Improving the creation process of digital platforms

A design pattern reference model

Ernst de Vries (s2213168)
Supervision by
prof.dr.ir. L.J.M. Nieuwenhuis
dr. L. Ferreira Pires
dr. J.L. Rebelo Moreira
L. Bakir MSc

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Abstract

Digital platforms designs cover multiple domains that cause complexity in the creation process, because there are many elements in these domains that have to be identified. The complexity and the choices made can cause misalignment between the different domains, like business-IT. We identified that the main cause is a lack of knowledge by the creators of digital platforms. Therefore, we created a reference model that transfers knowledge about the motivation, business, application, and data domains. With the support of literature, we identified relevant concepts of a digital platform and created Enterprise Architectural patterns (EA) in each domain with the ArchiMate language. These patterns describe the choices one has to consider when creating a digital platform for exchanging services. In the application domain, we also focus on the alignment between business and IT. To overcome the obstacle that ArchiMate is not widely known, we created a visualization tool that enables natural language to create viewpoints with the reference model. We validated the reference model with a case study at a company called Castlab that wants to create a digital platform to provide a casting on-demand service and analyzed an existing digital platform to validate the generalizability.

Keywords: Digital platform, Servitization, Enterprise Architecture, Patterns

Acknowledgements

Sometimes, we see a quote or inspirational statement and adapt our frame of reference to be inline. We adjust our values and behavior based on a text that has been taken out of context and put in a diminished form in our lives, into our frame of reference. The power an inspirational statement has is created by the aggregation of knowledge, either old or new. I believe that models yield the same power. They combine knowledge, either old or new, so we may adjust our frame of reference in the context of what the model teaches us about a complex topic. Taking that into consideration, I wanted to work on a model for my master thesis. This document shows that I succeeded in making a reference model, but it is not only my effort.

I would like to thank everyone at Castlab for providing the opportunity to work on the assignment and help with my research. In particular, I would like to thank Koen Melis for the aid and information he provided. The many talks we had, through teams due to COVID-19, allowed me to have an open mind on the possible solutions, and the positive attitude of Koen provided an insight into life lessons.

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Definitions

Creation process: The process of defining the digital platform attributes like, but not limited to, the actors, the value, the purpose, and functionality. This process is about creation on a high level, not about the realization of the digital platform at the system level, which is called development.

Digital platform: a technical infrastructure that utilizes information technologies to facilitate the online exchange of value between at least two parties in a market.

Digital platform application landscape: The information technology infrastructure structure with all applications needed to facilitate the business processes within a digital platform.

Knowledge topic: A body of knowledge on a topic that is communicated between knowledge carriers.

Knowledge carrier: An individual, organization, or other actors that transfer knowledge by communicating a knowledge topic.

Pattern: An approach to describe at least one solution to a reoccurring problem.

Platform: see digital platform.

Reference Model: a collection consisting of clearly defined concepts and their possible relations for a particular subject on a high level.

View: The representation of a related set of concerns. A view is what is seen from a viewpoint and is always specific to the architecture for which it is created.

Viewpoint: A definition of the perspective from which a view is taken. It is a specification of the conventions for constructing and using a view. A viewpoint defines: how to construct and use a view by means of an appropriate schema or template. A Viewpoint is generic and can be reused.

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1. Introduction

This thesis presents a reference model that aims at supporting the creation process of developing a digital platform by justifying the choices made in the design of a digital platform. The reference model contains viewpoints with patterns that describe the motivation, business, IT application & communication, and the data elements of the digital platform design. The current chapter provides the problem definition, the context in which the thesis applies the research question, and the research goals. Section 1.1 describes the problem context by introducing the concept of digital servitization. Section 1.2 describes the problem definition with regard to digital platform design and an intended solution. Section 1.3 describes the goals of the research and the scope. Section 1.4 describes the main research question and is divided into sub-questions that allow us to answer the main research question. Section 1.5 describes the research methodology to conduct the research. Section 1.6 describes the outline of the thesis structure.

1.1 Problem Context

The world is becoming increasingly more digital with technologies like artificial intelligence, big data, digital platforms, and others. However, Small and Medium Enterprises (SMEs) do not fully benefit from the data generated and used by these technologies (European Commission, 2020). Only 17% of the SMEs have successfully integrated digital technologies into their businesses, compared to 54% of the large companies (European Commission, 2020). Digitalization continues to be a cornerstone of innovation in manufacturing (Mc Cormack, 2019). In the manufacturing industry, digital technologies can support flexible, adaptive, agile manufacturing, which would contribute to responsive production by responding quickly to changing customer demands, fluctuating characteristics of materials, and changing business targets (Mc Cormack, 2019).

Servitization describes the shift in perspective from offering products to offering services. These services are customer-focused and can be combinations of goods, support, and knowledge by delivering value in use (Paschou et al., 2020). In the light of the world becoming more digital, servitization has a digital counterpart called digital servitization. Digital servitization is associated with service offerings becoming digital and smart, thereby causing organizations to change business models and create new strategic assets to create competitive advantage (Paschou et al., 2020). Digital servitization can be defined as "the transformation in processes, capabilities, and offerings within industrial firms and their associate ecosystems to progressively create, deliver, and capture increased service value arising from a broad range of enabling digital technologies" (Sjödin et al., 2020). Therefore, digital servitization can be conceptualized as the development of new services or the improvement of existing ones through the use of digital technologies (Paschou et al., 2020). Among the digital technologies used are the Internet of Things (IoT), big data and analytics, cloud computing, 3d printing, and Artificial Intelligence (AI)(Paschou et al., 2020; Sjödin et al., 2020).

The benefits of digital servitization can be divided into three categories: benefits for customer, benefits for the provider, benefits for society and the environment. The potential benefits for the customers are to minimize downtime and transfer of risks to the manufacturer/provider (Grubic, 2018) secure transmission of data (Nybacka et al., 2010), increased differentiation, flexibility, and customization (Paluch & Wunderlich, 2016) improved customer performance in usage process

(Weinman, 2016), and empowerment of the customer (Hernández Pardo et al., 2012). The provider has the following potential benefits: reduction of the service delivery costs (Grubic, 2018), improvement of maintenance efficiency and effectiveness (Grubic, 2018) improvement of product performance and availability (Grubic, 2018), generate new value, thereby creating new revenue streams (Demirkan et al., 2015), and being able to have a platform-based business (Cenamor et al., 2017). The society and environment benefit by the reduced energy consumption and environmental impact (Opazo-Basáez et al., 2018), sustainable production (Bressanelli et al., 2018) and the delivery of value to the surrounding society(Georgakopoulos & Jayaraman, 2016).

An example of digital servitization can be found by Rolls-Royce's Power-by-the-Hour program. This is a servitized business model where Rolls-Royce offers airline manufacturers to pay for the use and availability of the engines by the hour, instead of buying them. Rolls-Royce implemented an IoT platform to monitor engine data in real-time to support maintenance (Baines et al., 2013).

In the light of digital servitization, companies go through a transition from being a product-oriented business to becoming a service-oriented business. Digital servitization employs digital technologies in its services. These technologies can also be used as a contribution to offering a service to a customer. One of the artifacts that a company can use to offer its services in a digital way is a digital platform that allows the exchange of value between at least two stakeholders, namely the consumer of the value and the manufacturer of the value. The service that digital servitization creates can be seen as the value that is exchanged. The company that offers the service is the provider of the service and can also be the manufacturer depending on the service. This illustrates the eco-system of a digital platform, and a company can join existing digital platforms or create a digital platform and become a digital platform provider. Based on Watts (2020) and Marrone (2019) the following classification of digital platform types is defined: Social media platforms, knowledge platforms, platforms for exchanging goods or services, and asset platforms. For example, Uber is classified as an asset platform, despite offering services.

Digital servitization does not only change the value exchange but changes the whole enterprise. These affect the business models, organization, operational models, IT systems, technologies, etc. Therefore, an enterprise architecture model needs to be presented to support the transition process (Ducq et al., 2012; Luyckx, 2019). An Enterprise Architecture (EA) is a coherent whole of principles, methods, and models that are used to classify, clarify, and introduce changes in the design and realization of an enterprise's organizational structure, business processes, information systems, and underlying infrastructure. It captures the essentials of business and IT and provides a holistic view of the enterprise (Lankhorst, 2009; Perroud & Inversini, 2013).

1.2 Problem Definition

Companies must be aware of the risks as many digital platforms fail to achieve a large customer base while having a high initial cost of digital platform operations. SMEs lack opportunities to enter the platform economy. These companies need knowledge of existing digital platforms and best practices to start adapting to the platform economy by creating a digital platform(Drewel et al., 2020). The creation of a digital platform can be seen as a step in a digital transformation. In

a study involving Swiss companies, the main barrier to digital transformation was, in 48% of the cases, a lack of knowledge and expertise (Peter & Dalla Vecchia, 2021). When companies lack knowledge of the eco-system of a digital platform, they adopt strategies from similar eco-systems, but these eco-systems are not based on the company's goals and might cause the eco-system to fail (West & Wood, 2013). Looking at similar companies that are successful and reading their stories to make decisions introduces the narrative fallacy. In which people base their decisions on positive elements in stories rather than objective data (Kahnman, 2011a).

A digital platform is a complex infrastructure that includes many different domains, like but not limited to, the eco-system, business models, regulations, and IT services. This can cause misalignment between domains, like the business functions and strategy of the digital platform and the supporting IT structure, thereby introducing another problem. The alignment between Business and Information Systems is a key issue in every organization, given the impact it has on the overall organization (Pereri Marques & Sousa, 2005). Better alignment between business and IT leads to lower costs, higher quality, and greater customer satisfaction (Lankhorst, 2009). The alignment between strategy, business, and IT can also be defined as strategic alignment. This is the ability of an organization to create synergy between the position within a competitive environment and the design to support the execution (Aldea et al., 2018). The different domains include many choices that need to be made in each domain for the design, and these choices cover many elements that require knowledge. The lack of knowledge results in a blind spot, which causes the inability to make these choices properly or be exposed to biases like the narrative fallacy. This does not contribute to a better alignment between the different domains of a digital platform.

Therefore, research needs to be conducted to identify these domains and the choices in the design of a digital platform to solve the lack of knowledge. This can be captured in a knowledge topic, which captures the knowledge that is communicated between knowledge carriers and actors that transfer knowledge (Lankhorst, 2009). The knowledge topic covered by this thesis is which elements and their relations in different domains might be considered in the creation of a digital platform. Current methods and solutions like Drewel et al. (2021) or Tura et al. (2018) provide an approach to creating a digital platform by focusing on value creation, regulation, and stakeholders but do not consider IT services or different roles in the eco-system. Nor do Drewel et al. (2021) explain the patterns they identified in creating a digital platform design. These current solutions do not look into the alignment of business and IT.

A solution to overcome the lack of knowledge that companies face is by using patterns (Drewel et al., 2020). Thus a possible solution to the problem could be to create a set of Enterprise Architecture patterns that describe the choices a company can make in different domains to solve parts of the problem, create alignment, and provide a holistic view of the digital platform. For example, one pattern could cover the entire eco-system while another could describe IT services. The EA design choices or architectural choices offered should support an initial step in the transition from a product-oriented business to a service-oriented business.

1.3 Research Goals

The main goal of the research is to transfer knowledge about the knowledge topic to knowledge carriers. The knowledge transfer contains EA patterns that cover multiple domains in the design of a digital platform that offers services. The means of communicating these patterns is by creating an architecture of these patterns, which is our reference model. This supports choices made in the creation, creates alignment, and provides a holistic view of the digital platform by explaining and justifying relevant aspects like the eco-system, business processes, and IT-services. The research should achieve two knowledge goals: introduction of knowledge and agreement to knowledge. The former introduces the knowledge to knowledge carriers and makes them aware of the knowledge, while the latter creates a mutual agreement between knowledge carriers (Lankhorst, 2009).

As a result of digital servitization, this research focuses on the digital platforms that exchange services. Not every service created in the light of digital servitization is suitable to be offered on a digital platform. The service must contain an artifact with an additional value, like maintenance of the artifact. This produces a set of requirements: users must have the option to browse services and manage offered services, and users must have the option to pay for services they are interested in and should receive the payment once an exchange is completed. Therefore, the digital platform needs to be able to execute processes like, e.g., payment. As a result, the research identifies these processes and explains the elements in these processes a company has to consider.

1.4 Research Questions

How to create a reference architecture that communicates EA patterns which explain the business model choices and provide business-IT alignment in the design of a digital platform, so that knowledge carriers can create a digital platform design to offer services in the context of a digital servitization offering?

To answer the main research questions, the following sub-questions have been identified so that each one covers part of the main research question:
1) What are current solutions identified in the literature and how do they relate to the knowledge topic?
2) What are the general requirements for a digital platform that exchanges services?
3) How should the reference model be structured?
4) How can the reference model transfer knowledge to knowledge carriers in a usable manner?

1.5 Research Methodology

This thesis followed the Design Science Methodology (DSM) for Information Systems and Software Engineering (Wieringa, 2010). According to the DSM template for problem design, the problem addressed by this thesis is*: Improve* the digital servitization service offering *by* creating a digital platform reference model *that* properly explains and justifies choices made in the design of a digital platform *in order* allow companies to create a digital platform design for service offering.

The DSM methodology defines four phases for creating an artifact, which are depicted in Figure 1. The following list describes how the phases have been applied to this master project:

1. For the problem investigation: a literature review has been conducted. This review followed the principles of Bryan and Bell (2015)[1] and has identified frameworks and technologies that are used as input for the treatment design phase.
2. The treatment design: we identify three different category requirements and analyze the identified frameworks for available treatments and useful concepts used in these treatments. Furthermore, a new treatment has been designed that describes choices for digital platform design about relevant aspects, like the eco-system. These are captured in EA patterns, and these EA patterns make up the reference model.
3. The treatment validation: we performed a case-study at a company called Castlab that wants to create a digital platform to become the Spotify of the casting industry, and a case study in which we analyzed an existing digital platform called Just Eat Takeaway. In addition, we validated the identified requirements to check if these are satisfied by the outcome of the Castlab and Just Eat Takeaway case studies. This thesis generalizes the problem of Castlab by looking at service offerings with a digital platform in general, compared to an approach that focuses on the requirements of a specific company like Castlab.
4. The treatment implementation phase is performed at Castlab and covers the embodiment of the reference architecture, which allows companies to use the reference architecture to create a digital platform, by the use of a visualization tool.

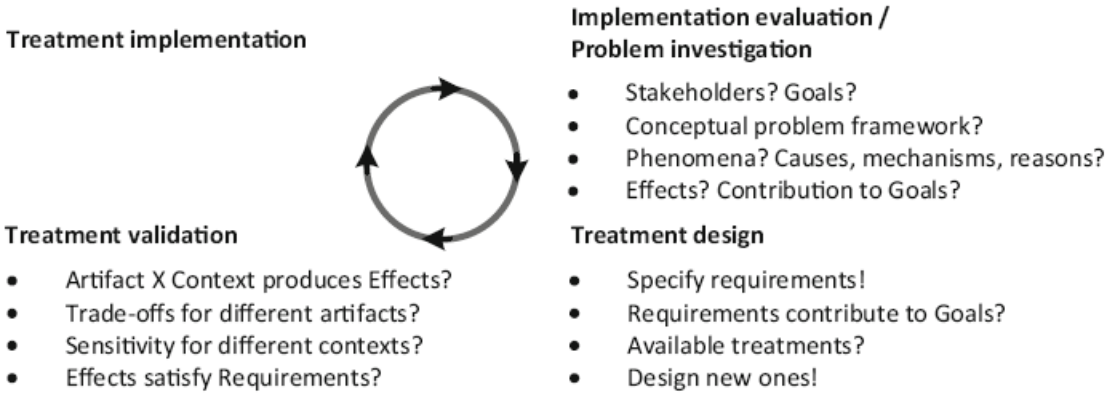


Figure 1 Design Cycle (Wieringa, 2010)

1.6 Thesis Structure

This master project describes the justification and validation of the reference model. This chapter discusses the problem we addressed and states the research question. Chapter 2 describes the background information from literature to identify frameworks to develop a digital platform and the workings of a digital platform eco-system. Chapter 3 describes the design of the digital platform by capturing the requirements and the creation and explanation of the digital platform layer model. Chapter 4 describes the motivation and business layer and Chapter 5 describes the

[1] See Appendix I

application and data layer. Chapter 6 describes the validation of the reference model with the company Castlab case-study. Chapter 7 describes the validation of the generalization with a case-study analyzing an existing digital platform called Just Eat Takeaway. Chapter 8 describes a discussion of our results. The final remarks with the conclusions, contributions and limitations of the study and recommendations for future work, are presented in Chapter 9.

2 Background

Our conceptual framework consists of a digital platform eco-system and relevant elements of identified digital platform development frameworks that need to be taken into consideration. This chapter will describe the creation of the conceptual framework and justifying the choices made with the support of literature.

2.1 The eco-system of a digital platform

In order to understand the digital platform eco-system, the concept of digital platform is explained. A platform is used to build upon and serves as a foundation upon which complementary products, technologies, or services can be developed (Gawer & Cusumano, 2002). A digital platform narrows this by being empowered by information technologies that enable the consumer and the producer of the market to exchange value (Bakos & Katsamakas, 2008; Gawer & Cusumano, 2002). These digital platforms are known as two-sided internet platforms or multi-sided internet market depending on the number of participating roles, like consumer and producer. This enables different groups of consumers, producers, providers, etc. to exchange information, goods, social content, create new services, business models, and markets (Eisenmann et al., 2011; Poniatowski et al., 2021). For example, one can think of Quora to exchange information, Instagram for social content, or the Amazon marketplace to trade goods.

For a digital platform design, there needs to be an architecture defining the value exchange, hardware and software components with how they fit together, an infrastructure supported by information technologies that facilitates the interaction between the participating sides, and a set of rules. These rules might contain the pricing terms, rights obligations and responsibilities of the participants, and standards that ensure compatibility between different components, or protocols that guide the information exchange. (Bakos & Katsamakas, 2008) (Eisenmann et al., 2011).

Within digital platforms, the network effect is quite important (Eisenmann et al., 2011). Network effects are the incremental benefit gained by an existing user for each new user that joins the network. To illustrate, one can think of a telephone network in which a phone is only useful if other people (users) also own a phone (Drewel et al., 2020). Only if one person owns a phone, the network has no value because it cannot be used to accomplish anything. If two people have phones, they can call each other, providing network value. When a new type of provider, such as a 112 provider, joins, the network's value increases dramatically because all users can now dial 112. The network effect has a direct and indirect effect. The direct effect, also known as same-side effects, states that the value of an item increases as the total number of consumers of that item increases. Like a telephone, it is only useful if the people that you want to call have telephones, so the more people who have phones, the more useful it is to have one yourself. The indirect network effects, also known as cross-side network effect, occur when the value of an item increases for one participating party when a new user from a different participating party joins the network. For example, the more consumers on the network, the more valuable that network is to producers. The indirect network effect is a characteristic of digital platforms and it is the driving force behind digital platforms like AirBnB or Uber. When these network effects contribute in a positive way, they become positive network effect. These are the foundation for

digital platforms. Thus, the more participants a platform has, the more attractive it becomes for other participants, which leads to the rapid growth of a digital platform (Drewel et al., 2021).

A digital platform uses information technologies to enable the exchange of value between participants in a network. Therefore, a digital platform does not exist on its own, since it is embedded in an eco-system with different actors that fulfill different roles that interact with the digital platform. In order to realize the digital platform concept, the eco-system needs to be created. We created an eco-system with three layers: the platform outer edge, the platform participating sides, and the platform core, based on the eco-systems presented by Drewel et al. (2021) and Poniatowski et al. (2021).

2.1.1 Functionality of eco-system layers

The platform core layer provides the infrastructure that enables the value exchange between the participating sides. The infrastructure contains a collection of information technologies that cooperate to enable the functionalities that are required for the participating sides to communicate with each other. The platform participating sides layer consists of all parties that are participating on the platform. This layer is based on the platform participants layer of Poniatowski et al. (2021), but is extended to cover a multi-sided market. The platform outer edge consists of all third parties that are involved with the digital platform, but do not belong to the participating side nor provide infrastructure functionalities (Drewel et al., 2021; Poniatowski et al., 2021).

