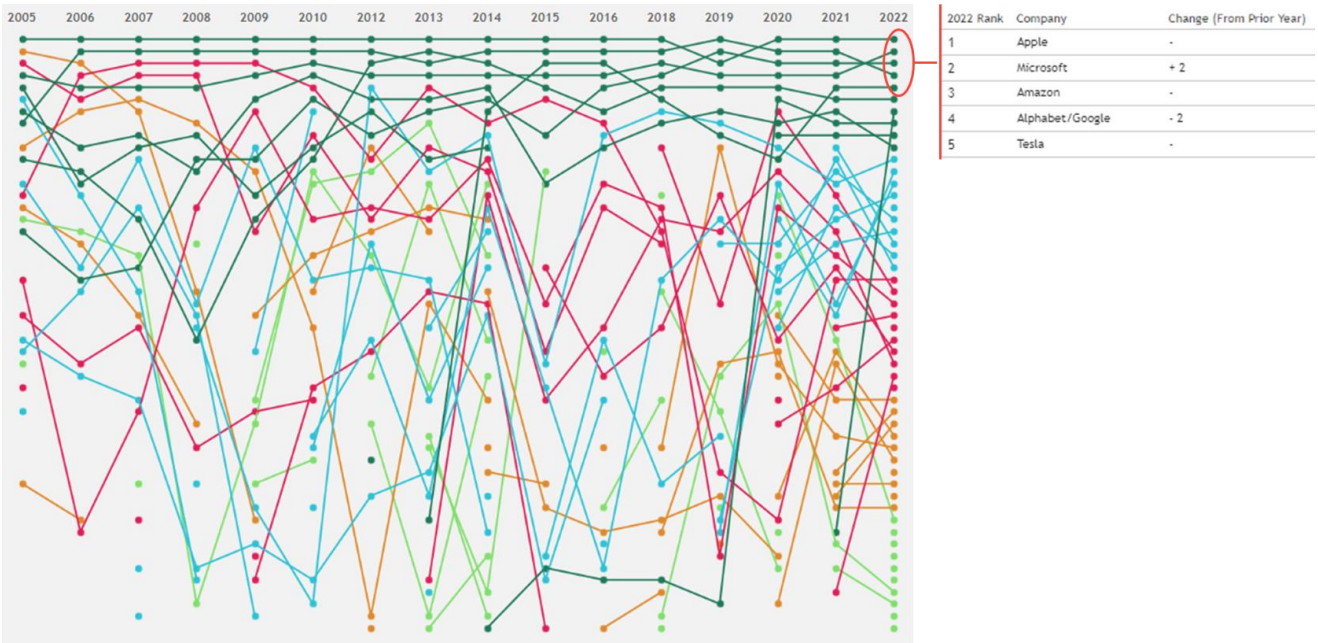
ArchiMate® 3.1 Specification (Source: The Open Group, 2019)

Appendix 5. Innovation management model



Structured approach to Innovation

Appendix 6. 50 Most Innovative Companies



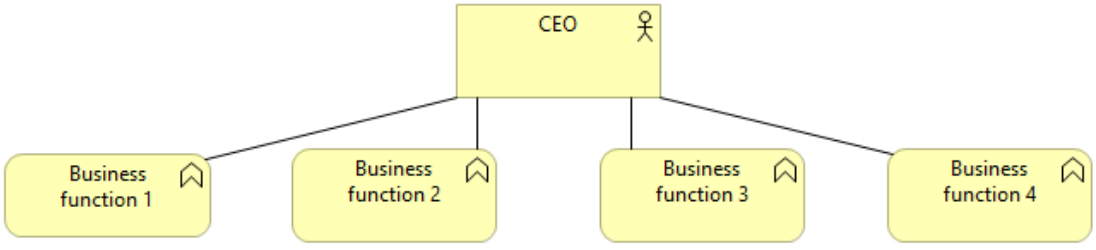
Rank of the 50 most innovative companies over the last 16 years (Source: BCG, 2022)

Appendix 7. Sources for the modelling of the case studies

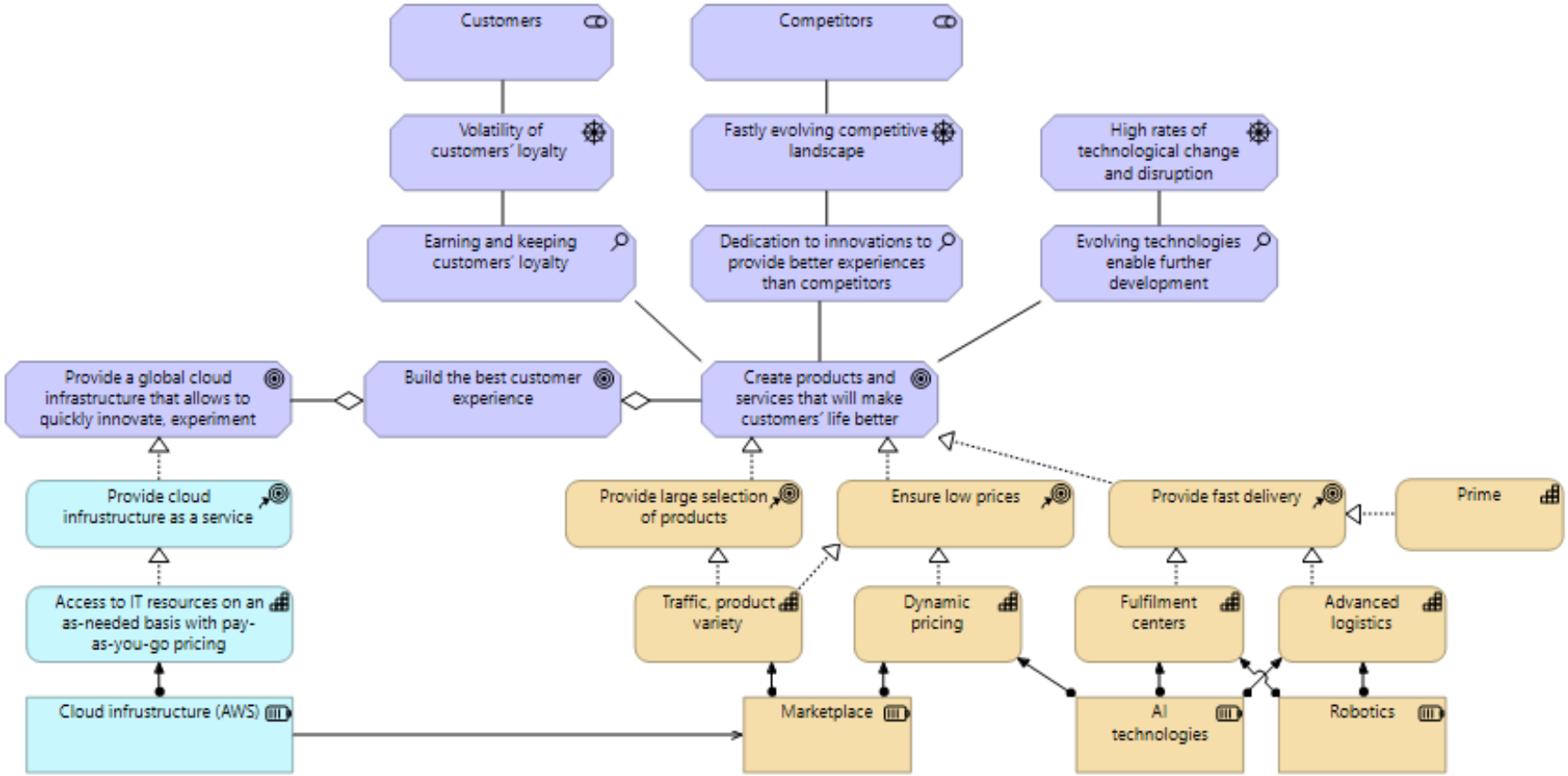
#	Company	Sources
1	Apple	Joel M. Podolny and Morten T. Hansen, "How Apple Is Organized for Innovation," *Harvard Business Review*, November 1, 2020, https://hbr.org/2020/11/how-apple-is-organized-for-innovation. Apple, Inc. (2022). Annual Report. 10-K 2022, 09.24.2022-2022-10-27-08-59 (q4cdn.com)
2	Microsoft	Microsoft Corporation (2022). Annual Report. 2022_Annual_Report.docx (live.com) Microsoft official Website. https://www.microsoft.com/pt-pt/
3	Amazon	Amazon.com, Inc. (2021). Annual Report. Amazon 2021-Annual-Report.pdf (annualreports.com) Colin Bryar and Bill Carr, *Working Backwards: Insights, Stories, and Secrets from Inside Amazon* (St. Martin's Press, 2021).
4	Alphabet	Alphabet, Inc. (2021). Annual Report. GOOG 10-K Q4 2021 (abc.xyz) Micky Lee, *Alphabet: The Becoming of Google*, 2019, https://doi.org/10.4324/9780429242939.
5	Tesla	Tesla, Inc. (2021). Annual Report. tsla-10k_20201231-gen.pdf (tesla.com) Nathan Furr and Jeff Dyer, "Lessons from Tesla's Approach to Innovation," *Harvard Business Review*, February 12, 2020, https://hbr.org/2020/02/lessons-from-teslas-approach-to-innovation.