2.1.2 Roles within the eco-system

The perspectives of Drewel et al. (2021) and Poniatowski et al. (2021) on the digital platform eco-system influenced the roles or actors in this thesis. The eco-system is also based on the digital platform concept (Eisenmann et al., 2011) and builds upon the stakeholder taxonomy of Wieringa (2010). In the platform core layer, the roles contribute to the support of the digital platform infrastructure. The owner of the digital platform initiates the creation of the digital platform and provides the budget for its creation. The creation process of the digital platform is performed by developers and managed by the project managers. The project managers are responsible for ensuring that development is successful. Once the digital platform is realized, there are roles for operating and maintaining the digital platform. The business operators ensure that the digital platform keeps running from a business perspective. For example, one can think about the following tasks, amongst others: financial tasks, customer support tasks, logistical tasks, and moderating the platform. The maintenance operators ensure that the digital platform keeps running from an IT perspective by providing bug fixes, keeping servers online, upgrading software, developing new functionalities, amongst others. In the case that IT is outsourced, for example, to a server hosting provider, the contribution towards the infrastructure determines whether the outsourced party is included in the platform core layer.

In the platform participating sides layer, roles can be identified in two-sided or multi-sided markets. The provider of an item offers the item or service to the digital platform in exchange for value. Value can be expressed in terms of money, but also in terms of other items or services. The consumer buys items or services that are offered by the provider on the digital platform. The producer of an item is called the manufacturer of that item. The manufacturer and the

provider can be the same person, but they can also differ. When the provider resells an item bought from the producer, either as a whole or by providing additional value in a service offering, a multi-sided market trade is established. The exchange of an item or service for value between provider and consumer, known as a value exchange, can be seen as a two-sided market. An actor can have multiple roles. For example, a wine manufacturer may sell the wine to a digital wine selling platform called Wine4life, which now serves as the consumer, while the producer serves as both the manufacturer and the provider. When Wine4life sells this wine, thereby providing its own items on the digital platform, Wine4life becomes a provider of wine to the digital platform's customers. If Wine4life added additional value, like a recipe for a dish that goes well with the wine, then they provide a service.

The platform outer edge contains third parties and other entities that do not fit into the other layers. The government defines rules and legislation that affect the context in which the digital platform operates. For example, if the government decided that substance X in amount Y is harmful in wine, therefore making it illegal to sell wines with this composition, then Wine4life must remove all offerings of wine with this composition in order to comply with the legislation. Another role within this layer is played by competitors that sell the same items or services as the digital platform. They do not have to be digital platforms to be considered competitors, but merely selling the same item or service makes them competitors. The owner of the platform does not always have enough funds, therefore, investors might be part of the outer edge by providing money. The platform outer edge may also contain third parties, like payment providers, delivery providers, and knowledge providers (consultants or knowledge institutions), amongst others. Although these roles make up the eco-system for a digital platform, they only cover the roles that contribute directly to the digital platform. The roles that indirectly contribute, like cleaners of the building where the platform operates, or the company that makes the lunch, etc., are not taken into consideration in the eco-system, although they could be included if necessary.

Figure 2 shows an overall view of the environment created by combining the functionalities and roles.

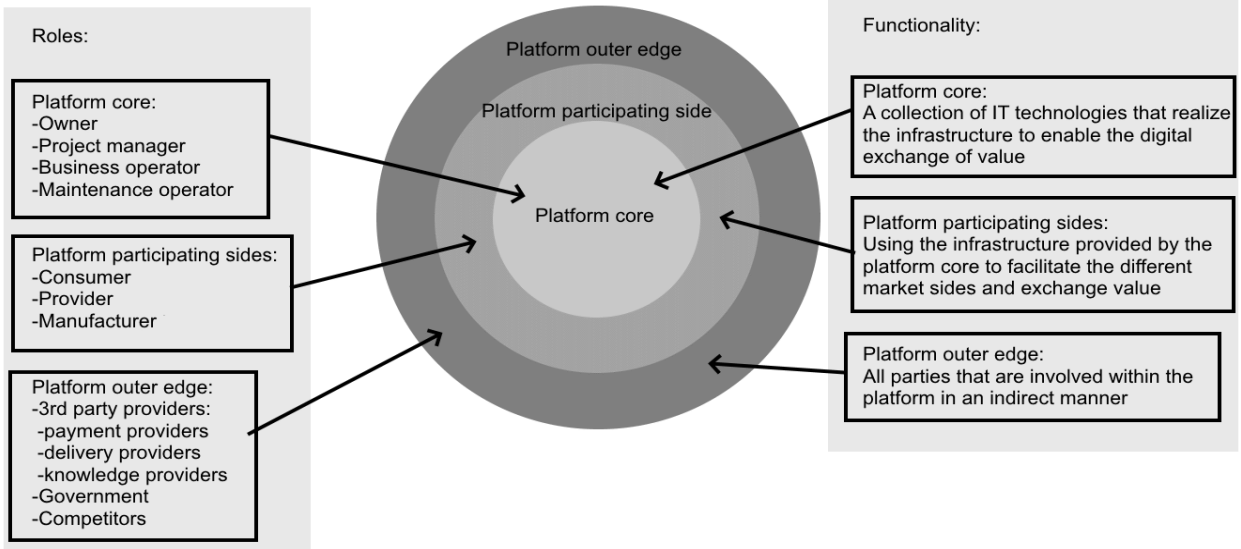


Figure 2 Overview digital platform environment

2.2 Digital platform development framework concepts

The concepts or building blocks of a digital platform that are used in this Master project are inspired by (Drewel et al., 2020, 2021; Perroud & Inversini, 2013; Tura et al., 2018). Tura et al. (2018) created a digital platform design framework containing four dimensions. For each dimension, concepts are defined to answer certain design questions. Perroud & Inversini (2013) developed numerous patterns that can be applied to common IT problems. A pattern is an existing common solution to a problem. They describe three categories of patterns: business patterns, support patterns, and infrastructure patterns. Drewel et al. (2020, 2021) describe digital platform design concepts, which have a general definition and contain patterns to create a digital platform. The general definition of each concept is given, but the corresponding patterns are not given.

The following concepts have been identified as relevant in the creation process of a digital platform: value unit, governance, platform architecture, acquisition of the participating sides, and competition. These are relevant as multiple identified platform development frameworks cover these concepts.

- The value unit concept captures the essence of the benefits of the digital platform. This concept represents the benefits and who gets them. The value unit concept also captures the value exchange, the item or service that is being exchanged between the provider role and the consumer role in Figure 2, which determines the business model of the digital platform.

- The governance concept captures the rules, laws, and managerial rules for the digital platform and the actors that participate in the digital platform eco-system. Most likely, these rules apply to consumers and providers of the digital platform and describe the terms in which value is exchanged or which rights and obligations each side has. Being part of the platform outer edge, the government can pose regulations that have to be adhered to by the digital platform. Furthermore, contracts between third-party providers and the digital platforms are also related to the governance concept. Another example is the set of rules the digital platform has for internal practices.

- The platform architecture concept captures the information technology infrastructure necessary to enable the value unit concept. The platform architecture concept realizes this by describing the structure of the IT and the IT technologies used. In addition, it captures the purpose of the digital platform and has some overlap with the value unit. This overlap is caused by the concern of the market structure and the key actors within the digital platform. The difference is that the value unit concerns the participants and, from that perspective, defines the actors, while the platform architecture concept concerns the information technologies and uses that perspective to define possible actors.

- The acquisition of the participating sides concept captures the way a digital platform deals with the classical chicken-and-egg problem. The participating sides concept maps this problem to digital platforms and states: who is first, the consumer or the provider?

This observation indicates that a digital platform needs providers to attract consumers, and consumers to attract providers. Therefore, the concept poses the following question: "Is one side prepared to join or use the digital platform, even when the other side does not provide much value?"

- The competition concept captures the processes involved in launching a digital platform and the strategy involved. Furthermore, the concept looks at competition and how the digital platform deals with it. A competitor does not need to be another digital platform, since any entity that offers the same item or services is a competitor of the digital platform.

In Figure 3, the concepts are mapped to the digital platform eco-system of Figure 2. The value unit affects the value exchange between the different participating sides, hence, it influences the platform participating side layer. The value unit overlaps with the acquisition of the participating sides, because the benefits of the platform and the exchange of value have an effect on the difficulty of acquiring participants. Therefore, the acquisition of the participating sides also influences the platform participating side layer. The platform core layer is based on the platform architecture; thus, the platform architecture is mapped to the platform core. Factors that influence the eco-system externally are governance and competition. A digital platform needs to obey rules that can shape the terms of the value unit functions, or competition might influence the acquisition of the participating sides. As a result, each layer is shaped not only by its own concepts but also, indirectly, by the concepts of other layers.

The digital platform eco-system as presented in Figure 3 has been used to create the reference model and gives an overview of our interpretation and understanding of the digital platform eco-system.

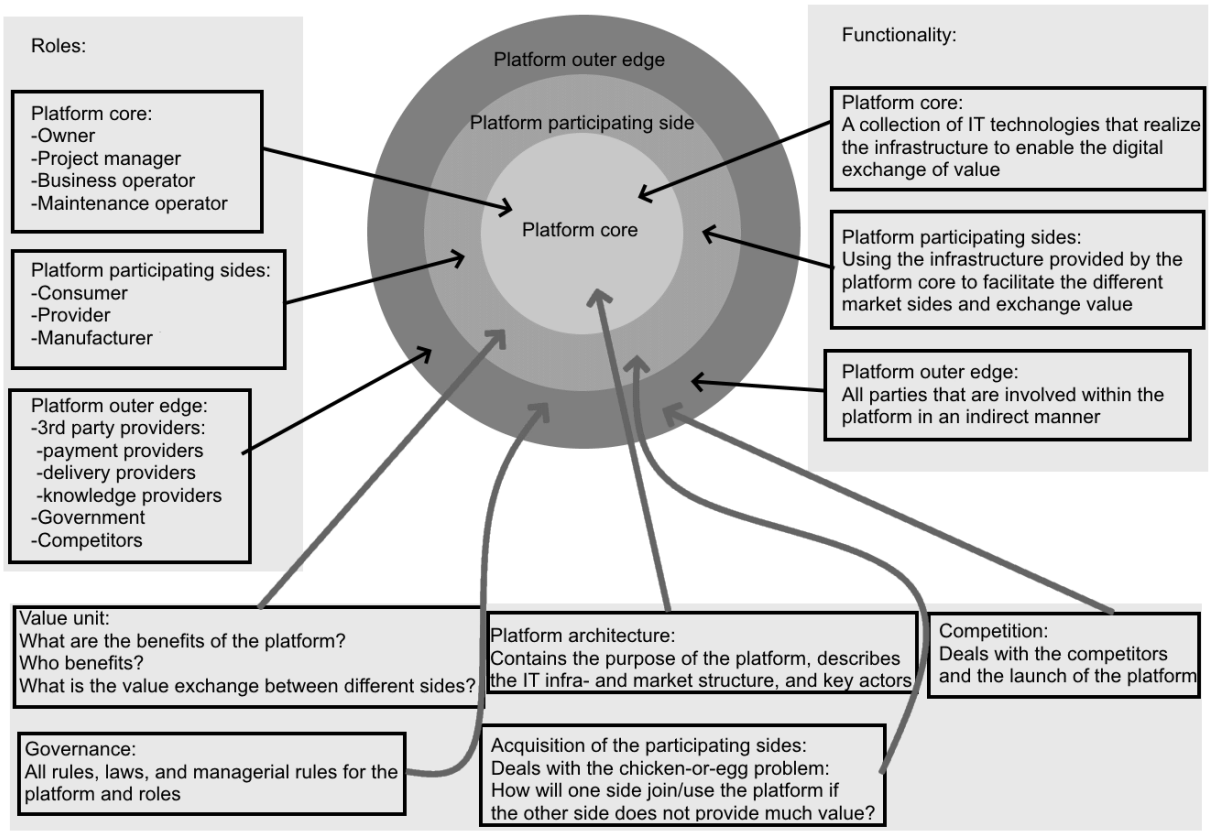


Figure 3 Digital platform Eco-system with concepts and roles

2.3 Conclusion

The first sub-research question is answered. The current solutions identified are presented by Drewel et al. (2021), Tura et al. (2018), and Perroud & Inversini (2013). Drewel et al. and Tura et al. describe platform development frameworks with elements a design needs to cover. In addition, Drewel et al. provide an eco-system of a digital platform on which different design fields are based. They provide patterns in these design fields, but they are not publicly available. Tura et al. provide a development framework with questions on different elements. For example, in the governance element, they ask questions like "What types of rules are enforced?" In contrast to Drewel et al. and Tura et al., Perroud & Inversini describe enterprise architecture patterns for IT problems. One of these is a solution to launching a digital shop. They provide business, IT, and technology information on the creation of a digital shop and provide a hollow view of a digital shop that has this information integrated. All solutions contribute to the knowledge topic by identifying different domains and elements that can be used in the design of a digital platform.

3 Digital platform design

Chapter 2 describes an eco-system in which different roles and users that interact with the digital platform are identified. Each of these roles defines requirements for the digital platform to satisfy. The eco-system also holds concepts that need to be structured in order to create viewpoints. Section 3.1 describes the requirements of a digital platform. Section 3.2 describes the digital platform layer model. Section 3.3 describes the different viewpoints for the digital platform layer model. Section 3.4 describes a template to systematically describe the content of each viewpoint.

3.1 Requirements

3.1.1 Capture strategy

In order to capture the requirements, we grouped them into three categories, namely: Digital Platform Stakeholders, Digital Platform Structure, and Reference model. Each category holds sub-categories that allow one to identify more requirements and add them to the corresponding category. An overview of the categories is presented in Table 1.

To introduce a systematic way of capturing the requirements, the MoSCoW prioritizing system is used. MoSCoW is a prioritization technique for helping to understand and manage priorities. The letters stand for: Must have, Should have, Could have, and Won't have (Agile Business Consortium, 2014). The requirements are captured by analyzing the design frameworks and patterns like Drewel et al. (2021), Perroud & Inversini (2013), and Tura et al. (2018). In particular, the Vending Machine pattern by Perroud & Inversini (2013) describes requirements for an e-commerce shop, which has many similarities with a digital platform. For example, requirements concerning legal information, browsing items, integration, and registering, amongst others, have been transformed into the context of a digital platform. In addition, the information about the digital platform for the company Castlab is generalized to capture requirements. Castlab is also used to define the requirements of the reference model.

The requirements cannot cover all aspects of the digital platform eco-system, since an eco-system covers many elements that make the research too broad, thus introducing complexities. Therefore, assumptions are made. Although the categories can be extended, there is no category to capture the chicken-or-egg problem, so the assumption is made that this problem is mitigated. This might not be a realistic assumption, as every digital platform needs to deal with it sooner or later. However, it does not influence the set-up of a digital platform or the general choices made in the creation of a digital platform design. There are also no requirements for user interfaces or user experience either as this is not within the scope of this project. The reference model does not specify which device is used to visit the digital platform. For instance, one can use an app on a smartphone, or use a web browser. The assumption made is that this is done through a web browser, although this choice should not influence the use of the reference model.

Table 1 Overview categories requirements

Category	Sub-categories
Digital Platform Stakeholders	Outer edge, Participants, Core
Digital Platform Structure	Functional, Non-functional
Digital Platform Reference model	Concept, Presentation

3.1.2 Digital Platform Stakeholders requirements

The Digital Platform Stakeholders requirements capture the need for a role within the layer of the digital eco-system. For example, the requirement "The user must receive money once a service is purchased" describes a need or expected function the digital platform has for the provider role. The inclusion of digital platform eco-systems as sub-categories is logical, as the eco-system encompasses the primary stakeholders for a digital platform. In Table 2, the identified requirements and the sub-category to which they belong are identified.

The outer edge sub-category concerns stakeholders that are indirectly involved with the digital platform. Therefore, these users need information about the digital platform to examine if the digital platform, for example, complies with laws like GDPR. In general, this sub-category concerns indirect involved parties and their expectations of the digital platform functionality.

The participants sub-category concerns stakeholders that are directly involved, having an active role, with the digital platform. Therefore, these users need to have access to the service and receive money if a purchase is completed. In general, this sub-category concern directly involved parties and their needs on the digital platform.

The core sub-category concerns stakeholders that are involved with the creation and maintenance processes of the digital platform. Therefore, these users need to monitor and manage the digital platform. In general, this sub-category captures the need to create and monitor the digital platform.

Table 2 Requirements Digital Platform Stakeholder

Sub-category	Identified requirements
Outer edge	• The user must be able to retrieve clear and consistent information about the digital platform on topics of interest, like policies. • The user should have the ability to integrate their third party service with the digital platform. • The user should have the option to view statistics concerning the provided service. • The user could have the option to

	provide another company to fulfill their service.
Participants	• The user must be able to access the service. • The user must receive money once a service is purchased. • The user should have the option to pay for the service. • The user should have the option to register to the digital platform. • The user could have the opportunity to share his/her experiences of the service on the digital platform.
Core	• The user must receive money once a service is purchased. • The user must have the ability to monitor the digital platform. • The user must have the option to manage offered services. • The user should have access to performance statistics of the digital platform. • The user could have a list of current bugs in the digital platform software.

3.1.3 Digital Platform Structure requirements

The Digital Platform Structure requirements capture the essence of how the digital platform looks from a technology point of view. These requirements capture the digital platform in terms of an IT system. The sub-categories capture the functional way, which is also known as functional requirements, and the qualities, also known as non-functional requirements. In Table 3, the identified requirements and the sub-category to which they belong are identified.
The sub-category "Functional" captures the functional requirements of the digital platform. These requirements answer the question "what" function the system requires to perform the expected tasks. For example, the digital platform needs to have functionality in place to deal with data. This can either be data that a user stores, like a new service, or data about the user, etc.

The sub-category non-functional captures the requirement that describe the qualities of the digital platform. These requirements answer the "how" functional requirements are expected to behave in the system and the general behavior of the digital platform. One standard that concerns non-functional requirements is ISO-25010 (International Organization for

Standardization, 2011). The ISO standard comes with eight categories to capture so-called product quality, which are: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, portability. For example, the digital platform must only show data that belongs to a user. User A should not have access to the purchase history of user B and vice versa. This can be considered a security requirement and tells "how" the functional requirement of data storage should behave.

Table 3 Requirements of the digital platform structure

Sub-category	Identified requirements
Functional	• The digital platform must have storage capacity to store data. • The digital platform must be able to modify services/information from storage. • The digital platform should be able to execute specific processes like payment. • The digital platform should have an interface to facilitate adaption by third-party providers. • The digital platform should be able to transfer data between different systems.
Non-functional	• The digital platform must only show data intended for the specific customer. • The digital platform must store data in a secure way by following best practices. • The digital platform should process requests within 5 seconds. • The digital platform should support multiple languages. • The digital platform could contain DDoS protection.

3.1.4 Reference model requirements

The reference model requirements capture the goals the reference model has to realize. They are defined by asking questions to a knowledge carrier, the company Castlab, about what they need in the communication to understand the EA patterns. By involving a knowledge carrier in the knowledge transformation processes, a valuable insight on how to communicate the information in the knowledge topic is created. The requirements are classified in two-sub categories, concepts and presentation. In Table 4, the identified requirements and the sub-categories are presented.

The sub-category Concept captures the requirements concerning the concepts the reference model should represent and should be able to explain. One can think of questions like: why does a user participate in the digital platform network? The concept category captures the tools needed to solve the problem. The Presentation sub-category concerns the visualization of the model for users. With questions like: how is the reference model presented to users? These two categories should contribute to solving the problem by increasing the understanding SME companies have about digital platforms. The questions are competence questions and have been created by us by filling in templates (Keet et al., 2019) and have been translated to fit the MoSCoW style.

Table 4 Requirements Reference model

Sub-category	Identified requirements
Concept	• The reference model must represent concepts to create a digital platform. • The reference model must increase the knowledge of digital platforms for companies. • The reference model should explain each concept with an example. • The reference model should show why alignment between business and IT is complex. • The reference model could evaluate alternative options and provide cost estimates.
Presentation	• The reference model must have a clear visualization. • The reference model must explain the concepts presented. • The reference model visualization must allow the users to use the EA patterns. • The reference model visualization should have an option to be used outside Excel. • The reference model visualization could contain a validator for the model.

3.2 Identification of layers

To use the concepts in Figure 3 in a design, a structure needs to be identified. Layering is a basic architectural structuring technique (Lankhorst, 2009), and therefore, it is applied to structure the concepts.

3.2.1 Concepts

The value unit concept concerns motivational and business-related elements of the digital platform. For example, a motivational question about value exchange influences the revenue

model of the digital platform. The platform architecture concept concerns not only the purpose of the digital platform but also the information technology infrastructure, which contains all applications, data, and communication within the digital platform. The purpose of the digital platform captures motivational elements, and information technology captures the application elements of a digital platform. The competition concept concerns how a digital platform deals with competitors and the launch of the platform. These are business-related elements of a digital platform, however, launch strategies are not within the scope of this project. The governance concept concerns all rules and laws that the digital platform is obliged to comply with and describes practices within the digital platform. These rules influence business-related and motivational elements as processes need to be in place to verify compliance. The acquisition of the participating side concept is concerned with the strategies of participants to join the digital platform in the future. This includes business-related and motivational elements. For example, identify the value these participants want to gain by participating on the digital platform.