Table: Sources of information for the development of the cases analysis

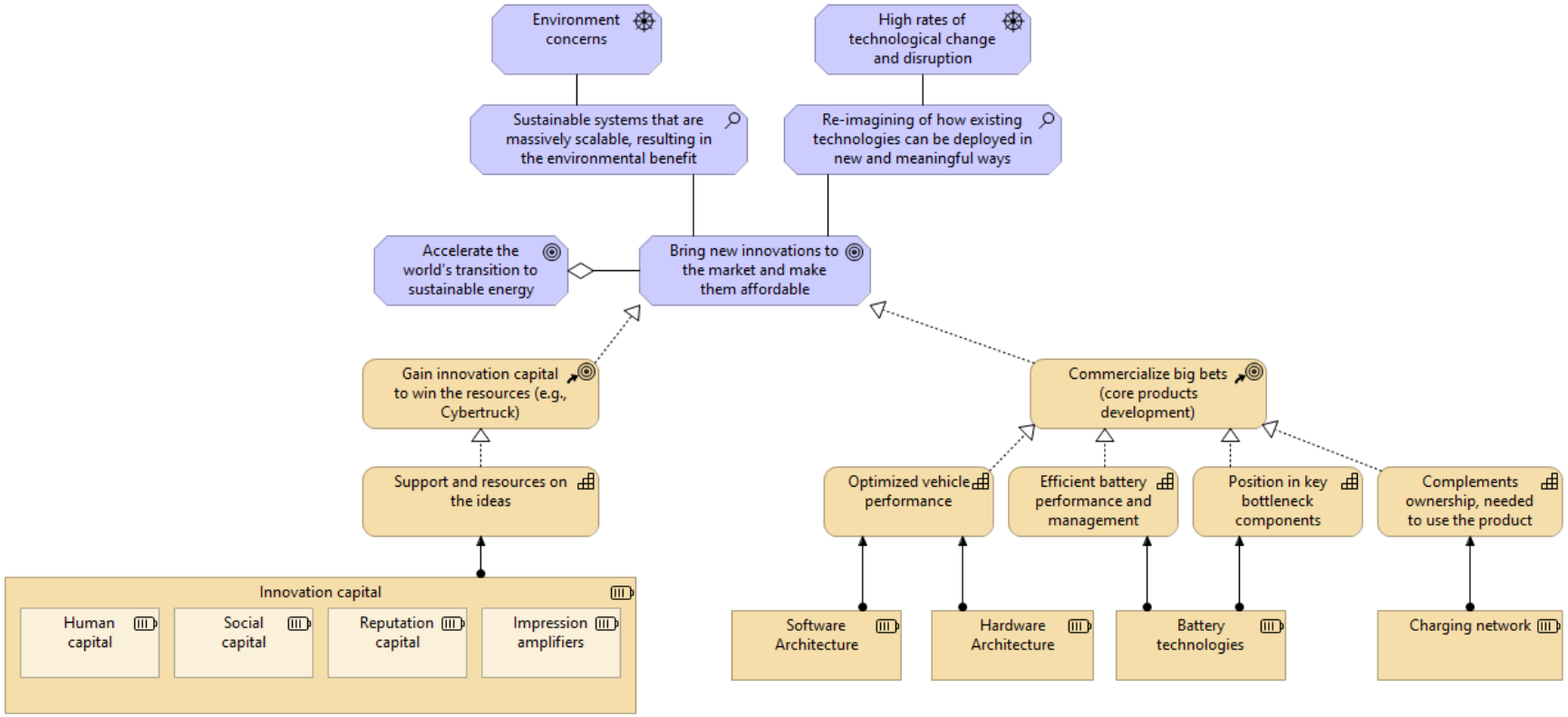
Appendix 8. Organizational structure Metamodel



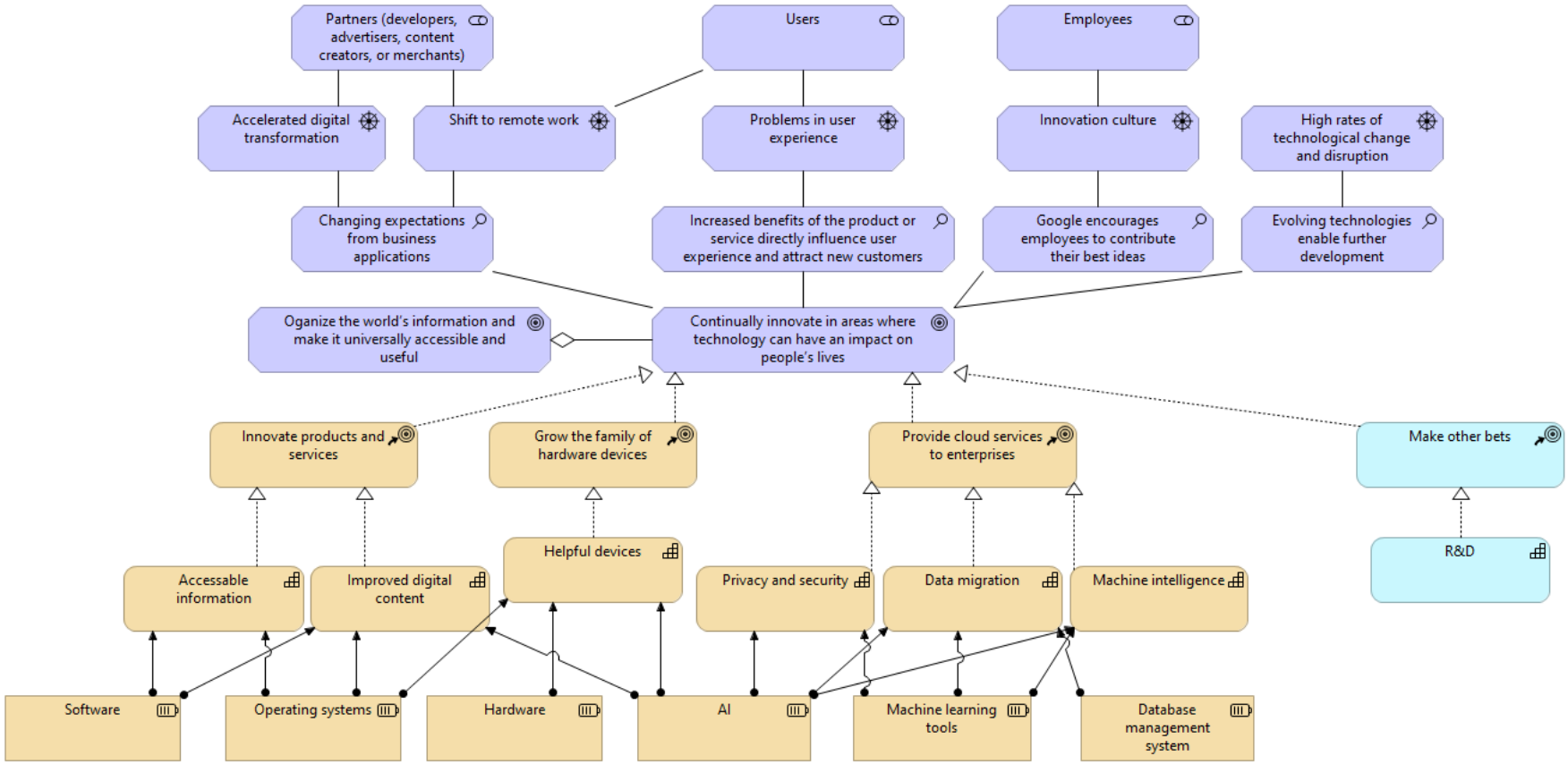
Appendix 9. Innovation strategy of Amazon



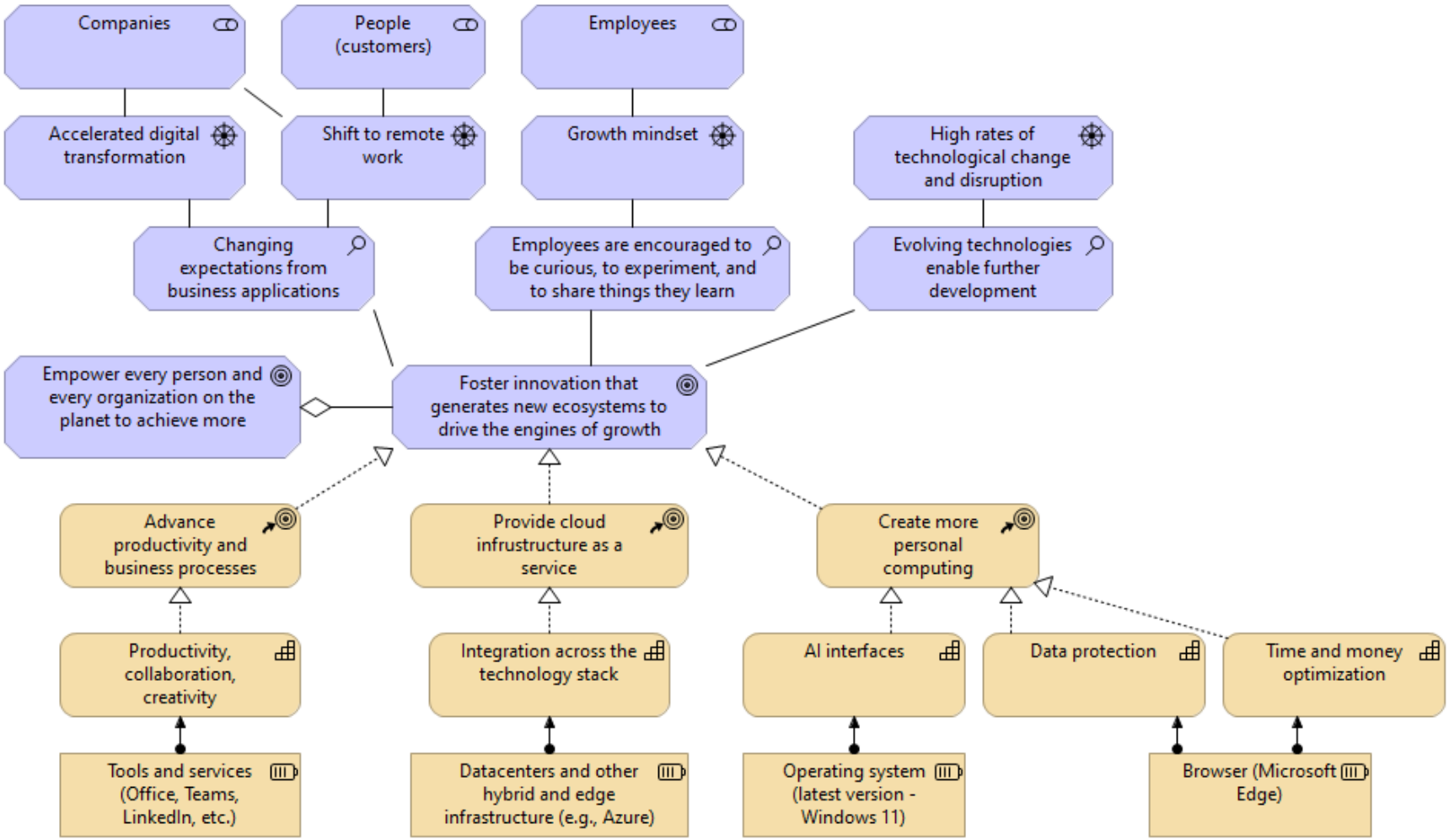
Appendix 10. Innovation strategy of Tesla