Based on these concepts, the following layers for the model have been identified: business, application, and data. The goal of these layers is to capture concepts and derive viewpoints that can be used to create models for the reference architecture.

3.2.2 Layers

The motivational elements influence the business-related or application elements. Therefore, motivational elements are considered to be cross-cutting. As a result, the motivational elements, which include the purpose of the platform, the participants in the digital platform, and who benefits from the digital platform, amongst others, are captured by a cross-cutting motivation layer. The business layer captures the business-related elements, like business processes, to describe the functionality of the digital platform and influence the application elements.

The application layer captures the application elements, like IT systems, communication between systems, and accessibility, amongst others. This layer is responsible for alignment between IT and business, by providing insight into business process realization by IT systems. The applications that are needed to realize business processes, like the value exchange between two participants, are the core of a digital platform.

Once the application layer has been established, the digital platform can adapt to another market. This is known as "platform envelopment" (Eisenmann et al., 2011), which states that digital platforms serve different markets, often employ similar application elements, and have overlapping participants[2]. As an example, one might consider the company Bencom (Bencom group, n.d.), which has a service to compare gas and electricity prices among different providers. But it also has a service to compare car, health, or home insurance. The underlying application elements can be reused to enter other markets. By entering, for example, the car insurance comparison market, they compete with the company Pricewise (Pricewise B.V., n.d.).Therefore, the applications are the core of the digital platform and allow it to be re-used to expand the digital platform into other markets.

[2] Platform envelopment considers platforms as business structures, not only digital platforms.

The data layer captures the data within the digital platform and should hold a high-level overview of the data objects, which are crucial pieces of information that allow the application elements to operate and facilitate different business functions. Besides, the data layer should make data more tangible through visualization, which can increase efficiency by, for example, not duplicating data.

Figure 4 depicts a visualization of these layers in the digital platform layer model.
The layers are depicted as horizontal lines, with the cross-cutting motivation layer depicted as a vertical line to indicate that it influences the other layers.

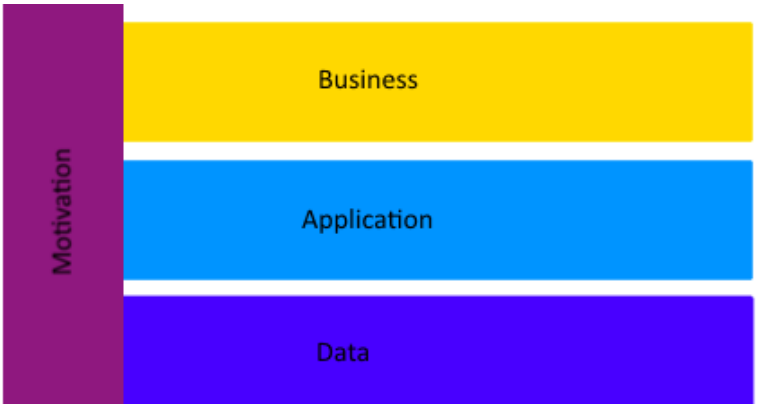


Figure 4 The digital platform layer model

3.3 Layered model viewpoints

The digital platform layer model contains empty layers, thus the concepts that explain the choices in the creation process of a digital platform design must be defined for each layer. Each layer contains at least one viewpoint that describes the concept(s) captured within it. For example, the application layer has viewpoints that represent the application elements, like the accessibility of IT systems. To create these viewpoints, a language that represents and captures the elements of a layer is required.

3.3.1 BMC, BPMN, and UML

Each domain in the digital platform layer model has its own language to model the concepts within the layer. For example the Business Model Canvas (Osterwalder & Pigneur, 2014) contains nine elements that allow the user to describe the business strategy of their venture. These elements can be used to describe the motivation layer as well as the business layer. Key partners, value propositions, and revenue streams have been identified as elements for the motivation layer. These allow one to consider motivational elements such as who the digital platform's participants are, how the participants gain value, and how the digital platform gains value.

The Business Process Model and Notation (BPMN) (Von Rosing et al., 2014) provides businesses with the capability to understand their internal business procedures in a graphical notation. This notation can be used to model the business procedures of a digital platform, which are captured in the business layer.

The application and data layers can be created in Uniform Modeling Language (UML). The Unified Modeling Language contains structure diagrams that can model and visualize the software and hardware components of a system. It also contains behavior diagrams like use case diagrams, which can be seen as motivational aspects. The structure diagrams can describe classes, components, deployments, or even packages. The Uniform Modeling Language is published by the Object Management Group (OMG) (Object Management Group, 2017) and is considered to be an ISO standard known as ISO/IEC 19501:2005 (International Organization for Standardization, 2005) for the design of software systems.

The main problem with these languages is their integration into the domains they represent. The business models cannot be integrated with the application model because BPMN and UML are two different languages. This makes it unclear how the concepts in one view relate to the concepts in another view. In addition, a concept might have a different interpretation in BPMN than in UML, so mapping concepts becomes error-prone. By using BPMN and UML in an enterprise architectural approach, where the domains are integrated, a problem of business-IT misalignment is created (Lankhorst, 2009). Multiple languages increase the communication process, as the knowledge carriers have to understand multiple languages.

3.3.2 ArchiMate

To solve the integration problem of different domains, create alignment between them, and model at an enterprise level, the language ArchiMate (The Open Group, 2019a) has been chosen. This is a language that can model the different steps that are described in the enterprise architecture framework TOGAF ADM (The Open Group, 2018a), which consists of various phases to create an enterprise architecture. As a result, ArchiMate is designed to create alignment between different domains, like business-IT. ArchiMate covers the business, application, technology, strategy, motivation, and planning and migration domains with corresponding layers. It has basic viewpoints for each layer, which are a simple selection of a relevant subset of the ArchiMate concepts and the representation of that part of an architecture that is expressed in a viewpoint, geared towards the stakeholders that will use the resulting views. In the documentation, the Archimate language specifies how it works with BPMN and UML and what the differences are between ArchiMate and BPMN and UML (The Open Group, 2019a).

3.3.3 Viewpoints

Since the documentation of ArchiMate describes the use of BPMN and UML, elements of these specific domain languages can be added to the viewpoints to model a domain more in-depth. A choice has been made to not follow the TOGAF ADM, as this would require an "as-is" situation, known as the current situation, and a "to-be" situation, known as the future situation. These situations would introduce complexities as multiple entry points for each layer would need to be defined.

Based on the ArchiMate language and the basic viewpoints, we defined seven viewpoints to fill the digital platform layer model. These viewpoints show a meta-model with concepts one needs to consider for a digital platform. The seven viewpoints with corresponding layers and ArchiMate references can be found in Table 5.

Table 5 Viewpoints and models

Layer	Viewpoint	ArchiMate basic viewpoint reference
Motivation	Goal, Actor Participate	ArchiMate Stakeholder, Goal realization viewpoints
Business	Business Process	ArchiMate Product viewpoint, Business Process Cooperation viewpoints
Application	Structure, Usage, Communication	ArchiMate Application Structure, Usage viewpoints
Data	Data	ArchiMate Information viewpoint

3.4 Template to describe viewpoints

The viewpoints are described in a systematic way, based on the work of Perroud & Inversini (2013) and Gamma et al. (1997). These authors describe various patterns, which are solutions to practical problems, in a systematic way and argue why certain sections are important. The created template contains five sections that need to be described for a viewpoint. The template contains the following:

3.4.1 Introduction

The viewpoint is described briefly and concisely in the introduction. This is accomplished by filling out a table and providing a brief description of its contents. This table contains answers to the following questions: What is the name of the point of view? What layer does the viewpoint belong to? What is the viewpoint's overarching goal? In addition, an overview of the concept and questions related to it are provided. Illustrating the concepts' questions and allowing users to create their own. The table below is used:

Dimension	Description
Name	What is the viewpoint called?
Layer	Which layer does the viewpoint belong?
Abstract	What is the general goal of the viewpoint?
Important concepts & Related questions	Name of the important concept(s) -Related questions to the concept.

3.4.2 Example

A short example, not more than 150 words, that shows a clear situation with the motivation of the viewpoint and the solution to the situation is given. The solution is explained in further detail in the solution section.

3.4.3 Problem

The problem section captures the problem that should be solved by the viewpoint. This differs from the example by providing more insight into the problem, providing more detail, and emphasizing the forces that must be taken into account.

3.4.4 Solution

The solution presents the concepts that create the viewpoint by providing a definition and explanation. In the explanation, the concepts are represented by *italicized text* and cover the meaning and justification of concepts. Justification is given by stating the sources on which the concepts are based or inspired. The concepts presented can hold the text "1..n" in the ArchiMate diagram, indicating that there should be at least 1 item of this concept present, but it can be more. A larger version of the ArchiMate diagram is included in Appendix III.

Definition: this layout is used to provide a definition of a concept.

3.4.5 Resulting context

The resulting context shows how the viewpoints relate to other viewpoints and shows the input a viewpoint receives and the output a viewpoint provides. The resulting context is visualized with a picture that can be found in Figure 5. In this figure, there are three layers, where the viewpoint that is being described is always shown in green. Arrows that point towards the green box are input arrows. In the figure, they can be found between layer 1 and layer 2. Therefore, the viewpoint in layer 2 receives input from the viewpoint in layer 1. The output is represented by outgoing arrows that point from the main viewpoint to another viewpoint. In Figure 5, this happens between layers 2 and 3. Therefore, the main viewpoint provides output to the viewpoint in layer 3.

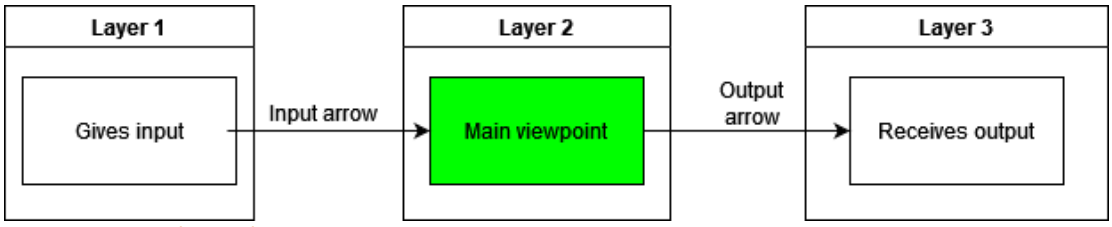


Figure 5 Example resulting context

3.4.6 ArchiMate models

The ArchiMate models have a notation to indicate relationships. The different relationships and their meanings are presented in Figure 6. For the exact meaning of a concept in ArchiMate see the ArchiMate documentation. (The Open Group, 2019a)

Structural Relationships		Notation	Role Names
Composition	Represents that an element consists of one or more other concepts.		← composed of → composed in
Aggregation	Represents that an element combines one or more other concepts.		← aggregates → aggregated in
Assignment	Represents the allocation of responsibility, performance of behavior, storage, or execution.		← assigned to → has assigned
Realization	Represents that an entity plays a critical role in the creation, achievement, sustenance, or operation of a more abstract entity.		← realizes → realized by
Dynamic Relationships		**Notation**	**Role Names**
Triggering	Represents a temporal or causal relationship between elements.		← triggers → triggered by
Flow	Represents transfer from one element to another.		← flows to → flows from

Dependency Relationships		Notation	Role Names
Serving	Represents that an element provides its functionality to another element.		← serves → served by
Access	Represents the ability of behavior and active structure elements to observe or act upon passive structure elements.		← accesses → accessed by
Influence	Represents that an element affects the implementation or achievement of some motivation element.	+/-	← influences → influenced by
Association	Represents an unspecified relationship, or one that is not represented by another ArchiMate relationship.		associated with ← associated to → associated from
Other Relationships		**Notation**	**Role Names**
Specialization	Represents that an element is a particular kind of another element.		← specializes → specialized by

Figure 6 ArchiMate relationship notation (The Open Group, 2019b)

3.5 Conclusion

The second sub-research question is answered. The general requirements are captured in two digital platform categories: stakeholders and structure. The stakeholder category captures the requirements for the outer edge stakeholders, like the ability to retrieve relevant information on policies, the participants, like being able to access the services or pay/receive money from services, and the core stakeholders, like being able to monitor the digital platform. The structure category captures the requirements for function of the digital platform, like being able to store data, and quality, like the data stored must only be shown to the customer it is intended for. These kinds of requirements are expected on every digital platform that exchanges services since every digital platform has stakeholders that have requirements, and every digital platform has functional and non-functional requirements. In addition, the requirements for the reference model have been identified, which includes concept requirements like the ability to explain each concept with an example and presentation requirements like having a clear visualization.

The third sub-research question is answered by the digital platform layer model. The reference model should contain four layers: motivation, business, application, and data. The motivation layer is a cross-cutting layer as it influences the other layers and contains the motivational elements like the purpose of the digital platform or participants of the digital platform. The business layer captures the business elements containing the business processes of the digital platform describing the functionality. The application layer contains the application elements, like IT systems and accessibility. The data layer captures the data objects within the digital platform.

These layers will be structured with the help of the ArchiMate language and the basic viewpoints provided in the ArchiMate documentation.

4 Motivation & Business Layer

The motivation layer holds two viewpoints, namely the Goal viewpoint and the Actor Participate viewpoint. The business layer contains one viewpoint called the Business Process viewpoint.

4.1 Goal viewpoint

4.1.1 Introduction

Dimension	Description
Name	Goal viewpoint
Layer	Motivation
Abstract	The goal viewpoint captures the reason one has to start a digital platform and the future plans/achievements for the digital platform.
Important concepts & Related questions	Reasons to create a digital platform -What change does the digital platform bring? -What value does the digital platform bring? -What is the price of participation for each stakeholder? Intended achievements of the digital platform -Where does the digital platform stand in two years? -What problem does the digital platform try to solve? -What is the unique competitive advantage of the digital platform in the future?

The goal viewpoint captures the reason to create a digital platform. It contains two main concepts: *reasons to create a digital platform* and *intended achievements of the digital platform.*

4.1.2 Example

Craft4you is creating a digital platform to offer artisans a place to sell their crafted artifacts and for consumers to buy these handmade artifacts. The digital platform Craft4you is creating has a purpose, a reason to exist, and objectives to achieve in the future. Craft4you knows that the goals and objectives define the strategic plans. Craft4you needs to capture these goals and objectives but lacks an explanation of which questions to answer to describe them. As a result, it must be possible to present questions and visualize the various goals and objectives for the Craft4you digital platform.

4.1.3 Problem

The first issue in designing a digital platform is determining the main purpose, the core interaction, and the related mission and vision (Gawer & Cusumano, 2008), which are required for enterprise architecture with the addition of a vision statement (Lankhorst, 2009).These related missions and goals influence the business actions and operations needed to achieve the goals and influence the business strategy an digital platform enterprise executes (Lankhorst, 2009). The goals and missions are existential questions that ensure the digital platform contributes to a problem or creates a change. Hence, the process of capturing these stands as the

first step in the creation process of a digital platform and influences the design of the digital platform to achieve the future objectives of a digital platform.

4.1.4 Solution

The Goal viewpoint, inspired by the mission and vision statement of a company, starts with the *creator of a digital platform* that is associated with motives to create and the intended direction of the digital platform.

Creator of a digital platform: an individual, team, or organization (or classes thereof) that is responsible for the start-up or/and creation of the digital platform.

These motives are captured in the *reasons to create a digital platform*, which captures at least one *reason* why the creator of a digital platform wants to create the digital platform and should reflect on the mission statement, which defines what an organization is, why it exists, its reason for being (Entrepreneur Media Inc., 2017) or the fundamental reason the organization exists (Gibson et al., 1990), and covers the core interaction problem element defined by Tura et al. (2018) . As a result, this concept raises questions such as what its primary purpose is, what value the digital platform brings, and what change the digital platform brings.

Reasons to create a digital platform: an external or internal condition that motivates the creator of a digital platform to define its goals to create a digital platform.

Reason: an external or internal condition

The *reasons to create a digital platform* have a positive influence on the intended direction of the digital platform, which is captured in the *intended achievements of the digital platform.* This reflects on the vision statement, which provides a direction or a course toward the future (Lucas, 1998). Although a vision statement describes how the digital platform should behave and what kinds of decisions to make without explicitly doing so, a vision statement is not about a strategy or plan or the past (Lucas, 1998). Even if it results in an inspirational statement or an idealistic future, it can still serve as an intended direction or a desired end state. In addition, the *intended achievements of the digital platform* cover the platform growth as defined by Tura et al. (2018), which questions how the digital platform grows and scales. These are seen as future plans or achievements of the digital platform.

Intended achievements of the digital platform: a direction or desired end state to achieve for the digital platform in a future state.

The *intended achievement of the digital platform* contains at least one *achievement.*

Achievement: a direction or desired end state.

The concepts of this viewpoint are illustrated in Figure 7.

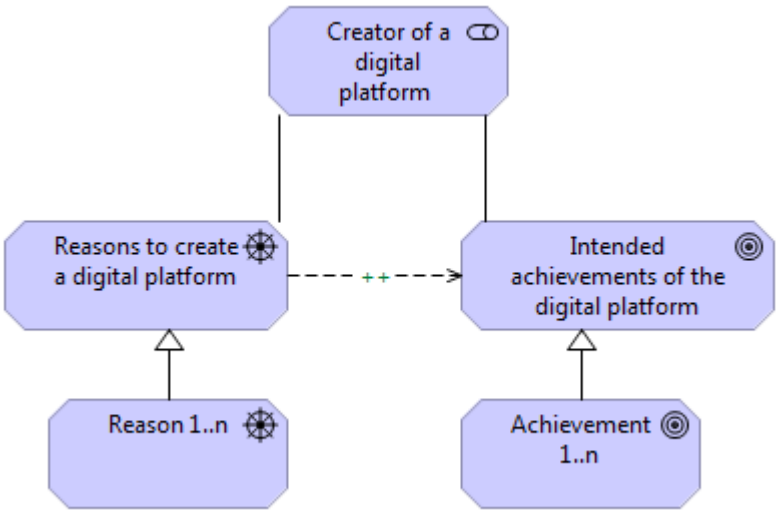


Figure 7 Goal viewpoint

4.1.5 Resulting context

The Goal viewpoint is used as input for the Actor Participate viewpoint illustrated in Figure 8. The Actor Participate viewpoint captures all actors and their reasons to participate. The goal viewpoint is considered to be the reason for the digital platform owner, a role from the digital platform eco-system core layer, to participate.

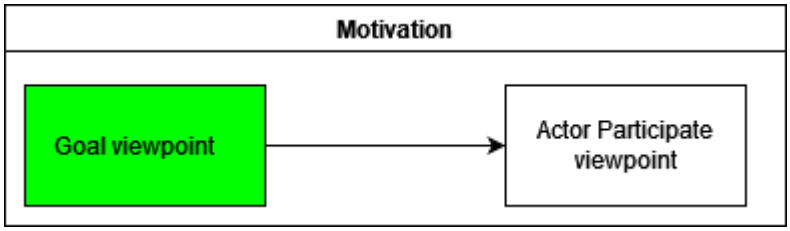


Figure 8 Resulting context goal viewpoint

4.2 Actor Participate viewpoint

4.2.1 Introduction

Dimension	Description
Name	Actor Participate viewpoint
Layer	Motivation
Abstract	The Actor Participate viewpoint captures the different stakeholders and their roles in the digital platform eco-system. For each stakeholder, the incentive to participate is captured.
Important concepts & Related questions	Stakeholder -Who are the main stakeholders that participate in the digital platform? Intended roles in the eco-system

	-What role/which roles does this stakeholder have? The intended reason(s) for participation -Why would a stakeholder participate in the digital platform network? Expected value gained by participating -What is the value this stakeholder gains by participating in the digital platform network? Ways to realize participating reason -Which functionalities does the digital platform need to have in order to realize the intended reason for participating? Requirement(s) - What are the requirements to participate? Limitation(s) -What are the limitations created by realizing the intended reason? (If there are any)

The Actor Participate viewpoint captures the motivation behind stakeholders and why they would participate in the digital platform. The viewpoint is made up of seven concepts: *stakeholder, intended role in the eco-system, the intended reason(s) for participation, expected value from participating, ways to realize the participating reason, requirements,* and *limitations.*

4.2.2 Example

Craft4you wants to identify the potential stakeholders of the digital platform, which can be possible users. In addition, Craft4you is interested in the motives of these stakeholders about using the digital platform, which allows Craft4you to define a strategy to convince and attract these stakeholders.