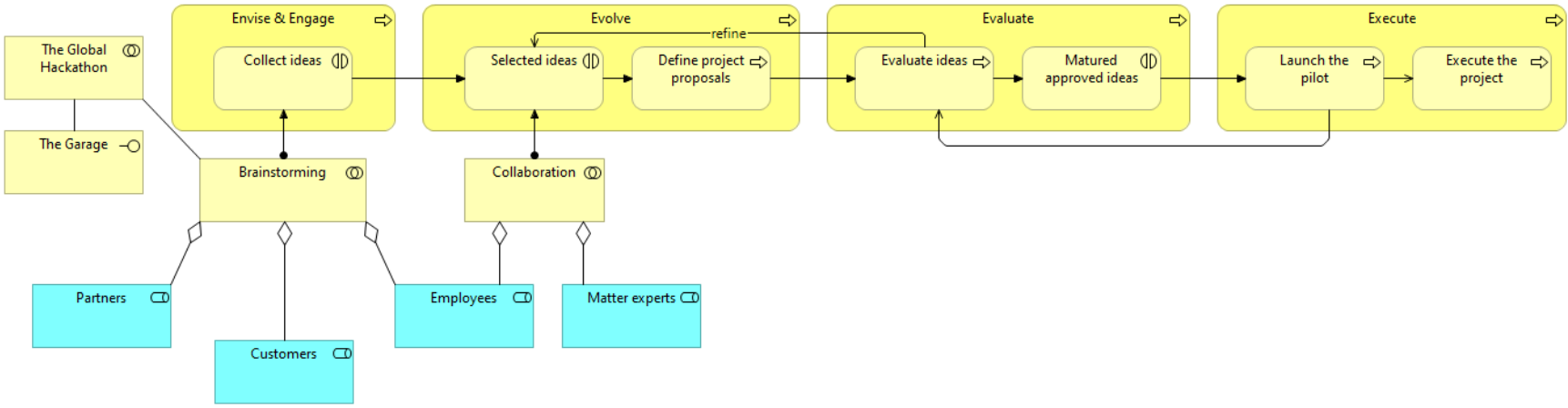
Appendix 11. Innovation strategy of Alphabet



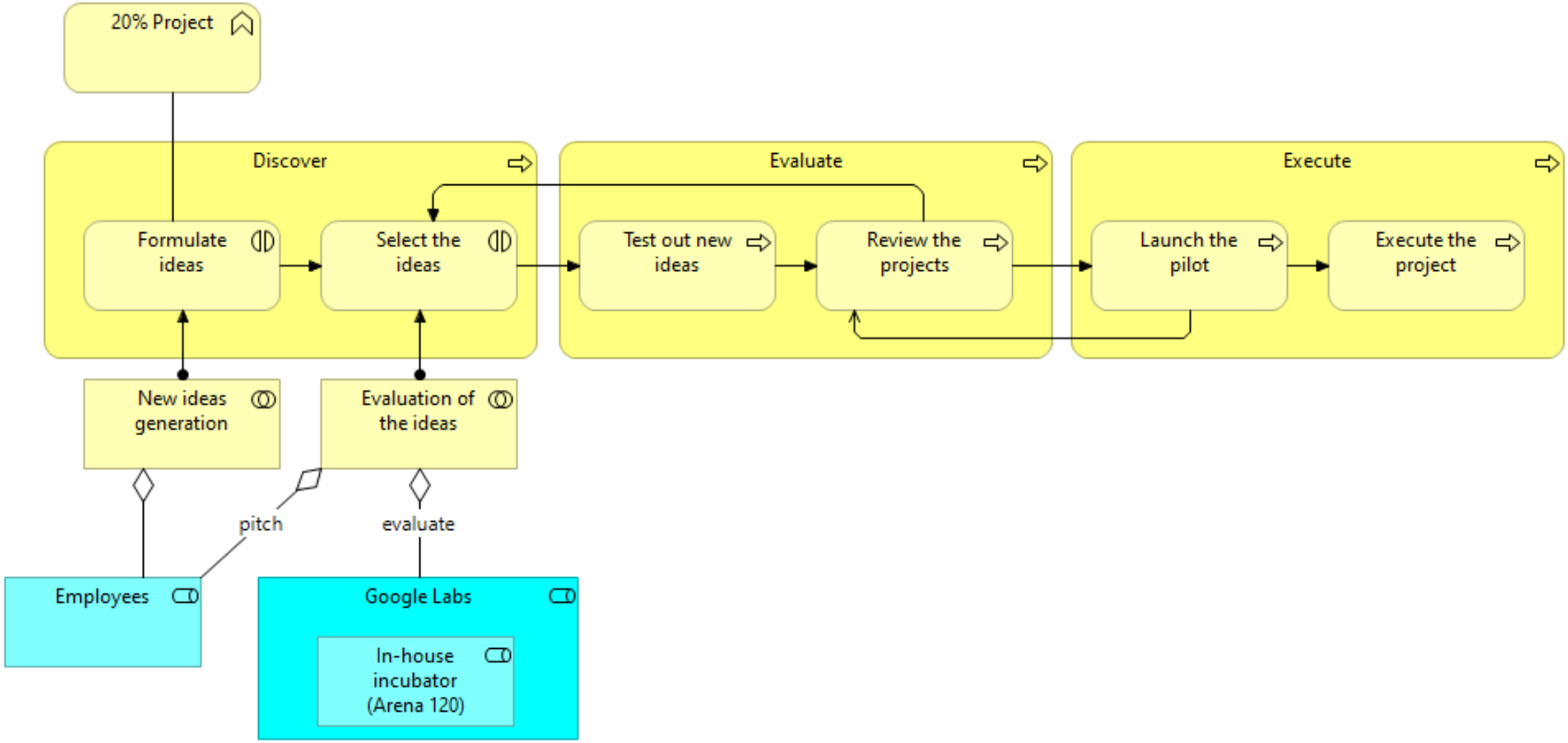
Appendix 12. Innovation strategy of Microsoft



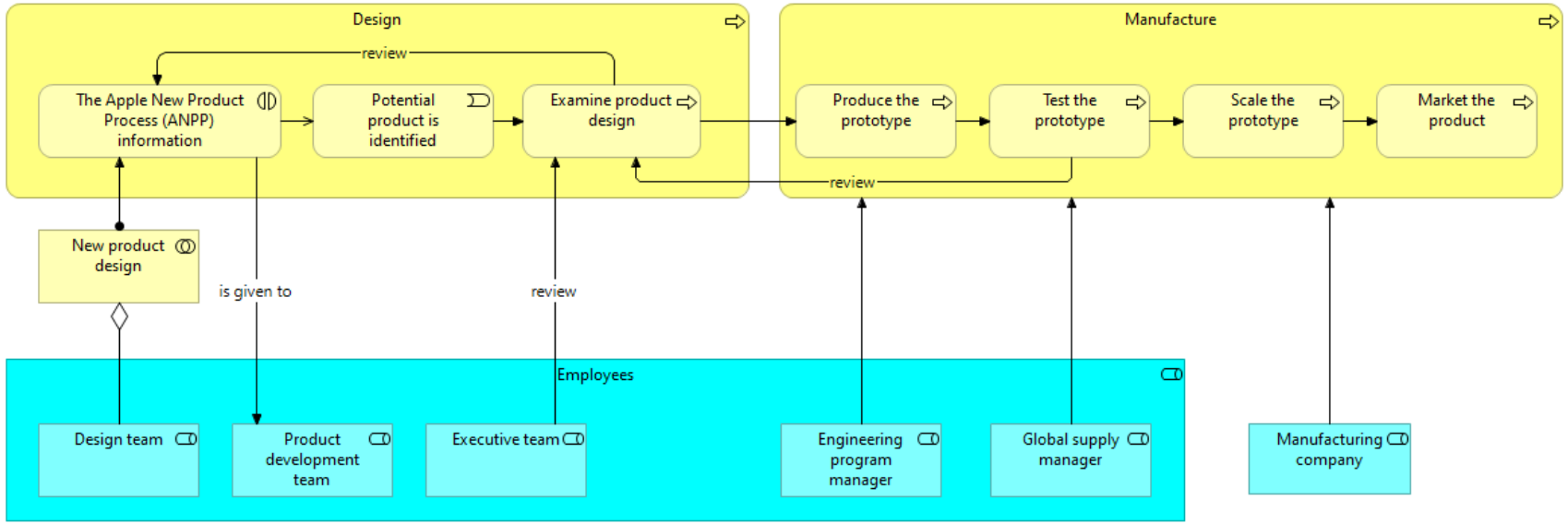
Appendix 13. Innovation process of Microsoft