4.2.3 Problem

The identification of the potential stakeholders is a crucial step in the creation process of a digital platform. The different stakeholders participate in a digital eco-system and fulfill a role. These roles should be identified early in the platform creation process (Tura et al., 2018). A digital platform can only achieve the exchange of value when two or more participating sides are present. However, if one side does not get an expected value out of the value exchange, it will not participate in the exchange (Drewel et al., 2020). Therefore, the assessment of potential stakeholders needs to identify the reasons why a stakeholder participates and the value the stakeholder expects to gain in a value exchange.

4.2.4 Solution

The actor participant viewpoint, inspired by the Business Model Canvas (Osterwalder & Pigneur, 2014), captures why a *stakeholder* (key partners in BMC) would take part in the digital platform eco-system, which role this stakeholder would play, which value the stakeholder would get, and requirements that the digital platform need to realize in order to attract this stakeholder.

Stakeholder: an individual, team or organization (or classes thereof) that represents their interest in the digital platform.

A *stakeholder* has at least one *intended role in the eco-system* (Tura et al., 2018), which corresponds with the roles defined in the digital eco-system (see Figure 2). These are static roles that every digital platform eco-system has. In addition, to provide a dynamic context-based role, one can add a role to the role of *context-specific roles*. The *stakeholder* concept is based on the key actor's concept from Tura et al. (2018) and combined with the *intended role in the eco-system*, which is based on the actor roles from Tura et al. (2018); the BMC key partners are defined.

Intended role in the eco-system: the responsibility for performing specific behavior bound to the roles within the digital platform eco-system, to which a stakeholder can be assigned, or the part a stakeholder plays in a particular action or event within the eco-system of a digital platform.

A *stakeholder* is associated with an *intended reason(s) for participation*, which describes the motivation a *stakeholder* has to participate in the digital platform eco-system.

The intended reason for participation: a high-level statement of intent, direction or desired end state the digital platform has or needs to have to motivate a stakeholder to fulfill a role.

These *intended reasons for participation* are associated with a value that the *stakeholder* gains, which is captured by the *expected value gained by participating*. This has to be at least one value, indicating that a *stakeholder* will only participate when it gains value. The *expected value gained by participating* is based on the BMC value proposition, and the *stakeholder* and *the intended reason for participation* are also based on the ArchiMate stakeholder viewpoint.

Expected value gained by participating: the expected relative worth, utility or resource gained by fulfilling a role within the digital platform.

The *intended reasons for participation* need to be realized in order to attract the *stakeholders* to the digital platform; hence it has an association with *ways to realize the participating reason(s)*, which contains possible solutions to realize the *intended reasons for participation*.

Ways to realize participating reason: possible solutions that need to be achieved to motivate stakeholders to fulfill a role within the digital platform.

Only when the *intended reasons for participation* are realized and the *stakeholder* gets the *expected value gained by participating*, a stakeholder might join the digital platform. Thus realizing possible solutions is an important step, which introduces the *requirements and limitations* of a solution. There is at least one *requirement* in terms of business functionality that is needed to realize a possible solution, and there might be a *limitation* in realizing a possible solution. These are based on the ArchiMate Goal Realization viewpoint, since *ways to realize*

participating reason hold solutions that need to be realized, thereby they become possible goals to realize. The *intended reason for participation* is with *ways to realize participating reason* based on the BMC key activities, which describes the activities you perform every day to create and deliver the value. The *intended reason for participating* captures these activities and *ways to realize participating reason* create options to deliver these activities.
The *requirements* and *limitations* represent the BMC key resources, as these are needed to create and deliver the value proposition through the concept of *ways to realize participating reason.*

Requirement(s): a statement of need that must be met to realize possible solutions.

Limitations: a factor that prevents or obstructs, a part of, the realization of a possible solution.

These concepts are illustrated in Figure 9.

4.2.5 Resulting context

The Actor Participate viewpoint receives input from the Goal viewpoint. This input is used to model the platform owner role and the intended reasons to create the digital platform match with the reasons to create the digital platform from the Goal viewpoint. The Actor Participate viewpoint provides input, requirements, to the Business Process viewpoint. The resulting context is illustrated in Figure 10.

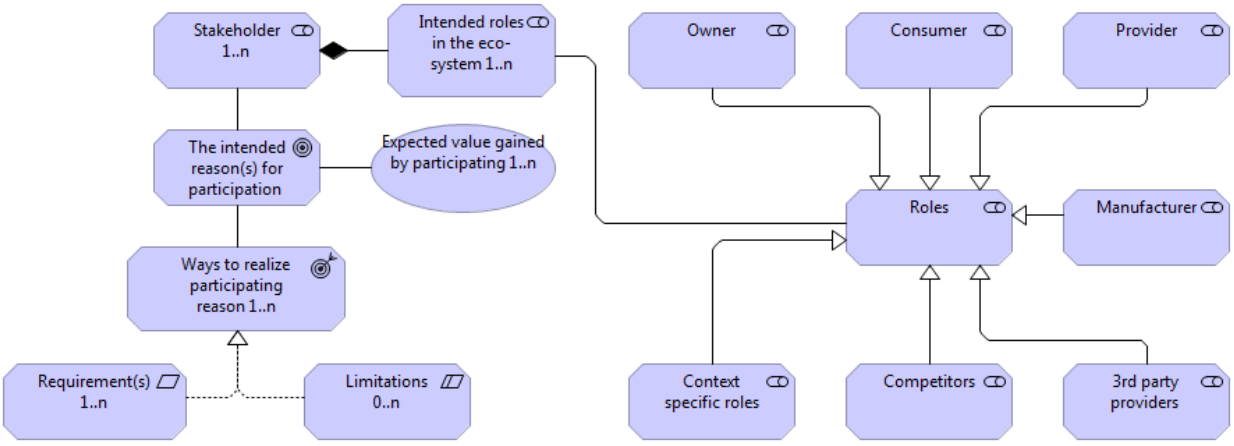


Figure 9 Actor Participate viewpoint

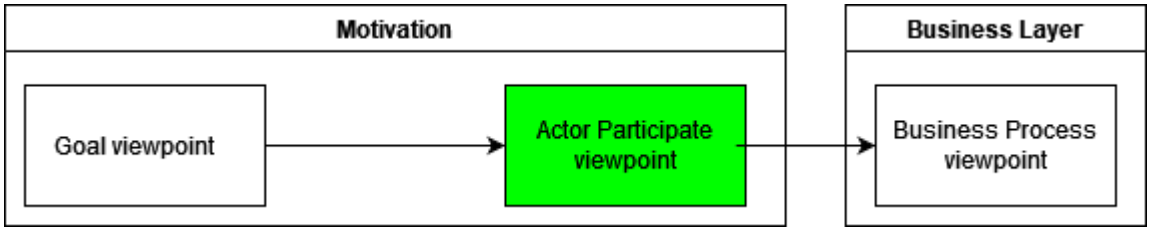


Figure 10 Resulting context Actor Participate Viewpoint

4.3 Business Process viewpoint

4.3.1 Introduction

Dimension	Description
Name	Business Process viewpoint
Layer	Business layer
Abstract	The Business Process viewpoint captures the various business processes that realize various business aspects, such as customer management, order management, or context-specific processes.
Important concepts & Related questions	Condition management -How are the services/content regulated? Data management - How does the digital platform manage data? Item/service offering -What are the items or services offered to consumers? Order management -How does the digital platform process the order? Which steps are there? Payment Who is responsible for the payment transactions? Is it a digital platform or a 3rd-party payment provider? Customer management -How can stakeholders get support or complain? Contextualized business process -Which of the requirements identified in the Actor Participate viewpoint needs a business process to be realized?

The Business Process viewpoint captures the business processes that operationalize the digital platform. This viewpoint holds nine concepts: *Condition management, Data management, Item/service offering, Order management, Payment, Customer management, Contextualized business process, Requirements,* and *Stakeholder*.

4.3.2 Example

Craft4you wants to capture the behavior of the digital platform, however, a digital platform covers many domains, which results in an extensive collection of behavior. This complexity requires knowledge to identify these domains and apply their behavior on a digital platform. As a result of a knowledge lack, Craft4you is not able to identify all behavior of their digital

platform. Therefore, Craft 4you needs a starting point to understand which domains exist and which behavior a digital platform performs within these domains.

4.3.3 Problem

The main behavior of a digital platform is to establish a value exchange between two or more participants (Drewel et al., 2020), however, other behavior needs to be captured as well in the design of a digital platform. The behavior of a digital platform expresses the functionality of a digital platform, therefore, the behavior is captured in business processes. The different domains require different business processes, which are realized by IT components in an IT structure. The identification of these processes can be troublesome as it requires knowledge about the domain, for example, the customer management domain or knowledge about the supply chain, etc. In addition, the general identified requirements to attract stakeholders to the digital platform influence the creation process. These digital platform stakeholder requirements hold different levels of stakeholders, which require processes, like getting clear information about the digital platform, the option to view statistics, receive money, etc. This expected behavior needs to be captured by business processes.

4.3.4 Solution

The digital platform is assigned to two types of processes: *general digital platform business processes* and *contextualized business processes.* These business processes capture what kind of behavior the digital platform can perform.

A digital platform's stakeholders may have requirements that must be met to attract the *stakeholder* to the digital platform. These requirements are captured by the *requirement* concept. The business processes created by the requirements are captured by the *contextualized business process* concept, which allows the viewpoint to be flexible and adjust to contextualized situations. The *contextualized business process* can be an extension of a *general digital platform business process*. For example, when a stakeholder needs insight into data, the digital platform might provide a service that specifically analyzes this type of data. This belongs to the *item or service offering* concept but is also a *contextualized business process* to meet the stakeholder's requirement, thus attracting stakeholders to the digital platform which realizes the acquisition of participations design field (Drewel et al., 2020).

General digital platform business processes: a sequence of common business behaviors within a digital platform that achieves a specific outcome.

Contextualized business processes: all business behavior that is needed to realize a requirement or business behavior that is specially bound to context.

There are six *general digital platform business processes* identified:

1. The *condition management processes* describe the management of the legal conditions like privacy statements, general terms of the digital platform, and working conditions. This includes processes to update legal documents, managing services or items that are offered, and managing role privileges within the digital platform. The creation of

governance includes consideration of the rules and which party is to enforce these rules on the digital platform (Tura et al., 2018). Consequently, allowing one to get information about the digital platform on certain topics, like the implementation of the GDPR, illustrates that different stakeholders can enforce the rules. As a result, this satisfies a requirement that users should be able to retrieve information. This concept is based on the governance concept (Tura et al., 2018) and inspired by the vending machine pattern (Perroud & Inversini, 2013).

Condition management processes: all business behavior that has the function to capturing the obligations and responsibilities of the digital platform on a legal level.

2. The *data management processes* encompass the administration and utilization of data on a digital platform. Data plays an important role within a digital platform and is used, for example, to learn about customer behavior, predict certain events, or, ultimately, become a data-driven company. In addition, the visualization of data is captured, which realizes an identified requirement. This concept is based on the platform openness and innovation & learning concept (Tura et al., 2018), and realizes the transactional anatomy design field (Drewel et al., 2020), which captures the way information is exchanged on the digital platform.

Data management processes: all business behavior that has the function to capture, analyze, or visualize data within the digital platform.

3. The *item or service offering processes* capture all the items or services that the digital platform offers to its stakeholders and realize the value unit design field (Drewel et al., 2020). These describe the value exchange of the digital platform and include processes that contribute directly, like browsing through a catalog, creating an order, etc. It does not include indirect processes, like login in, accessing a purchase history to reorder an item, etc.

Item/service offering processes: all business behavior that has the function to directly contribute to the realization of the value exchange within the digital platform, and does not belong to other general digital platform processes.

4. The *order management* processes capture the processes needed to process an order. These processes can include passing an order to the providers, validating the order, delivering the order (physical or digital), and creating order overviews, amongst others. It focuses on the supply chain and the processes that are needed to manage the order within the digital platform. This concept is based on the supplier-to-consumer pattern (Perroud & Inversini, 2013), which describes the order management process and the supply chain with the example of a traditional reseller of wine to cover all aspects one needs to understand when reselling items.

Order management processes: all business behavior that has the function of receiving, tracking, and fulfilling customer orders within the digital platform.

Order: a (digitally) written intention on, at least, two roles that agreed on performing a value exchange.

5. The *payment processes* capture the processes that relate to the payment of the value exchange and realize the monetization design field (Drewel et al, 2020), which covers how the monetization of the digital platform is done. These can be the creation of invoices, for example, is there an invoice for each transaction, or is the billing done monthly, etc.? But also cover the execution of payment transactions, etc. If a third-party payment provider is involved, the processes captured are likely requirements to use the payment provider's services. The *payment process* concept realizes two identified requirements: that a user can receive money when a service is purchased and that a user can have the option to pay for a service. This concept is based on the value proposition and revenue model concept (Tura et al., 2018), which covers the price a stakeholder pays for participation, in which manner the stakeholder pays, and what the stakeholder receives. Although the value proposition belongs to *item/services offering processes* as well. In addition, the *payment, item/service offering, and order management processes* are inspired by the vending machine pattern (Perroud & Inversini, 2013).

Payment processes: all business behavior that is involved in the settlement of the value exchange within the digital platform.

6. The *customer management processes* capture the processes to manage customers on the digital platform. These involve the processes of handling complaints, acquiring feedback, aiding customers in the purchase of a service or item, updating information in an account, and even sending newsletters to customers, amongst others. In addition, realizes an identified requirement by letting stakeholders register an account, and is inspired by the know your customer pattern (Perroud & Inversini, 2013).

Customer management processes: all business behavior that is involved by managing customers within the digital platform.

The Business Process viewpoint is inspired by the UML activity diagram, which allows modeling of the activity or the flow of entities, and BPMN. Within ArchiMate, there are two basic viewpoints: the Business Process Cooperation Viewpoint and the Product Viewpoint. The ArchiMate documentation describes the product viewpoint as: "The product viewpoint depicts the value that these products offer to the customer or other external parties [...] It may then serve as input for business process architects and others that need to design the processes and ICT to realize these products. " and the Business Process Cooperation as "The business process cooperation viewpoint is used to show the relationships of one or more business processes with each other and/or with their environment. It can be used both to create a high-level design of business processes within their context [...] "(The Open Group, 2019a).

The concepts of the business process viewpoint are illustrated in Figure 11.

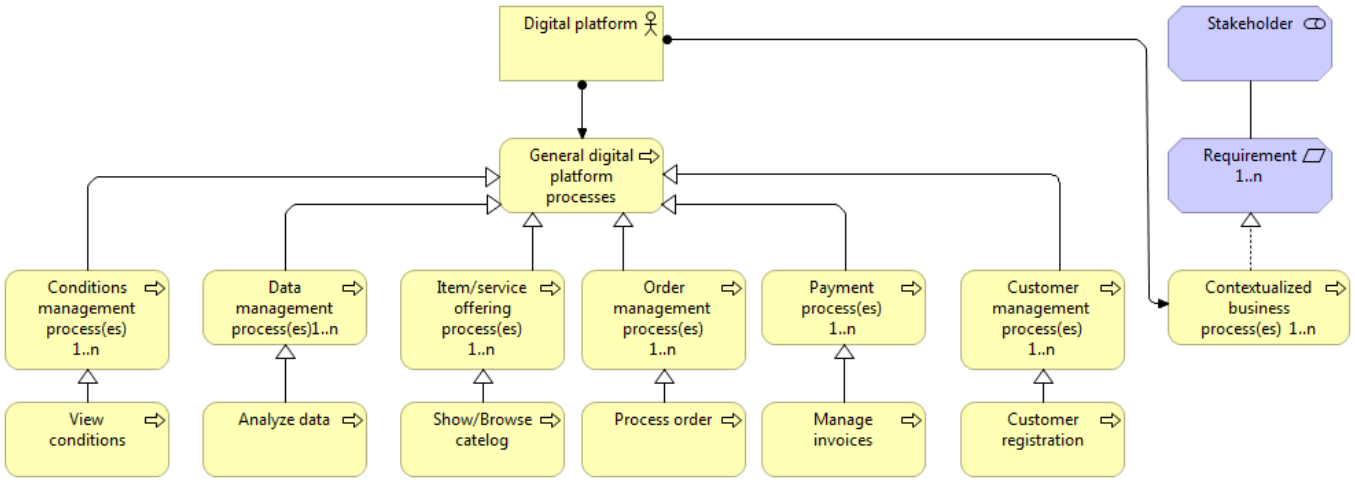


Figure 11 Business Process viewpoint

4.3.5 Resulting context

The Business Process viewpoint receives input from the Actor Participate viewpoint, which describes the requirements that stakeholders might have in order to participate in the digital platform. The Business Process viewpoint gives input to the Application Structure viewpoint by stating which business processes need to be realized by systems and input to the Application Usage viewpoint by providing the business processes. The visualization can be found in Figure 12.

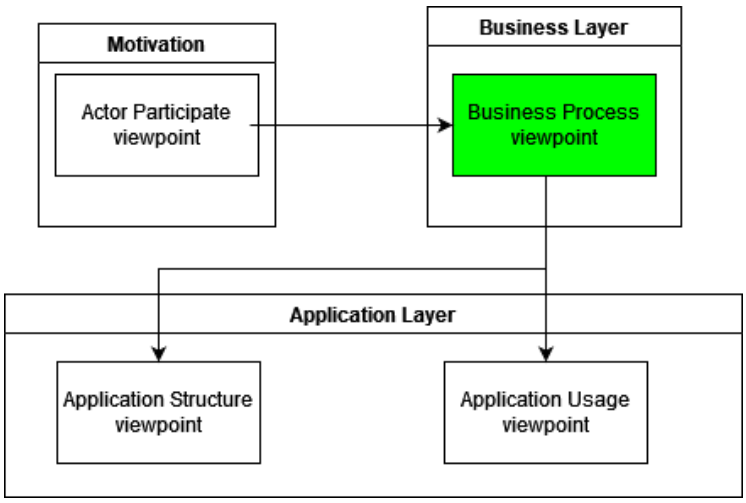


Figure 12 Resulting context Business Process viewpoint

5 Application and Data layer

The application layer contains three viewpoints that realize the application landscape of the digital platform. The main goal of the application landscape is to facilitate the business processes of the digital platform. The three viewpoints are: Application Structure, Application Usage, Application Communication. The data layer contains one viewpoint, the data viewpoint, that captures the data structure within the digital platform.

5.1 Application Structure viewpoint

5.1.1 Introduction

Dimension	Description
Name	Application Structure viewpoint
Layer	Application Layer
Abstract	The Application Structure viewpoint captures the different systems and their services and functions that are required to realize the business processes of the digital platform.
Important concepts & Related questions	Answers should build upon the Business Process viewpoint. Item/Service offering -How does the system present the item/services? Conditions -How are the conditions stored in the system? Customer management -How are the support requests managed? Order management -Which steps does this process contain and what needs to be registered in the system? Data management -How can a stakeholder start an analysis? -Which stakeholder can start an analysis? Administration - Which steps can a stakeholder take when managing invoices? -Which steps does the system go through when executing a payment? Contextualized system - How do these functions or services work? What data is created? What system functionality is needed?

The Application Structure viewpoint captures all the IT systems and their services and functions that are needed to realize the business processes. The four concepts are: *contextualized system, service/function, the purpose of the service or function,* and *data objects.*

5.1.2 Example

Craft4you wants to start creating the IT part of their digital platform. With the support of the business process viewpoint, Craft4you managed to identify its behavior captured in business processes. However, Craft4you has no knowledge of IT, hence, they do not know which elements are important to consider and how IT can help them realize the identified business processes. Therefore, Craft4you needs support in the IT creation processes.

5.1.3 Problem

The behavior of a digital platform captured in business processes needs the support of Information Technology (IT), which requires the identification and assessment of the infrastructure containing the systems, services, functions, and data. The problem arises in creating these elements and relating them to each other without creating redundant systems.

5.1.4 Solution

The systems within the digital platform are captured within a *contextualized system* and serve as a focal point that has relations with other concepts.

Contextualized system: an encapsulation of application functionality aligned to support or realizes a specific set of business processes within the digital platform. It encapsulates its behavior and data, exposes functions or services, and makes them available through interfaces.

A *contextualized system* can use the functionality provided by *services or functions*. A service is external behavior and can be used by other *contextualized* systems or by business processes, while functions are internal behavior that is used for internal processing or is a part of a service. ArchiMate has two different concepts to represent services and functions, they are combined into one to make this viewpoint easier to understand.

Service or Function: behavior that the contextualized system can perform to realize business processes. Services are external behavior and functions are internal behavior.

These are captured by *the purpose of the service or function* to clarify the behavior the *service or function* performs when implemented. This is a high-level description that leaves technical implementation details out, for example, "Retrieve string from the database with query Select X from Y where Z" becomes "Retrieve information from the database", which allows non-technical people to use the viewpoint.

The purpose of the service or function: a short textual implementational description on a high level of the service or function, which describes the purpose or behavior performed when the service or function is implemented.