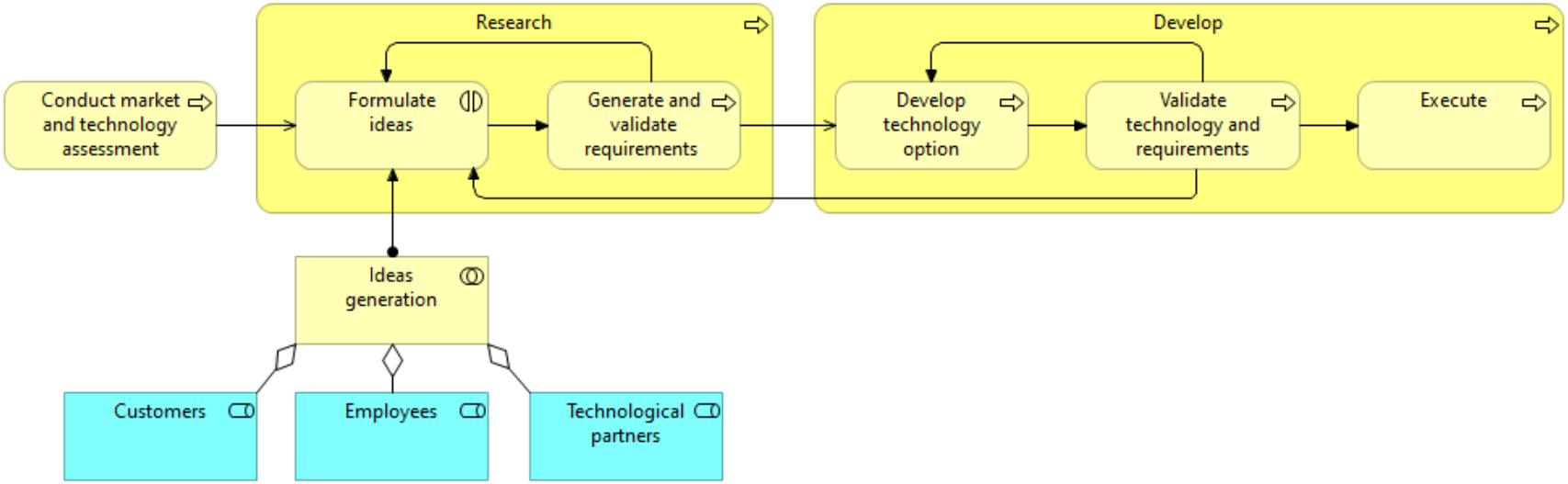
Appendix 14. Innovation process of Google



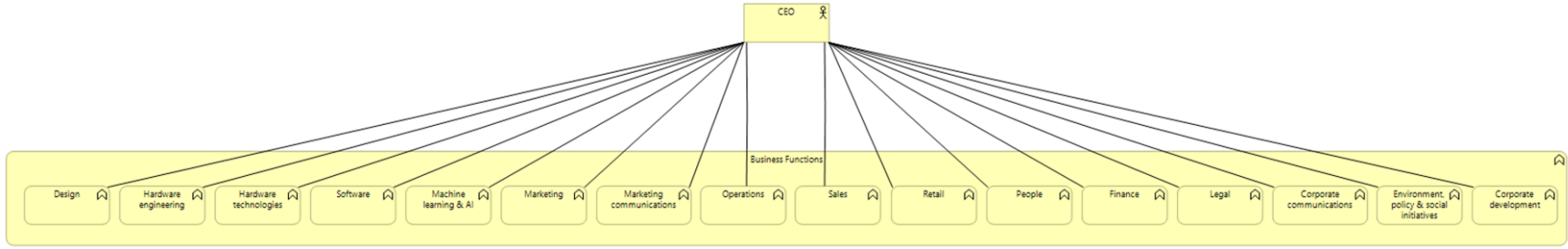
Appendix 15. Innovation process of Apple