The *contextualized system* accesses, creates, and manipulates data, which is captured at a high-level in a *data object*. All objects identified must also be presented in the data viewpoint (see Section 5.4), and this viewpoint can be used to describe *data objects* in more detail.

Data object: a high-level object that contains information about a topic structured for automated processing within the digital platform.

These concepts are applied to the general digital platform business processes, as a result, there are six predefined *contextualized systems* with example *services or functions* and *a data object*. There is no *purpose of the service or function* as it is up to interpretation on how the *service or function* concept should be implemented. The example *services or functions* and the d*ata object concepts* are based on Perroud & Inversini (2013) and their description of the following patterns: vending machine, supplier to consumer, and know your customer. The various questions are a result of using these patterns, the implementation of these patterns, and the digital platform development framework by Tura et al. (2018). By answering these questions, a digital platform creator has to think about how a system looks, how it behaves, which steps the system has, and what the system's flow has. Therefore, these questions establish the IT structure by defining the various systems, their functions and services, the flow of the system, and the data that is stored within this system. The Application Structure is also inspired by the ArchiMate Application Structure viewpoint (The Open Group, 2019a), the UML composition diagram (Object Management Group, 2017), and realizes the platform infrastructure design field (Drewel et al., 2020).

1. The *item or service offering* system is a type of *contextualized system* that supports the capture of the value exchange of the digital platform. An example of a *service or function is* the *service of browsing products* and *altering products*. The "browse products" feature allows the consumer to navigate through all of the products available and find what they are looking for. The *altered products* allow providers and the digital platform maintenance operators to change products. The *data objects* that are created and used by the *item/service offering* system are the products. These are the value exchange products the digital platform facilitates.

2. The *order management* system is a type of *contextualized system* that supports all the IT-related ordering processes. There are four examples of *service or function* concepts: *viewing orders, altering orders, placing orders, and processing orders*. The idea behind these concepts is to answer questions like, but not limited to, the following: How does a consumer view an order? Can a consumer change an order once placed? If so, for how much time? How does the digital platform process the order? Which steps does this process contain and what needs to be registered in the system? The *data object* captured by this system is an *order*.

3. The *administration* system is a type of *contextualized system* that supports the administrative part of a digital platform. The *service or functions* can be to manage invoices by *adding invoices* and *altering invoices* and to *create* and *manage payments*. The question a digital platform provider has to ask is whether it is capable of performing

processing payment tasks or whether a third-party payment provider takes care of these tasks. In addition, a digital platform provider can use a third-party program to manage its administrative part. However, depending on the business market type (B2B, B2C, etc.) a consumer might want to download an invoice from the digital platform. As a result, functionalities within the administration system that handle this process must be in place. These are questions a digital platform provider needs to consider about the administrative processes and their in-house or outsourced capabilities. The *data object* that captures all these different information is called the *Administration data object*.

4. The *conditions* system is a type of *contextualized system* that supports the processes on a legal level, like the legal documents to capture responsibilities and information gathering processes. The example *service or functions* of this system are to *view conditions* and *alter conditions*. A digital platform has to consider where users can view these conditions that capture the obligations and responsibilities, and the way of implementation determines *the purpose of the service or function*. The same holds for *altering conditions.* For example, does a digital platform have an editor to alter the conditions, or is there a document on the digital platform that can be replaced? These are implementational decisions a digital platform provider has to make. The *data object* that captures the legal practices is called *conditions*.

5. The *customer management system* is a type of *contextualized system* that supports the various processes for managing customers. The example *services or functions* are: *alter customer, register customer, view profile, alter profile, support,* and *newsletters.* The flow of these processes is, like the other systems, dependent on the digital platform context. For example, a B2B (Business to Business) digital platform might have a closed option to register, while a B2C (Business to Consumer) digital platform is likely to have an open register option. The *support* service is done with an e-ticket system. This allows consumers to write an e-mail that will be converted into a ticket with a number and a status like "open," "pending," or "closed." The digital platform can monitor all tickets and, for example, get an overview of all open tickets and provide support for these tickets. The *support* service can either be used for complaints or provide feedback when a consumer needs help. The *data object* that captures all customer data is called *customer information.*

6. The *data management* system is a type of *contextualized system* that supports the various processes to capture, analyze, or visualize the data within the digital platform. The main purpose is to achieve the goals of the digital platform by using data as an advantage. In order to support this goal, the *data management* system must at least provide the *services or functions* to perform *data analysis* and *view statistics*. These are two basic functions a digital platform creator has to implement within their digital platform. The questions like what metrics are useful for the digital platform, which data can be used in order to gain an advantage, and how the data needs to be presented, help the digital platform creator identify which data to analyze and visualize. This does not have a particular data object as it concerns all data within the digital platform.

The viewpoint is illustrated, in two parts to ensure readability, in Figure 13 and 14.

5.1.5 Resulting context

The Application Structure viewpoint receives input from the Business Process viewpoint, which are the business processes that define the six systems. The application structure viewpoint provides output to the data viewpoint, in which the data objects are described in more detail, and to the application usage viewpoint, in which the usage of the systems is shown along with the corresponding business process and how the system is reached. The application structure viewpoint also gives output to the application communication viewpoint by providing services/functions that can communicate with other services/functions within the same system or another system. The visualization is given in Figure 15.

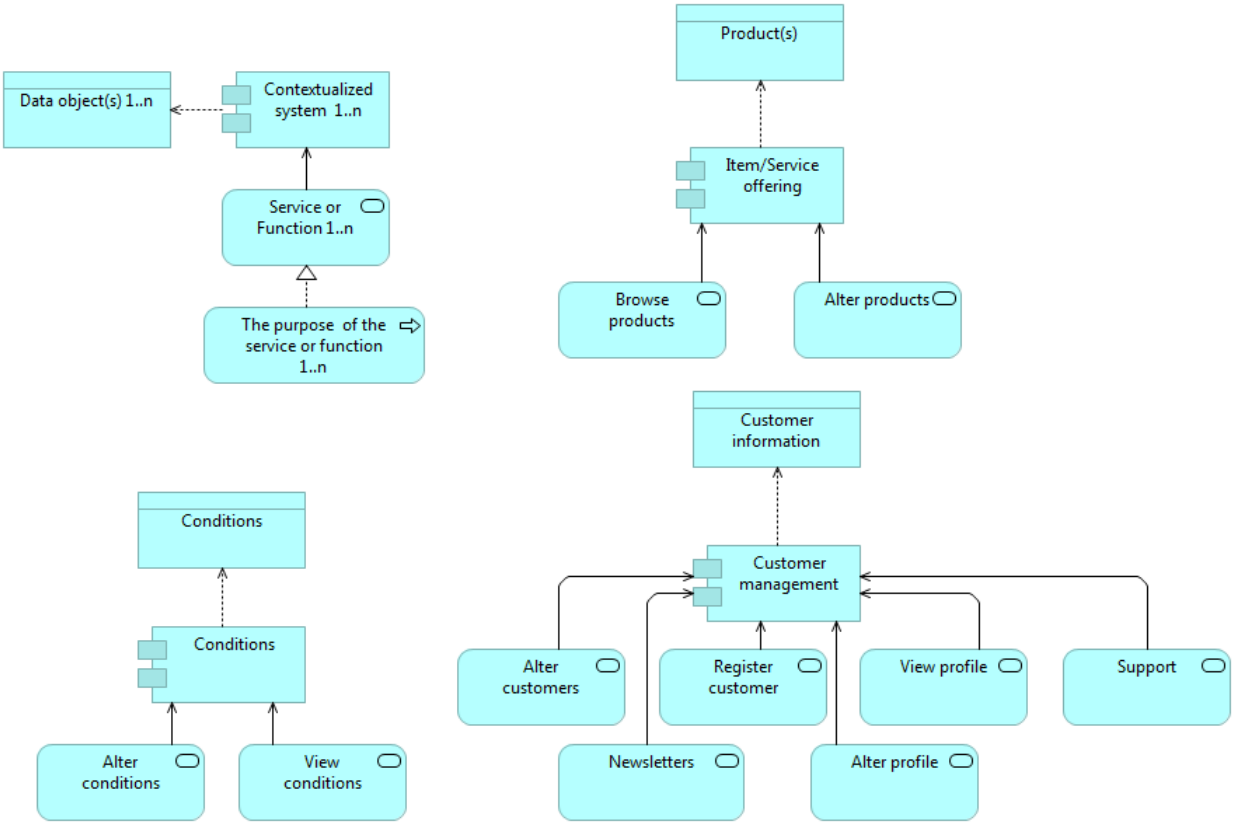


Figure 13 Application Structure viewpoint part 1

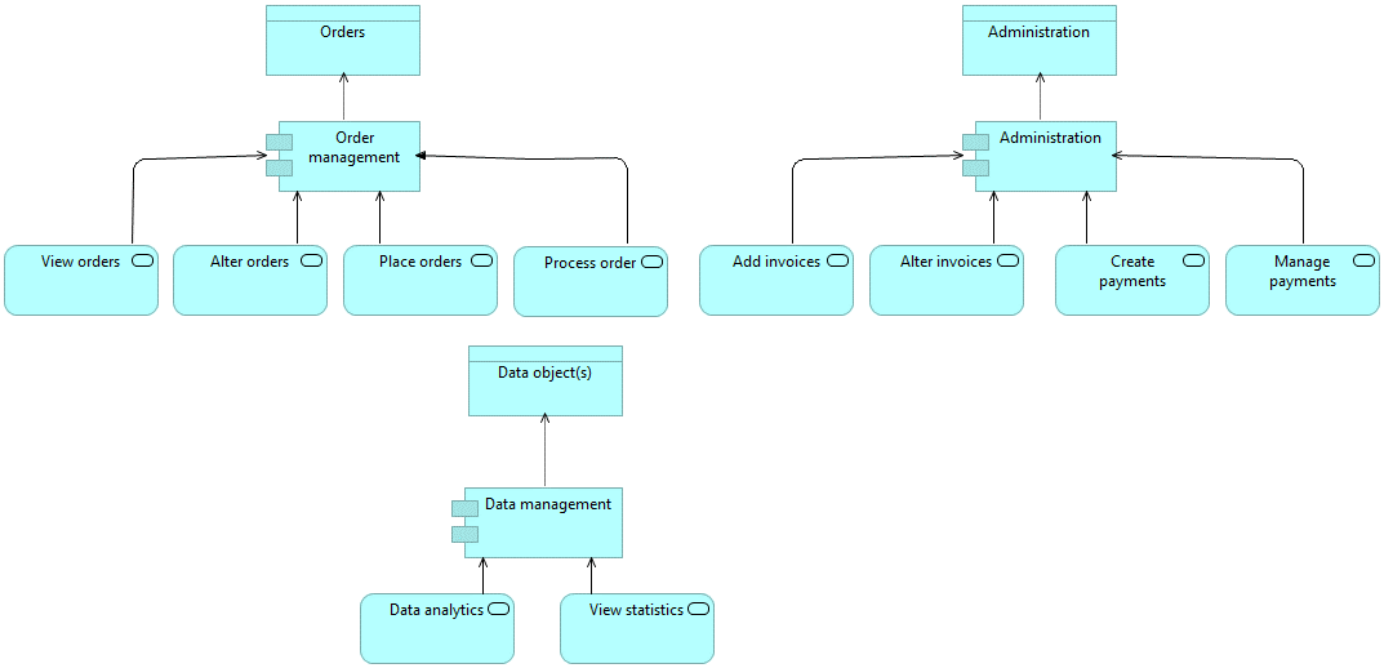


Figure 14 Application Structure viewpoint part 2

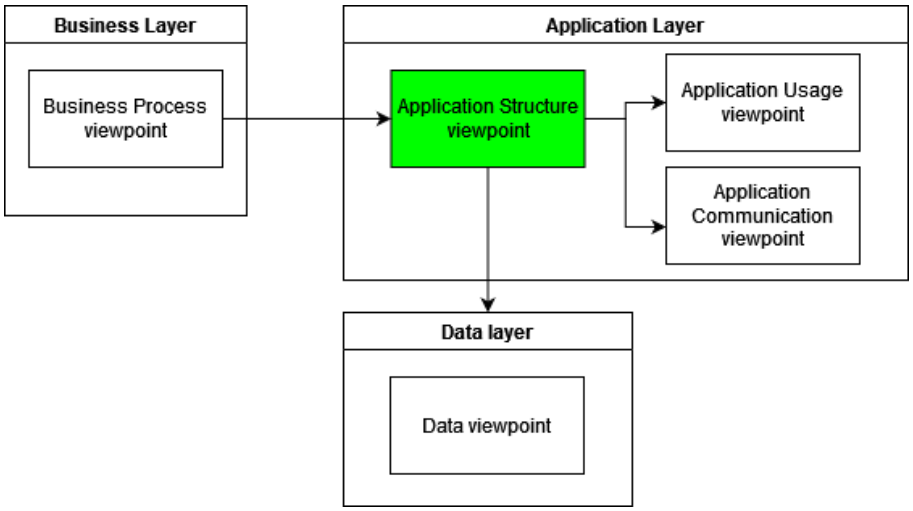


Figure 15 Resulting context Application Structure viewpoint

5.2 Application Usage viewpoint

5.2.1 Introduction

Dimension	Description
Name	Application Usage viewpoint
Layer	Application
Abstract	The Application Usage captures the realization

	of business processes by the identified IT systems and the accessibility of these IT systems.
Important concepts & Related questions	Business Process -Does each business process belong to a contextualized system? Contextualized system -Does each system realize a business process? Interface -How to ensure access to the platform? -How does the system provide its functionalities?

The Application Usage viewpoint captures the realization of business processes by IT systems and the interfaces that are required to access the systems and their functionalities or services. It provides business-IT alignment by visualizing connections between IT systems and their business processes. This ensures that each business process is connected to an IT system and that no duplicate systems exist. Business processes, contextualized system, and interfaces are the three concepts that make up this viewpoint.

5.2.2 Example

Craft4you identified their business processes and IT systems, although they are not sure if all business processes are covered by their IT systems. Besides, it is not clear how consumers will access the different systems and their functionalities. Therefore, Craft4you needs information on these topics.

5.2.3 Problem

The identification of business processes and the identification of IT systems can create the problem of redundancy, where there are IT systems that cover multiple business processes or IT systems that serve no purpose at all. The other way around can also occur, a business process that is not realized by any IT system at all. As a result, there is a misalignment between the business and IT. Another problem is the accessibility of IT systems. Currently, there is no interface defined to be accessed by customers of the digital platform or by other IT systems. The way accessibility is implemented influences the digital platform design. For example, the integration with a consumer system needs an API when the consumer is in the context of a B2B digital platform. The B2B customer might have their own ERP environment in which they have the functionality to reach the digital platform. In addition, the integration with third-parties also requires interfaces to be defined.

5.2.4 Solution

The *contextualized systems* have an *interface* to expose the behavior of services to other external entities and describe the accessibility of these services. This can be in a graphical manner, like a webpage with a login screen, an e-mail to provide support, etc. And in a non-graphical manner with an Application Programmable Interface (API) to facilitate the integration in ERP systems or other third-party supplier systems. This master project does not look into the creation of an

API, see Appendix II. The digital platform creator can ask questions like how a consumer or provider accesses the functionality if the functionality is presented on a webpage or is another tool needed, and how does the webpage look? For the latter, the digital platform creator can think about User Experience and User Design. The interface concept is inspired by the platform launch concept (Tura et al., 2018), which covers the accessibility of the digital platform.

Interface: a point of access where an application service is made available to a user, another application component, or a node.

The *contextualized systems* realize *business processes*, either *general digital platform business processes* or *contextualized business processes,* by providing the supporting IT structure, which allows visualizing the relation between *contextualized systems* and *business processes* to increase the alignment between business and IT. The *interface*s allow the digital platform creator to think about how the functionalities are accessible to users of the digital platform, realizing an identified requirement that users must be able to access the services and 3rd party integration must be possible.

The three concepts are applied to the *general digital platform business processes* with the *contextualized systems* that support these processes. The *payment* business process is realized by the *administration* system. The *item or service offering* business process is realized by the *item/service offering* system. The same holds for the other four business processes that were identified and mapped towards the four systems that correspond with their name. If a stakeholder has a *contextualized business process*, this can be mapped by using the three concepts, which allows the digital platform creator to model to the digital platform context.

This viewpoint is based on the ArchiMate Application Usage viewpoint and the concepts of this viewpoint are illustrated in Figure 16.

5.2.5 Resulting context

The Application Usage viewpoint receives input from the Business Process viewpoint and the Application Structure viewpoint. These are the business processes and the identified systems to realize them. This viewpoint does not provide output to other viewpoints. The visualization can be found in Figure 17.

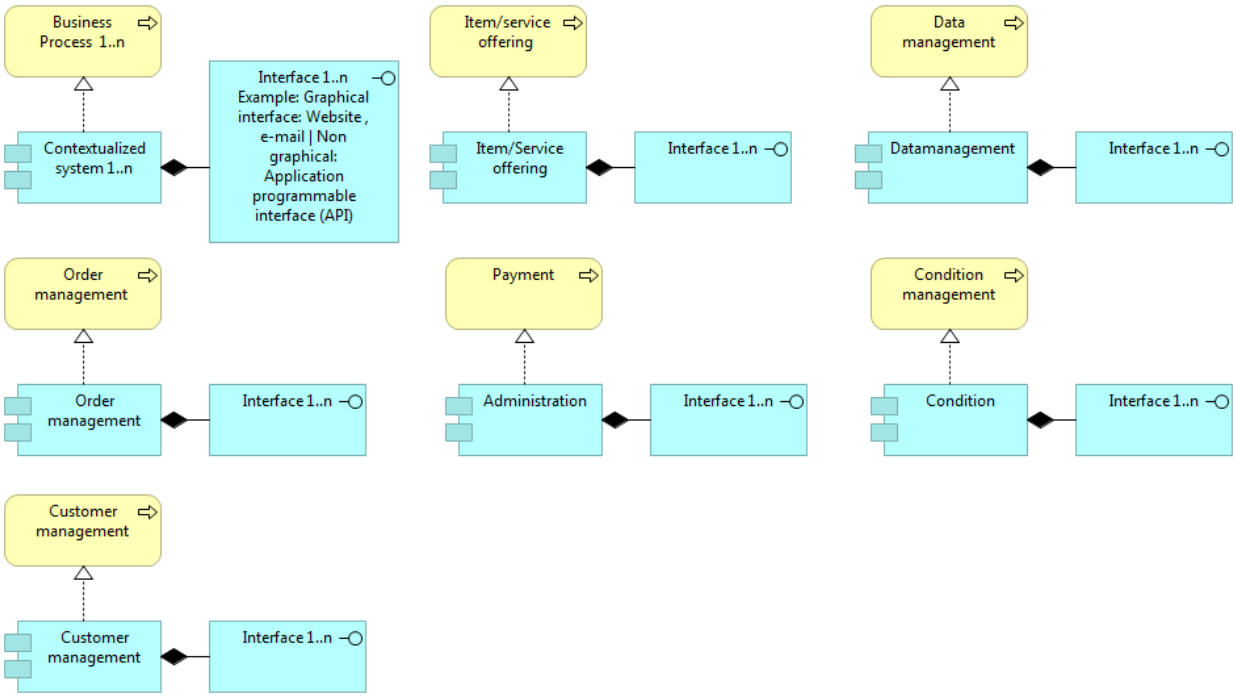


Figure 16 Application Usage viewpoint

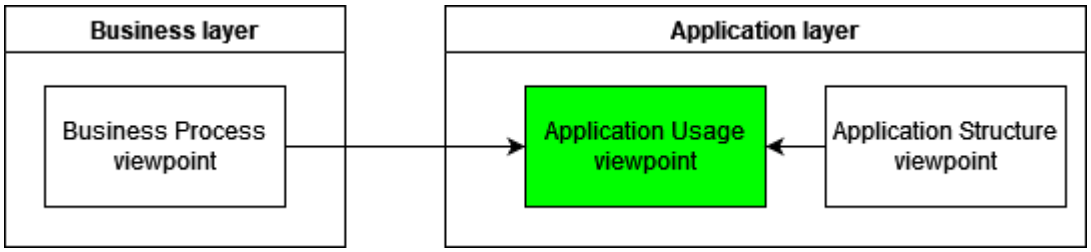


Figure 17 Resulting context Application Usage viewpoint

5.3 Application Communication viewpoint

5.3.1 Introduction

Dimension	Description
Name	Application Communication viewpoint
Layer	Application layer
Abstract	The Application Communication viewpoint captures the services and functions that communicate together; one goal can be to achieve better functionalities.
Important concepts & Related questions	Service initiating communication -Which service initiates the communication? Service responding

	-Which service responds? Interaction -What is the purpose/goal of the interaction? Data object -Which data is being exchanged?

The Application Communication viewpoint captures the communication between different systems and their services and functionalities. The concepts are the *service initiating communication,* the *interaction,* the *service responding,* and the *data object.*

5.3.2 Example

Craft4you's digital platform hosts a number of services that all use the same data. The distinction is that each service uses the data in a different way and produces a different result. This process is inefficient; therefore, it would be beneficial for Craft4you to improve its efficiency.

5.3.4 Problem

Services on a digital platform use data to perform certain actions, which can also be used by other services or functions of the digital platform. As a result, the digital platform's IT structure becomes a mess with a lot of services and functions that almost perform the same task. In addition, an IT system communicates with other IT systems and their functionalities. A digital platform is no exception. For example, when a third-party payment provider is a participant, this touches upon the identified requirement that the digital platform should be able to transfer data between different systems. This requires a digital platform to capture the communication flow between different services.

5.3.5 Solution

The communication between two *services or functions* is started by the *service initiating communication*. The *service responding* is the receiving party of the communication.

Service initiating communication: The service or function that initiates the communication.

Service responding: The service that receives the communication and responds to the communication.

The two services or functions have an *interaction* in which a *data object* is communicated. The *interaction* describes the purpose of the communication, and the *data object* describes the data that is being communicated.

Interaction: A unit of collective application behavior between two services or functions to exchange data objects.

There are no predefined interactions between the six identified *contextualized systems* because the implementation of the services can differ based on *the purpose of the service or function*. For example, one can think about a service that calculates the cost and a service that registers new

items. These need information about the product, so the service that calculates the cost can give input to the service that registers items. The *data object* will be a product, and the *interaction* can hold a description like receiving registered data. The user only needs to fill in their data once and the registration service also gains access to this data.

The Application Communication viewpoint is inspired by the ArchiMate Application Co-operation viewpoint and the UML sequence diagrams. The *service initiating communication* and the *service responding* can be seen as UML sequence diagram object symbols, and the *interaction* can be seen as a set of UML sequence diagram activation boxes with corresponding messages. These allow modeling the communication within a *contextualized system*. An illustration of the concepts is given in Figure 18.

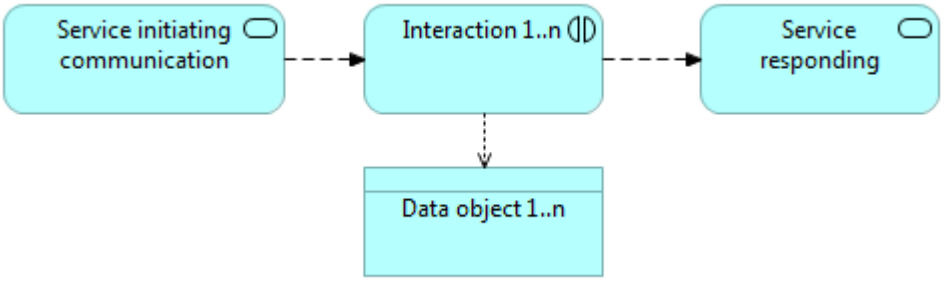


Figure 18 Application Communication viewpoint

Resulting context

The application communication viewpoint receives input from the application structure viewpoint. These are the services that carry out the communication. In addition, the application communication receives input from the data viewpoint, namely the data objects. Although the data is also presented in the Application Structure viewpoint, it is the Data viewpoint that provides it to other viewpoints. The Application Communication viewpoint does not give any output to other viewpoints and is illustrated in Figure 19.

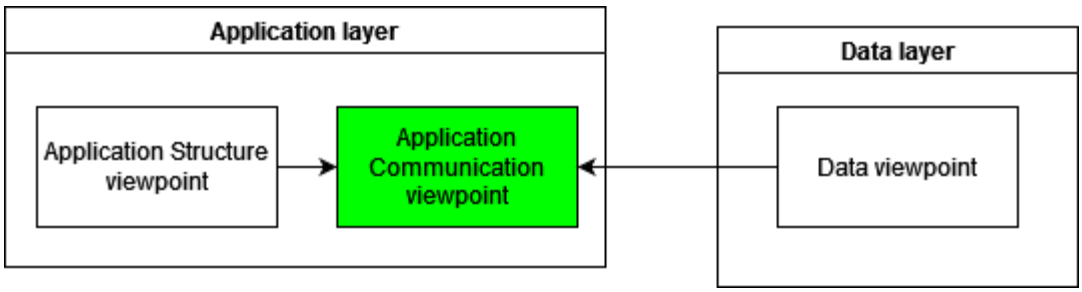


Figure 19 Resulting context Application Communication

5.4 Data viewpoint

5.4.1 Introduction

Dimension	Description
Name	Data viewpoint
Layer	Data layer
Abstract	The Data viewpoint captures all data objects within the digital platform. These are used in other viewpoints to clarify how the data is used.
Important concepts & Related questions	Data object -What are the different data objects created in the Application Structure viewpoint? -What do these data objects contain, and how are they related to other data objects? -What do these data objects contain? -How is the data within this viewpoint used to improve the digital platform?

The Data viewpoint captures all data objects within the digital platform. This viewpoint has at least one concept called *data object*, which can be composed of multiple data objects.

5.4.2 Example

Craft4you has identified business processes and IT systems to realize these processes. They know the data that flows within the digital platform. However, they have no overview of all the data in the system. Therefore, they only describe the data at a high level and lack a more detailed description of the data objects within the digital platform.

5.4.3 Problem

Data is all around us, and the Big Data movement uses data to create data-driven solutions (McAfee & Brynjolfsson, 2012). For example, the digital platform creator cannot manage what is not measured. As a result, data is required to assess performance and take action based on the results (McAfee & Brynjolfsson, 2012). In the case of a digital platform, the creator can measure the success in terms of statistics and metrics that show important information about the performance of the digital platform. In addition, data can create insights into consumer and provider patterns. As a result, the digital platform can adapt to become more successful. The first step is that a digital platform has an option to store the data to gather an insight into the data within the digital platform. This satisfies a requirement that has been identified.

5.4.4 Solution

The data within the digital platform is captured in at least one *database*, which contains *data objects*.

Database: An IT system with the function of collecting data objects to be arranged for the ease and speed of search and retrieval.

The *data* objects have the option to contain other *data objects*, thus creating a parent-child structure. These *data objects* can have two relationships: specialization or part-of. The former indicates that a child object is a special case of a parent object. For example, the parent object is digital platforms, and the specialization is a specific digital platform like a service offering digital platforms. The latter indicates that a child object belongs to the parent object. For example, your arms (a child object) are a part of your body (a parent object).

The *database* and *data objects* present an overview, structure, and define the *data objects* in more detail by using the relationships. For example, the *administration data object* is further specified, by specialization relationships, including *invoices* and *payments* data objects.

Concerning the six identified *contextualized systems* and their data objects, the *conditions data object* is further specified to hold different data or documents like *privacy statements, payment methods, shipping methods,* and *general terms.* The *customer information data object* is specified to hold a *customer data object*, which contains information about the customer, and a *newsletter* data object that holds all the newsletters and information associated with it. The support service and a ticket system *data objects* are not captured as this is implementation depended. For the implementation, the digital platform creator can question the usage of the data within the digital platform, improve processes in terms of efficiency with data, and determine the value of each *data object* to clarify the importance of *data objects* within the digital platform. The *database* contains all information and can decide the openness of the digital platform (Tura et al., 2018) by providing access to certain stakeholders to visit certain data.

This viewpoint is inspired by UML ERD diagrams, which model the database and data objects. This is often done in more detail than the data viewpoint allows, for example, by specifying the data types of different data objects. The Data viewpoint aims to capture the *data objects* at a high level to simplify the model. Figure 20 illustrates the concept(s).

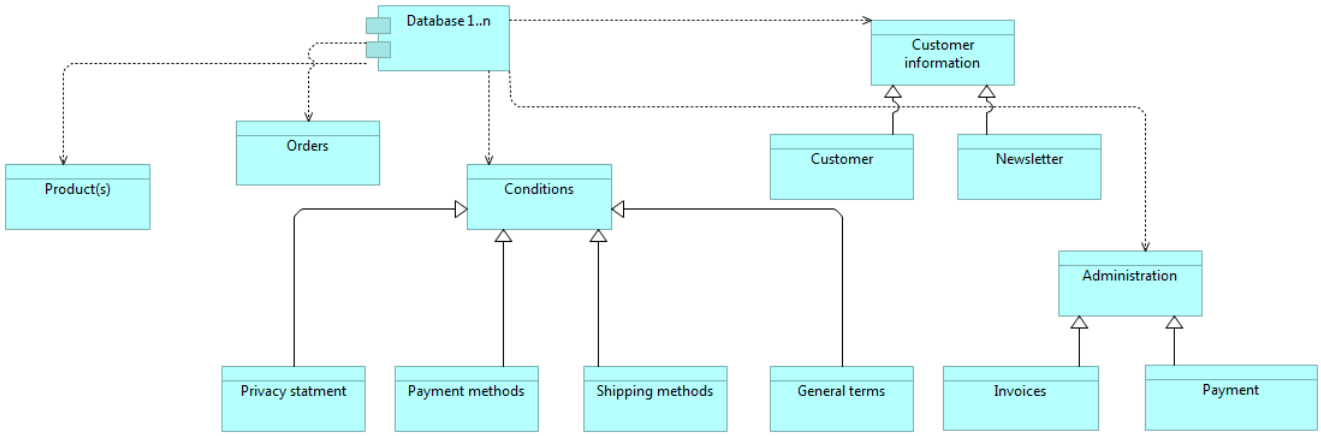


Figure 20 Data viewpoint

5.4.5 Resulting context

The data viewpoint receives input from the application structure viewpoint. These are data objects needed to realize the IT systems. The data viewpoint produces output for the application communication viewpoint. These are data objects used for communication between different services or functions. The resulting context is illustrated in Figure 21.

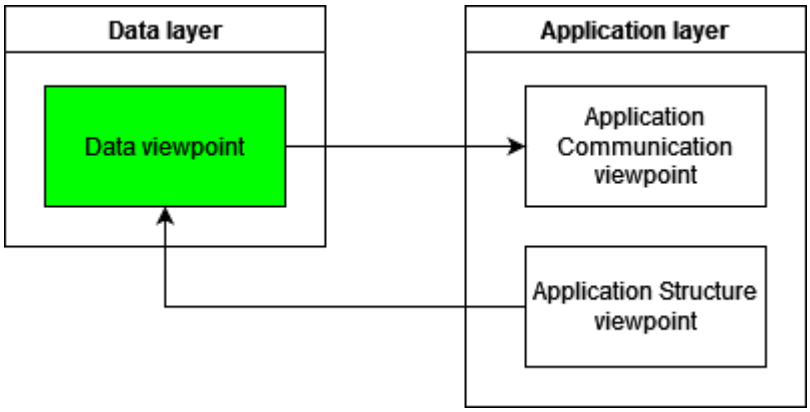


Figure 21 Resulting context Data viewpoint

6 Validation of the reference model

The validation process aims at justifying that the solution artifact would contribute to stakeholder goals when implemented in the problem context (Wieringa, 2010). In our case, we must demonstrate that the digital platform layer model, with different viewpoints, should contribute to stakeholder goals when implemented to facilitate the creation process of a digital platform. In order to do this, the solution is applied to a real-life case study at a company called Castlab that wants to create a digital platform. This chapter is structured as follows: Section 6.1 describes the company, Section 6.2 describes the case study setup, Section 6.3 describes our reference model applied to the context of Castlab, and Section 6.4 describes the opinion of Castlab on the reference model results.

6.1 Castlab description

Castlab is a business-to-business (B2B) start-up organization that uses modern manufacturing techniques combined with traditional casting techniques to manufacture obsolete spare parts for the rail infrastructure. Modern manufacturing techniques like additive manufacturing with 3D-printers allow Castlab to print sand molds that can be filled with traditional casting techniques. As a result, Castlab can produce small batches of an artifact, which results in a reduction in the Total Cost of Ownership (TCO) for companies. The reduction is because companies do not need to have surplus stock stored for an artifact as it can be created in a small batch and, in addition, Castlab delivers within 30 days.

Castlab has several services that are being offered to customers: Digital Intake to register artifacts, Digital Library as an overview place to easily (re)order all your artifacts, Price Estimation Tool (PET) to find out what the TCO for your company will be when switching to the Castlab method, and a Digital Inventory Tool that scans through a data set to predict which items are castable. Along with these services, Castlab tries to digitalize the whole supply chain as foundries tend to work in analog instead of digital way. Foundries that work with Castlab need to have the "Castlab DNA", which means that the structure should be semi-open. There needs to be a digital platform to facilitate the value exchange of small batch amounts of castable artifacts. Castlab should act as a mediator on this digital platform to prevent a "race to the bottom" in pricing. Castlab wants to deliver quality, and that is part of the "Castlab DNA". Overall, the digital platform should allow Castlab to realize the value exchange in a digital way and build towards becoming the Spotify of the casting industry.

6.2 Case study set-up

The goal of the case study is to validate if the knowledge goals to transfer knowledge from the knowledge topic to the knowledge carrier, in this case study Castlab. To make Castlab aware of the knowledge and to validate the introduction knowledge goal, we used an elicitation interview technique These interviews, with the managing director and IT manager of Castlab, revealed information about Castlab and the goals, processes, IT structure that Castlab has and the future situation of Castlab, also known as As-is situation and to-be situation. The questions asked, correspond with the type of questions given in the Excel visualization document (See section 6.5). The questions were asked in iterations where models are grouped to make the questions

relevant and not getting ahead of the processes, for example, the Goal and Actor Participate viewpoints were covered in one iteration, as the data viewpoint is not relevant in this stage. We used the answers to model the different viewpoints and would ask Castlab to clarify answers if questions would arise.

To validate the agreement knowledge goal, we used a validation interview technique, again with the managing director and IT manager of Castlab. In these interviews, we had the aim to find out if the viewpoints tailored to Castlab's information match the view and expectations of Castlab. Castlab would see each viewpoint with an explanation of the viewpoint and would comment if the information was understood and processed correctly. If a process was not understood, thus wrongly displayed in the viewpoint, questions were asked to find out if the idea or explanation was wrong. The answers are used to improve the viewpoints. In addition, Castlab was asked to describe their perceived usefulness of these viewpoints, the approach, and whether they understood the digital platform processes better with the aid of these viewpoints and related questions. These interview techniques are recommended by Lankhorst et al. (2009) to validate these types of knowledge goals.

6.3 Viewpoints applied

The following viewpoints present the result of the different interview sessions and use the corresponding metamodel that is defined in Chapters 4 and 5.

6.3.1 Goal viewpoint

The *creator of a digital platform* is Castlab and they have four *reasons to create a digital platform*:

1. Digitalizing the casting supply chain to gain scalability and sustainability. Currently, the foundries work in an analog way and Castlab wants to digitalize this, which allows events as the collection of data on material usage. This can be used in purchasing the material in bulk, which increases sustainability.
2. The perseverance of tacit knowledge about the casting techniques knowledge topic. Tacit knowledge fades away as knowledge carriers are unable to transfer their knowledge, which is caused by schools not teaching these techniques, foundries moving to other countries thus passing knowledge from generation to generation is not applicable anymore.
3. Facilitating the replication of legacy equipment. Castlab wants to create spare parts which include the parts that might not be manufactured anymore and the equipment is classified as legacy.
4. Competition with disruptive players in the market. The traditional methods of foundries have large batch sizes and long production times. There are initiatives to produce smaller batches and have faster production times, which is a disruptive movement in the casting industry. Castlab wants to compete with these initiatives and become a major player in providing smaller batch sizes and fast production times.

These four *reasons to create a digital platform* have a positive influence on the *intended achievements of the digital platform*, which contains three *achievements*:

1. Reverse engineer legacy equipment, which is needed to facilitate the replication of legacy equipment.
2. Combine new techniques with old ones. Castlab wants to combine new techniques, like 3D sand printing, with traditional techniques to adapt to the disruptive movement.
3. Lower the Total Cost of Ownership (TCO) by removing the long production times, which results in less surplus stock for customers.

The digitalization of the supply chain is not captured in a single *achievement* as it is needed in all *achievements*. It is the backbone on which Castlab can offer the disruptive model.

Castlab's Goal viewpoint is illustrated in Figure 24.

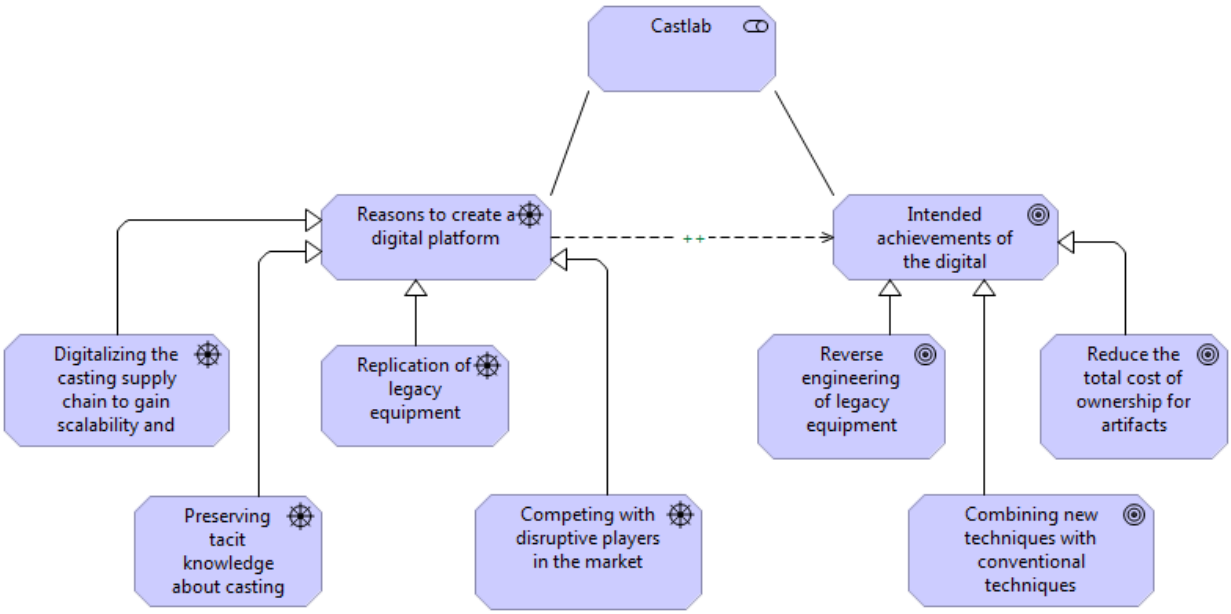


Figure 22 Castlab's Goal viewpoint

6.3.2 Actor Participate viewpoint

There are four identified *stakeholders* in the digital platform eco-system of Castlab being Castlab, NS (Dutch railways), foundries, and post-processors. There are more *stakeholders* in the digital platform eco-system, but these four represent the most important roles.