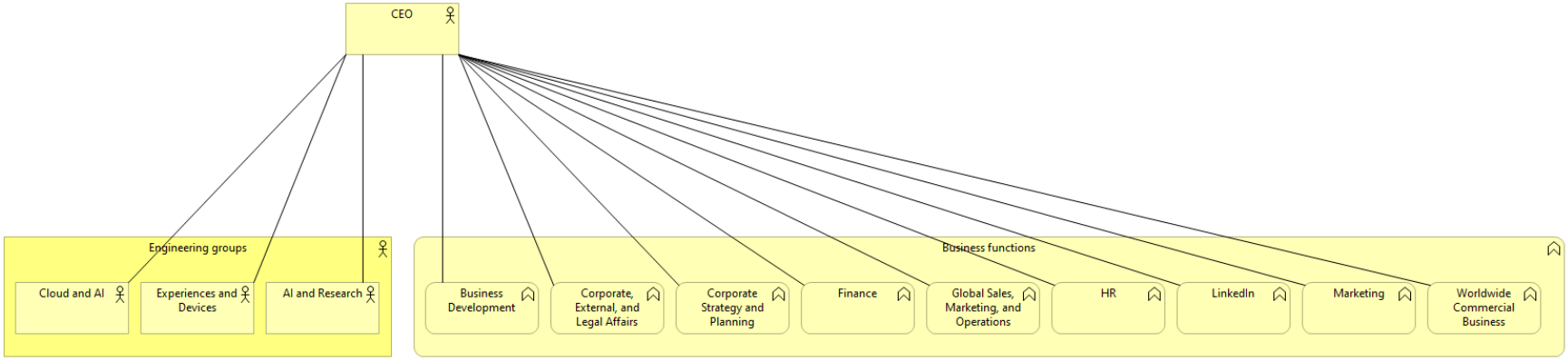
Appendix 16. Innovation process of Tesla



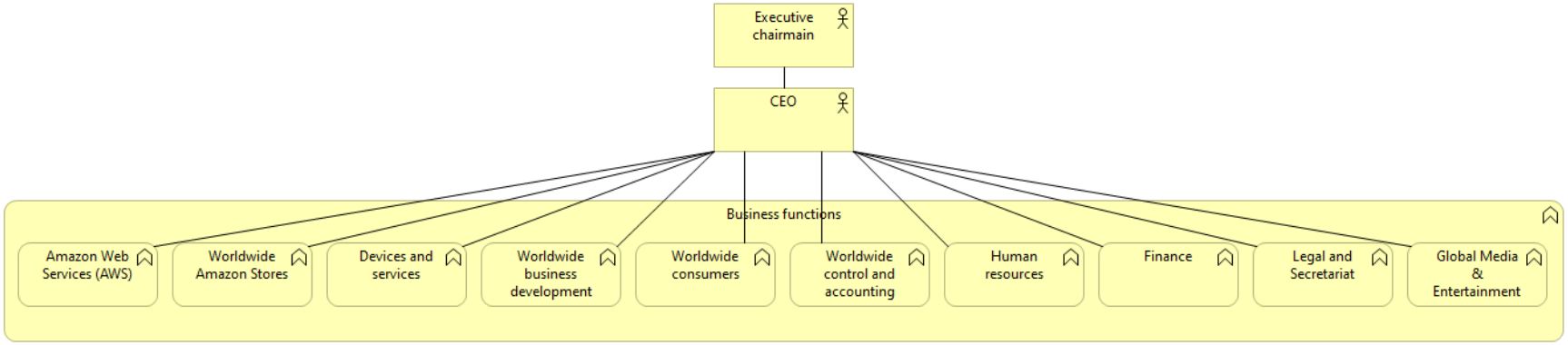
Appendix 17. Organizational structure of Apple



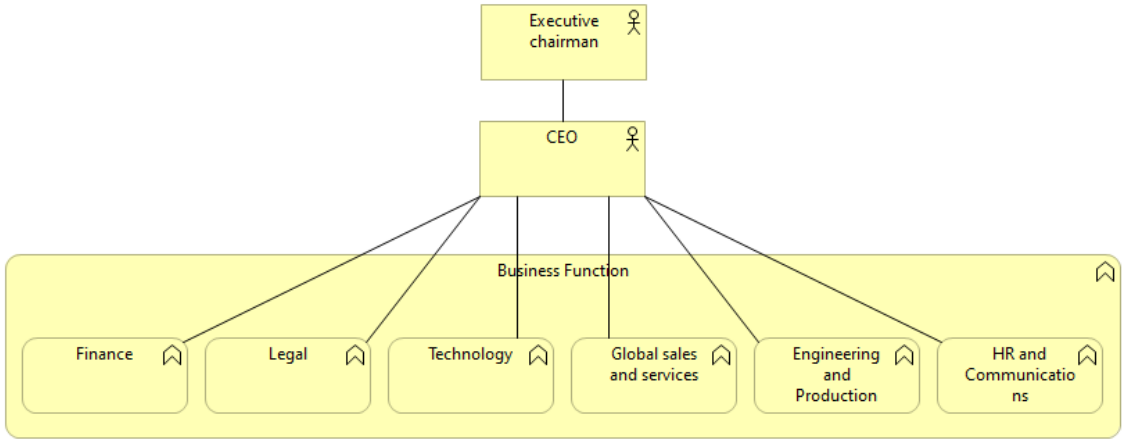
Appendix 18. Organizational structure of Microsoft



Appendix 19. Organizational structure of Amazon



Appendix 20. Organizational structure of Tesla



Appendix 21. Organizational structure of Alphabet