The *stakeholder* NS has the *intended role in the eco-system* of the consumer. As a consumer, *the intended reason for participation* is to: reduce the amount of surplus stock as storing these is an expensive operation, reduce the downtime of material that needs legacy equipment, and increase sustainability. The *expected value gained by participating*, for NS as a consumer, is a sustainable solution that increases the fleet reliability and reduces the TCO by 50-80%. Castlab has three *ways to realize the participating reasons*: offering casting on demand, a digital library, and digital twins. Castlab should offer to cast on demand, which would allow faster ordering and delivery times. By offering a digital library, a place to store artifacts, the NS can easily re-order artifacts that are produced by the casting on-demand service. These artifacts are stored in a file type called RTC (Ready To Cast), which is a file format invented by Castlab to ensure that the

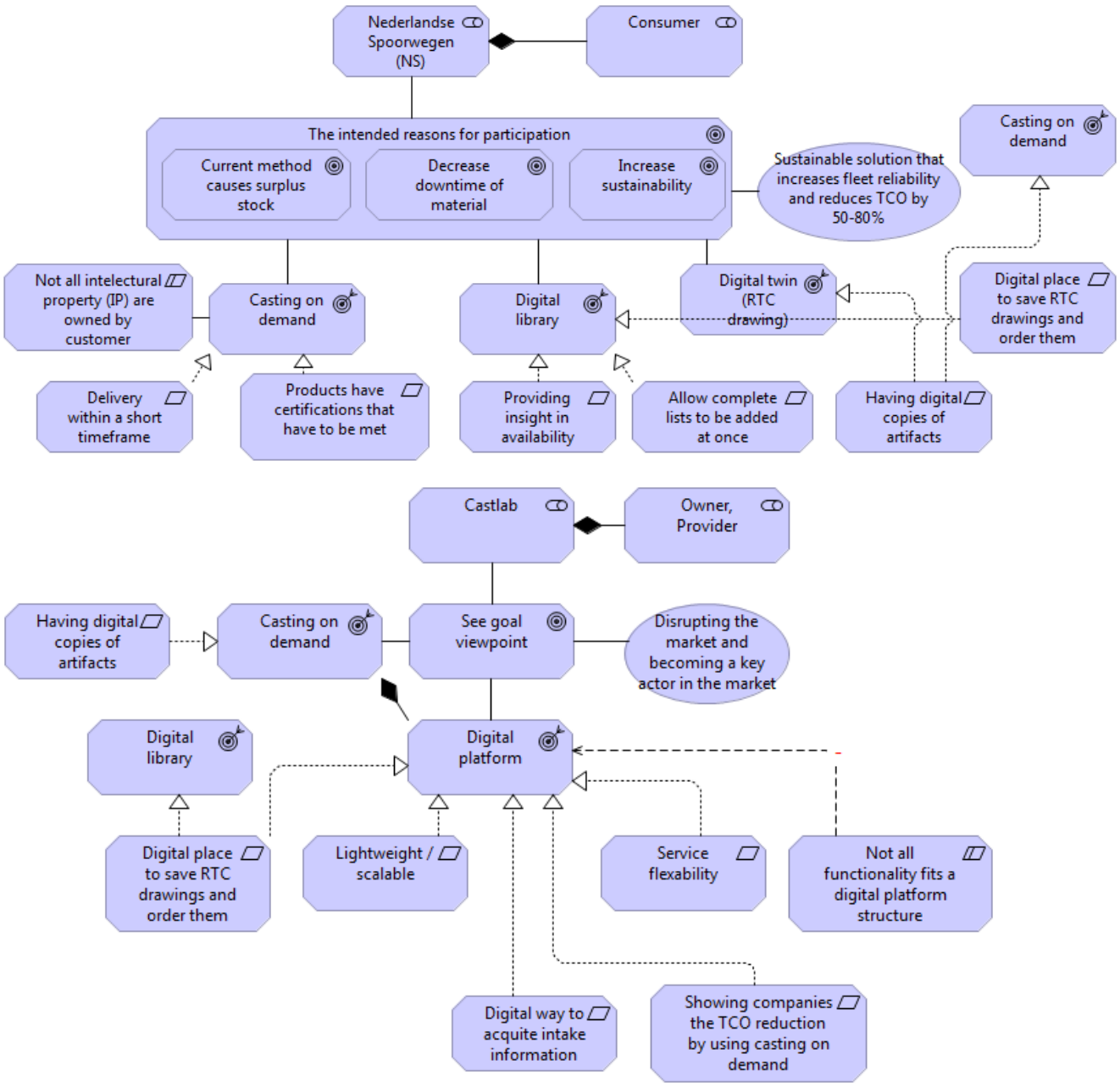
digital twin becomes a correct physical artifact when produced and that the foundry can instantly produce the artifact when the customer orders it. A digital twin is a digital representation of each part that needs to be produced and stored in a RTC file. These *ways to realize the participating reasons* have *requirements* and *limitations*. The *limitation* for casting on demand is that not all intellectual properties (IP) of the artifacts are owned by the NS, therefore, they do not have the right let Castlab produce all artifacts. The *requirements* of casting on demand are to deliver the artifact within X days, and the products must meet certain certifications. The digital library has the *requirements* that it provides insight into the availability of the digital twin stored, which should show when the NS can order a part and when the part is available, be a digital place to store digital twins and order them. And allow complete item lists to be added at once, because it is likely that 100 items or more are added to the digital library at once. The digital twin has the *requirement* that it needs to be an exact digital copy of the physical artifact.

The *stakeholder* Castlab has two *intended roles in the eco-system*: owner of the digital platform and provider of services to consumers of the digital platform, which demonstrates that a *stakeholder* can have multiple roles. As an owner, *the intended reasons for participation* are captured in the goal viewpoint (Figure 22). The *expected value gained by participating* is becoming a key actor in a disruptive movement, which is small batch sizes and fast delivery times as service combined with the digitalization of the casting industry. Castlab has two *ways to realize the participating reason:* the creation of a digital platform and casting on demand. The digital platform captures the digitalization Castlab wants to initiate on which the services are offered. The digital platform has multiple *requirements*: it needs to be a digital place that can store and order RTC drawings, it should be lightweight and scalable to easily adapt to future growth, and it should contain a digital way to acquire intake information as part of the digitalization, it should have the option to show (potential) customers the TCO reduction by adapting Castlab's services, and it should have service flexibility, which covers that new services are easy to integrate into the existing digital platform service offering. The digital platform has one *limitation*, not all functionalities fit a digital platform structure. For example, the 3D printers that are being used can be controlled in a cyber-physical manufacturing manner (Liu et al., 2017) and have nothing to do with a digital platform, but contribute to the digitalization of foundries. The casting on-demand service has the same *requirements* as described by the NS *stakeholder*.

The *stakeholder* foundries have the *intended role in the eco-system* of the manufacturer. They share this role with the *stakeholder* post-processors. Both *stakeholders* have different *intended reasons for participation* and *expected value gained by participating*. For the foundries the *intended reasons for participation* are to stay relevant as a foundry, fit the small-batch strategy, and preserve casting knowledge. To stay relevant as a foundry adaption to digital techniques is required, this is a goal of Castlab. In addition, large batch sizes are (mostly) outsourced to countries where the production is cheaper, thus to stay relevant a foundry needs to adopt a new business model. If a foundry already fits the small and flexible batch size strategy, adoption of Castlab's way provides more revenue. By casting many items the foundries can preserve the casting knowledge and pass it to younger people. The *expected value gained by participating* is increased revenue with an increase on the margin. For the *stakeholder* post-processors, *the*

intended reasons for participation are to increase revenue and to secure a place in a disruptive model. The latter is a consequence of beating the completion, as not joining allows a competitor post-processor to take your spot and the work associated with it. The *expected value gained by participating* is a new business model with increased revenue by incremental margins. Both *stakeholders* have the same *ways to realize the intended reason*, which is the casting on-demand service. The *limitation* of this service is that both *stakeholders* need to reserve production capacity. The *requirements* for this service are that the *stakeholder* needs certification to properly make the artifact and that the correct casting techniques are practiced. Castlab does not assign an order to a foundry that does not have the casting technique to process the order.

Castlab's actor participate viewpoint is illustrated in Figure 23.



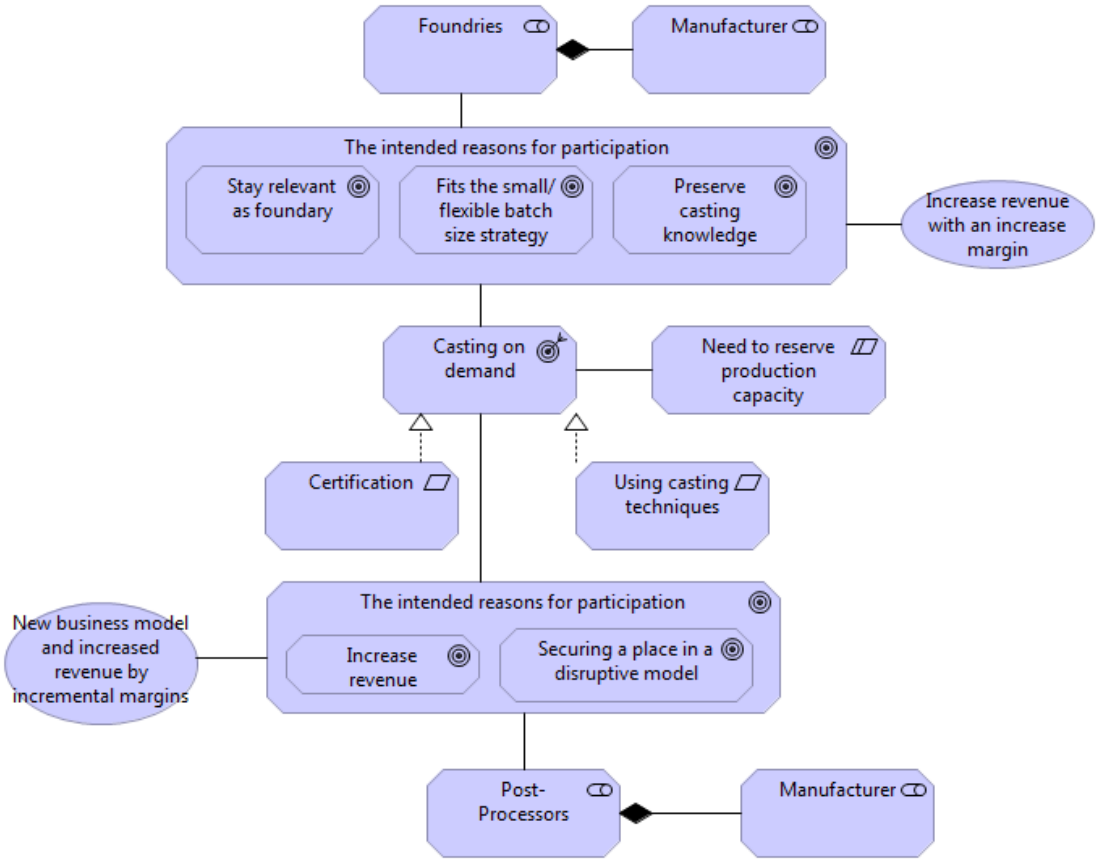


Figure 23 Castlab's Actor Participate viewpoint

6.3.3 Business Process viewpoint

There are processes identified for each of the *general digital platform business processes:*

1. The *condition management processes* contain processes that manage the legislation that applies within the digital platform. These include viewing and altering the condition, which covers the obligations and responsibilities of different stakeholders within the digital platform. These stakeholders can view the conditions on the website of Castlab and Castlab can alter the conditions by changing the text through an editor on the website.

2. The *data management processes* include the processes to analyze the data, viewing statistics of the data, and exporting the data. These processes are very general, as Castlab is not quite sure what they should look like within their digital platform. The most important element for Castlab is that they can learn from the data and use it to grow as an organization. As an example, they can use the order data to determine which materials are the most used and use this information to buy these materials in bulk. This example requires a data analysis process to analyze the order data and the view statistics process to view which materials are most used. The export of the data process is more

like a function that allows these statistics or data can be exported and used in a third-party program for data analytics.

3. The *customer management processes* include customer registration, customer complaints, applying for foundry membership, altering profile, viewing profile, customer support, and altering customers. The customer registration process allows new customers to register and is executed by a member of Castlab in cooperation with the company that registers as a customer (or consumer in the digital platform eco-system), since Castlab is a B2B company they do not expect a lot of registrations at a single time. Thus handling them individually should be doable. The application for the foundry membership process allows foundries, which have the "Castlab DNA", to join the digital platform. The "Castlab DNA" describes the way how Castlab works with the small and flexible batch strategy. Since Castlab is the mediator and assigns an order to a foundry, Castlab does not need a lot of foundries. Therefore, the digital platform structure of Castlab can be seen as semi-open. The consumers can join without limit, but the foundries can only join if they have the Castlab DNA and there is room. The customer support process allows customers to ask for help concerning services offered on the digital platform, like the digital library, ordering, the creation of a digital twin, etc. The complaint process is used when a customer is not satisfied with the artifact or the process that Castlab delivers. Customers should have their personalized environment within the digital platform, in which they can view and alter their profile. This environment contains information about invoices, the delivery address of the artifact, and other personal information and the digital twins artifacts can be viewed, and the order process status can be viewed. Since there is a customer support process and customers can ask Castlab to change information, there needs to be a process that allows Castlab to change the customer's profile and alter the information on the profile. In addition, this process is also necessary to manage the digital platform. There is no newsletter process as Castlab is a B2B digital platform.

4. The *order management processes* include a process to receive the order, update the order status, forward an order to a foundry, and view all orders. The receiving order process gets the order from the digital library and needs to ensure that it is valid. The update of the order status process allows different stakeholders to update the order status, so a customer can see an accurate order status in their personalized environment. The forwarding of an order to a foundry is the process in which Castlab assigns a foundry to an order. This process should ensure that the foundry has access to the order and is notified about a new order to manufacture. The view all orders process contains multiple processes: foundries can see the orders that they have to manufacture, customers can see their orders and their status, and Castlab can see all orders within the digital platform. The orders a foundry receive include the RTC file that is needed in order to make the artifact.

5. The *payment processes* within Castlab are expected to be outsourced to a third-party program and payment provider. Therefore, there might be a process to import invoices so customers can download them through the personal environment. There might also be a

process to export the orders to the format the third-party program or payment provider requires.

There are four *contextualized business processes* that realize four requirements: 1) have a digital place to order and store RTC, 2) have digital copies of artifacts, 3) have a digital way to acquire intake information, and 4) show companies the TCO reduction with casting on demand. The *contextualized business processes* belong under the *general digital platform business process* item/service offering as these are services Castlab offers to customers, being:

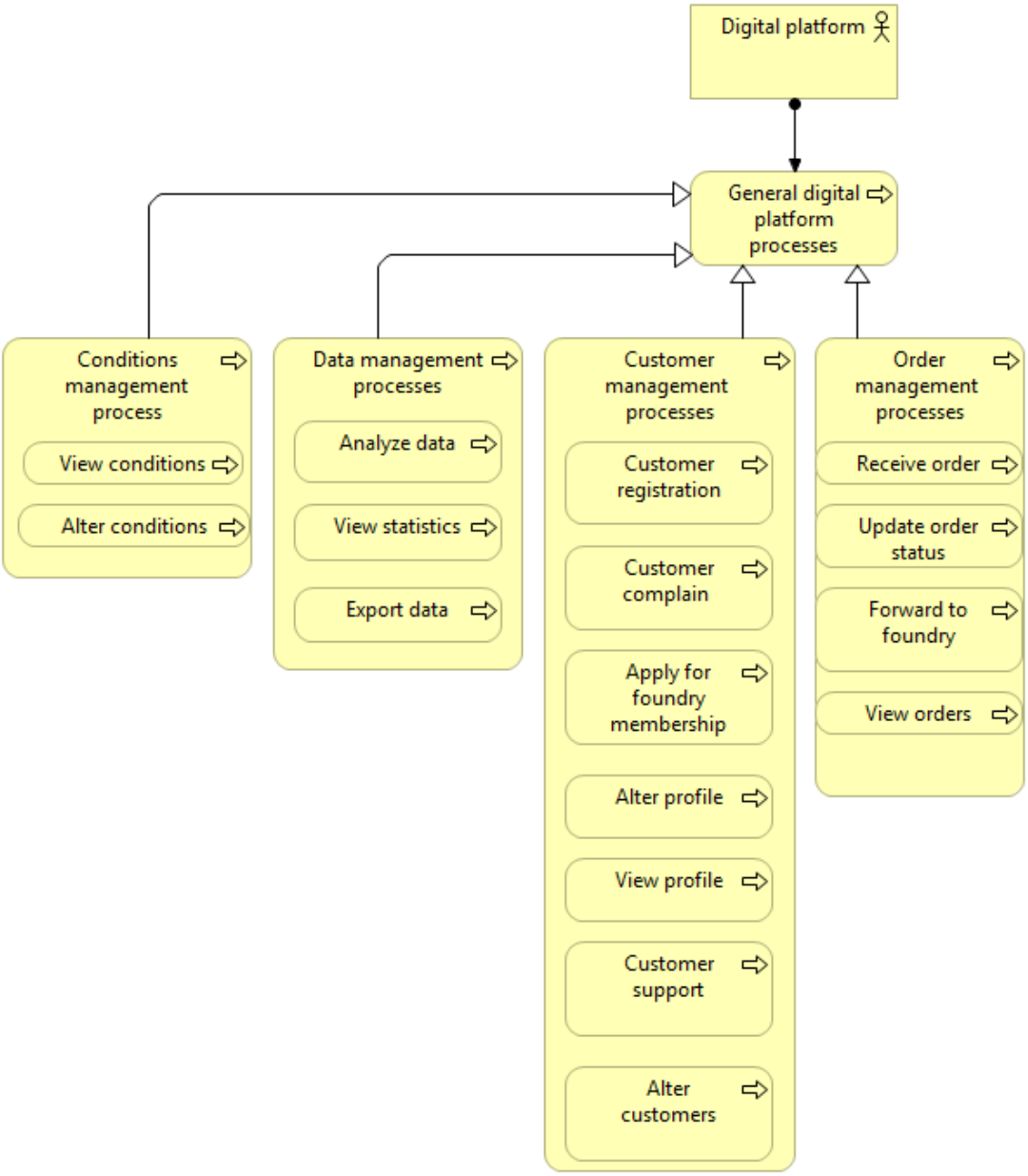
1. The *digital library* is the place on the digital platform where the digital twins (RTC files) are stored. There are three business processes identified: placing an order, browsing RTC files, and adding or altering RTC files. The place order process allows a customer to order an artifact. To select an artifact the browse RTC process is needed, which allows customers to browse to a catalog of RTC files present in their personal environment. The adding or altering RTC process allows Castlab to place new RTC drawings in the digital library and alter them if the customer is not satisfied. This realizes the *requirement* to have a digital place to save and order RTC drawings.

2. The *digital twin creation process* allows Castlab to create RTC files of physical artifacts. The process also includes the validation of a RTC file which is done by making a First Article Inspection (FAI), which allows Castlab to make the artifact and allow the customer to inspect the artifact. When the artifact is correct, there are no faults according to the customer, the RTC file is saved in the digital library. If there are faults, Castlab will make changes based on the customer's feedback and repeat this process till the customer is satisfied with the artifact. This allows Castlab to ensure that a RTC will produce the correct artifact and that fast production times can be achieved. This realizes the *requirement* of having digital representational copies of artifacts.

3. The *digital intake process* provides Castlab with information about an artifact that a customer wants to add to the digital library. This process acquires the artifact to make a RTC in the digital twin creation process and lets Castlab determine the approach to create the RTC and FAI. This realizes the *requirement* of having a digital way to acquire intake information.

4. The *Price Estimation Tool* (PET) *process* shows (potential) customers how much they can reduce the TCO if they follow the small-batch strategy of Castlab. This process calculates a TCO reduction estimate based on a questionnaire about the artifact and the traditional way against Castlab's way. This realizes the *requirement* of showing companies the TCO reduction with casting on demand.

Castlab's business process viewpoint is illustrated in Figure 24.


Digital platform
General digital platform processes
Conditions management process
View conditions
Alter conditions
Data management processes
Analyze data
View statistics
Export data
Customer management processes
Customer registration
Customer complain
Apply for foundry membership
Alter profile
View profile
Customer support
Alter customers
Order management processes
Receive order
Update order status
Forward to foundry
View orders

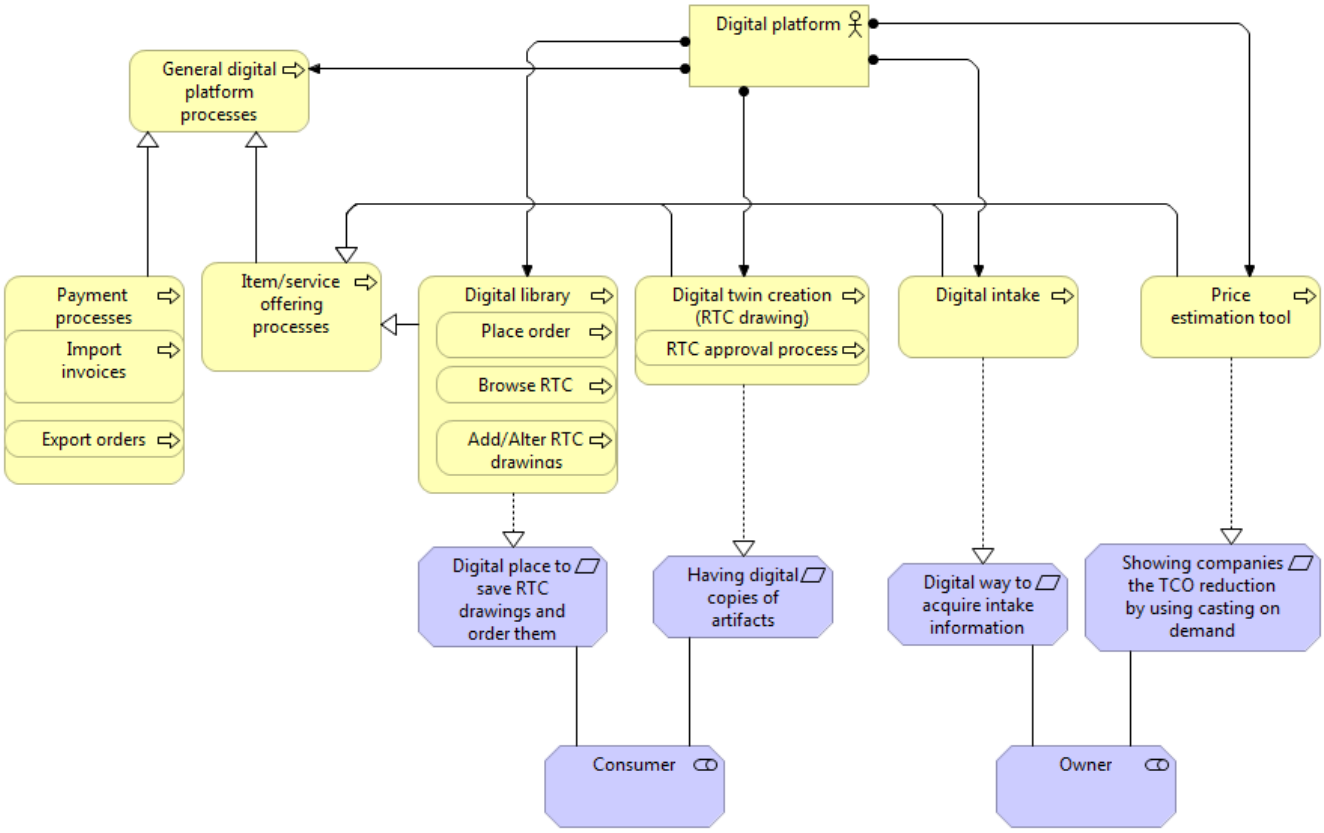


Figure 24 Castlab's Business Process viewpoint

6.3.4 Application Structure viewpoint

For Castlab there are the predefined *contextualized systems* and the *contextualized systems* that support the processes created by the result of requirements. The predefined *contextualized systems* are applied in the following manner:

1. The *condition system* supports the condition management processes by facilitating *services or functions* to alter and view the conditions. *The purpose of the* alter condition *function is to* upload new condition texts, for example, a new privacy statement or general terms of the digital platform. *The purpose of the* view condition *function* is to retrieve the conditions and provide them to the stakeholder that requests them. The data associated is the condition *data object*, which captures the different types of conditions.

2. The *data management system* supports the data management processes by providing three *services or functions*: analyzing the data, viewing the statistics, and exporting the data. *The purpose of the* analyzing data *service* contains multiple steps: selecting the data, determining the analysis technique, performing the analysis, and saving and exporting the results. These should allow Castlab to analyze the data on the occurrence of metal types, purchase predictions, etc. *The purpose of the* viewing statistics *service* contains two steps: selecting the variable to view, and selecting the visualization technique, like pie or bar chart, etc. This allows Castlab to see the results of the analyzed

data. *The purpose of the* export data *service* contains two steps: selecting the data that needs to be exported and selecting the format to export, like CSV, txt, or another extension type Castlab finds relevant. The save and export results step, from the analyze data service, uses the export data service. The data management covers all the data within the digital platform, thus the *data objects* are all the data objects that exist.

3. The *order management system* supports the order management process by having the *services or functions* to manage orders and receive orders. The orders service exists out of two *services or functions:* alter orders and view orders. *The purpose of the* alter *function* includes the step to update the order status and forward an order to the foundry. Although, forwarding an order to the foundry can be seen as a status update to the order. *The purpose of the* view orders *function* is to provide a list of orders for the corresponding stakeholder. The receive order *service* is responsible to receive orders from the digital library and other interfaces, like an interface that is integrated with an ERP system of a stakeholder, which covers *the purpose of the* receive order *service.* The data is captured by the orders *data object*.

4. The *administration system* supports the payment processes, which are expected to be outsourced. In this light, the *administration system* contains two *services or functions*: import the invoices and export orders. *The purpose of the* import invoice *function* is to receive invoices from 3rd party applications by uploading a file that includes invoices, which can be assigned to the corresponding stakeholder. *The purpose of the* export order *function* is to export the order information to a data format that is supported by the third-party application. The data is captured by the administration *data object.*

5. The *customer management system* supports the customer management processes and holds seven *services or functions*: altering customers, applying for foundry membership, customer registration altering profiles, viewing profiles, support, and customer feedback. *The purpose of the* alter customers *function* is to create a new customer, remove an existing customer, or change the information of a customer. *The purpose of* the applying for foundry membership *function* is for foundries to enter their information, based on this information assess if the foundry fits the Castlab DNA, and gives an acceptance or decline signal back by an e-mail. *The purpose of the* customer registration *service* is to perform a digital intake. A stakeholder needs to have at least one castable artifact to become a customer. *The purpose of the* alter profile *functions* is to allow a customer to change information on their profile. This function is accessed by the view profile *service*, which allows a customer to see the current order and order status, see the invoices, view and alter their profile information, and acquire customer support. The support and customer feedback *functions* share the same *purpose of the function*, which is to receive tickets, answer these tickets, and track the status of the tickets. The latter should ensure that a ticket does not get lost or go unanswered. The data for the support function is captured by the ticket *data object* and the customer services and functions data is captured by the *participants data object*.

The contextualized business processes have supporting systems as well. These business processes are the services Castlab offers and belong under the *item/service offering system.* There are four services Castlab offers to customers: the digital library, a digital twin creation, a digital intake, and the price estimation tool. Each service has its own *contextualized system* and *data objects.*

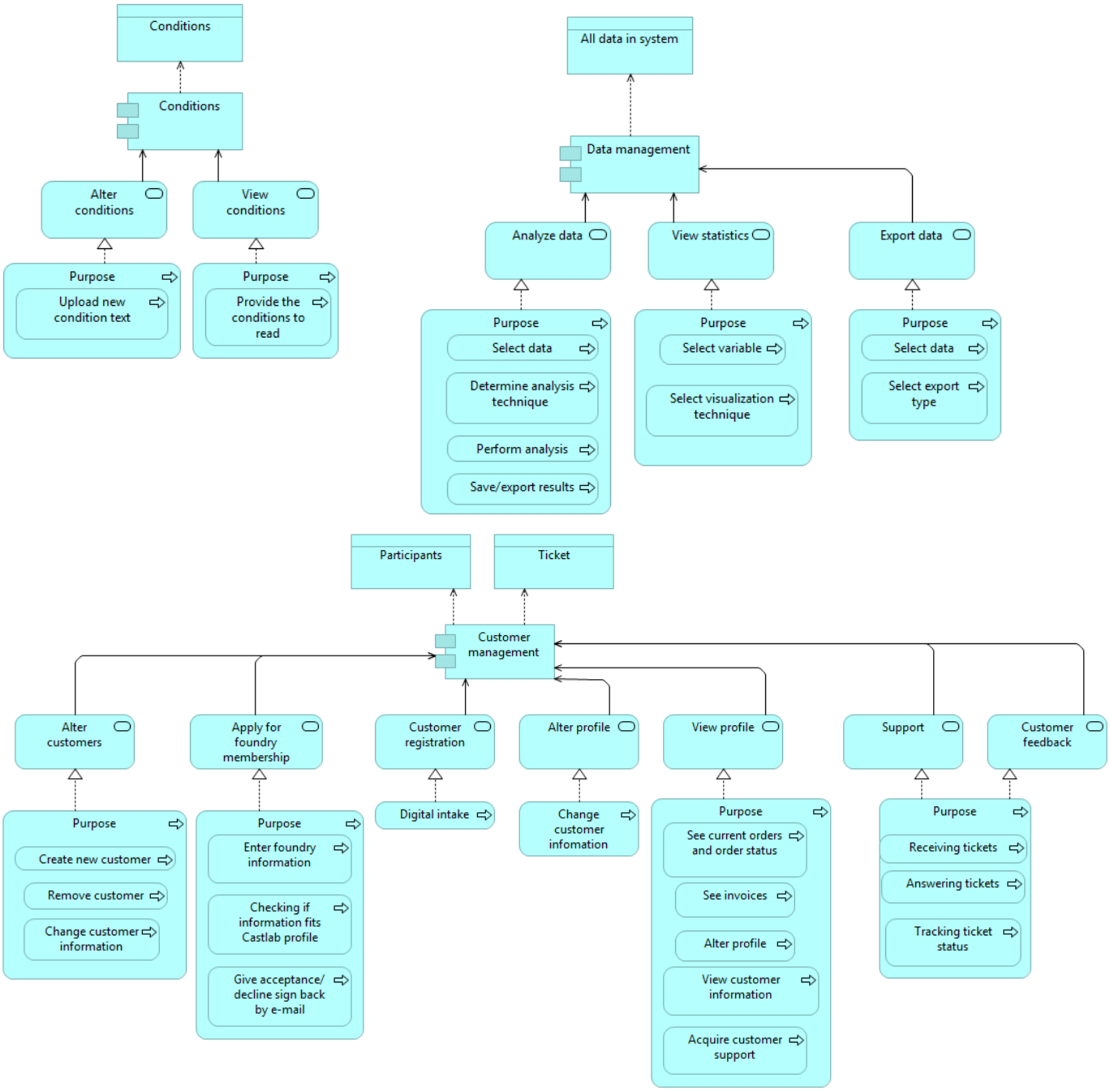
1. The digital library *service* is realized by the *digital library system*, which has four *services or functions*: to browse RTC drawings, let customers accept a RTC drawing, add and alter a RTC drawing, and let the customer order an RTC. *The purpose of the* browse RTC *function* is to retrieve all the RTC files assigned to the customer and all information associated with these drawings. The function to accept an RTC drawing has the *purpose* of letting the customer accept or decline an RTC file based on the changes made, however, Castlab does not know how this functionality looks in implementation on the digital platform, either through an e-mail or through a service on the digital platform. *The purpose of the* add and alter RTC *function* is to provide the option to upload a form with the information concerning the RTC, which can be assigned to a customer. An existing RTC has the form already filled out, thus changing the values of this form alters the RTC. *The purpose of the* ordering RTC *service* is to provide customers the option to order a RTC and allows Castlab to give the customer feedback about the order, for example, that the order is received. This service communicates with the *receive orders service* from the *order management system* to validate the order. The data created is captured in the RTC *data object.*

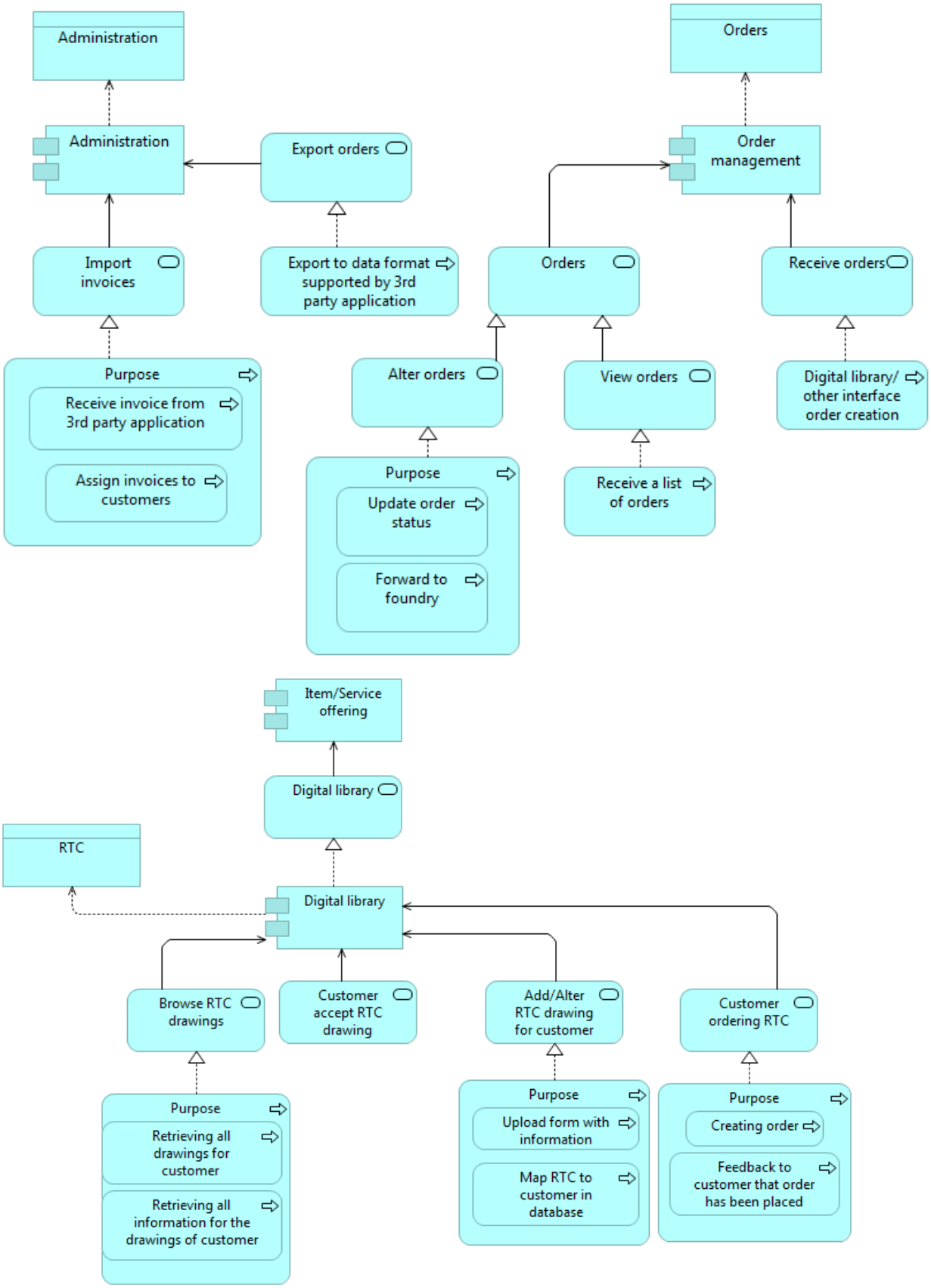
2. The digital twin creation *service* is realized by the *digital twin creation system* with the *service or function* of creating a RTC file. The *purpose of* create a RTC *function* is to load a 2d or 3d file. Based on this file, create a sand mold that can be used for the FAI, and produce the FAI. The data created is captured in the digital twin creation *data object.*

3. The digital intake *service* is realized by the *digital intake* system with the *service or function* of a questionnaire which collects the 2d or 3d file of the artifact along with information. The data created is captured in the digital intake *data object.*

4. The Price Estimation Tool *service* is realized by the *price estimation tool* system, which has the *description* to acquire data and gives an estimate on the price input based on the data gathered. The data created is captured in the PET *data object.*

Castlab's application structure viewpoint is illustrated in Figure 25.


Conditions
Conditions
Alter conditions
View conditions
Purpose
Upload new condition text
Purpose
Provide the conditions to read
All data in system
Data management
Analyze data
View statistics
Export data
Purpose
Select data
Determine analysis technique
Perform analysis
Save/export results
Purpose
Select variable
Select visualization technique
Purpose
Select data
Select export type
Participants
Ticket
Customer management
Alter customers
Apply for foundry membership
Customer registration
Alter profile
View profile
Support
Customer feedback
Purpose
Create new customer
Remove customer
Change customer information
Purpose
Enter foundry information
Checking if information fits Castlab profile
Give acceptance/ decline sign back by e-mail
Digital intake
Change customer infomation
Purpose
See current orders and order status
See invoices
Alter profile
View customer information
Acquire customer support
Purpose
Receiving tickets
Answering tickets
Tracking ticket status


Administration
Administration
Export orders
Import invoices
Export to data format supported by 3rd party application
Purpose
Receive invoice from 3rd party application
Assign invoices to customers
Orders
Order management
Orders
Receive orders
Alter orders
View orders
Digital library/ other interface order creation
Purpose
Update order status
Forward to foundry
Receive a list of orders
Item/Service offering
Digital library
RTC
Digital library
Browse RTC drawings
Customer accept RTC drawing
Add/Alter RTC drawing for customer
Customer ordering RTC
Purpose
Retrieving all drawings for customer
Retrieving all information for the drawings of customer
Purpose
Upload form with information
Map RTC to customer in database
Purpose
Creating order
Feedback to customer that order has been placed

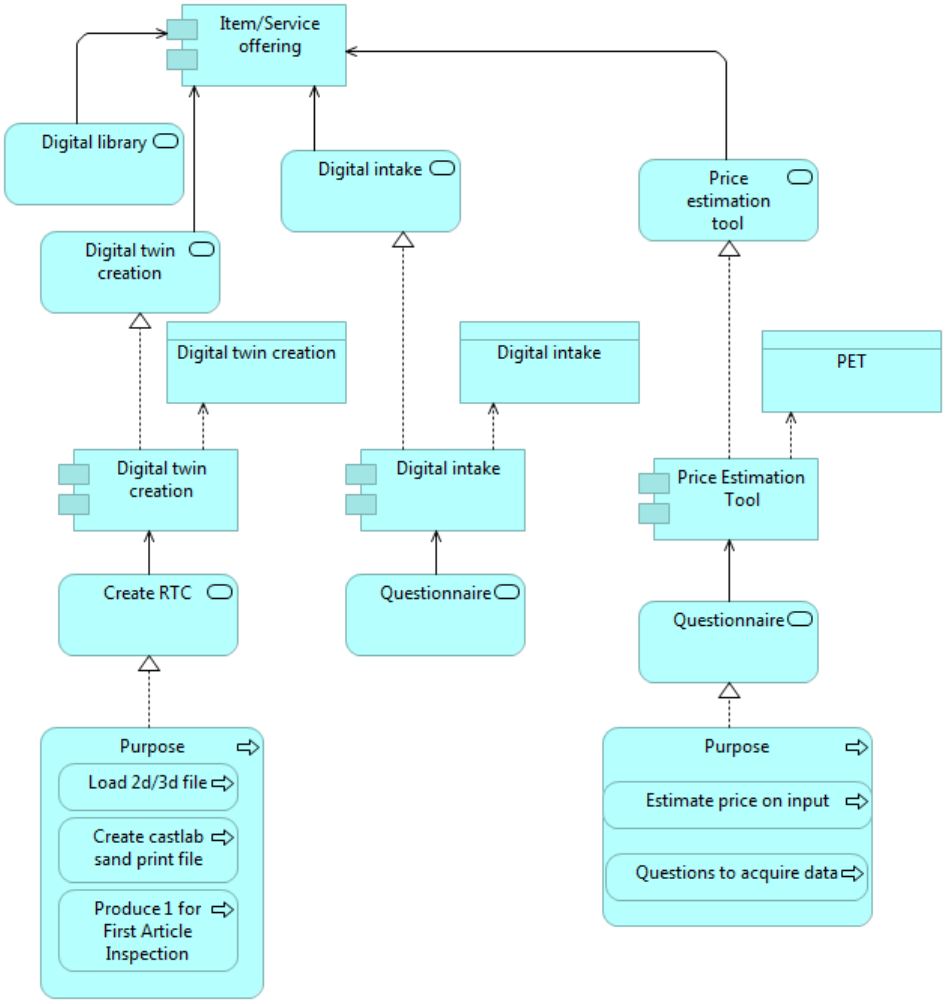


Figure 25 Castlab's Application Structure

6.3.5 Application Usage viewpoint

The *contextualized systems* enable the *general digital platform* and *contextualized business processes* to operate on the digital platform. To reach the functionalities, as a stakeholder, there is an *interface*. Castlab has a difference in terminology between a website interface and a digital platform portal. The former is a static page that shows information, like the contact information. The latter is a web technique that serves dynamic content offered by Castlab, like login functionality, browsing RTC files, etc. The definitions of Castlab are used since the study was performed at Castlab.

For the *general digital platform processes,* the following *contextualized systems* realize them and provide the functionalities to the following interfaces:

1. The *condition management processes* are realized by the *condition system*. The *view condition* process is realized by the *view condition function* and the *alter condition*

process by the *alter condition function*. The *interface* to access these functionalities is the *website* of Castlab, which allows a stakeholder to read the conditions and Castlab to alter the conditions.

2. The *data management processes* are realized by the *data management system*. The *data analysis process* is realized by the *data analysis service.* The *view statistic process* is realized by the *view statistic service*. The *export data process* is realized by the *export data service.* The *interface* to access these services is the *digital platform portal*, which is part of the digital platform.

3. The *customer management processes* are realized by the *customer management system*. The different *processes* are realized by the *service or function* that corresponds, like the *customer registration process* is realized by the *customer registration service*, the *customer support process* is realized by the *customer support function*, etc. The only exception is the *customer complains process*, which is realized by the *customer feedback function*. The *interfaces* to access these functionalities are *e-mail* for the *support* or *complain processes* and the *digital platform portal* for the other processes.

4. The *order management processes* are realized by the *order management system*. The *processes* are realized by the *service or function* that corresponds, like the *receive order process* is realized by the *receive order service*, etc. The *interface* to access these functionalities is the *digital platform portal*.

5. The *payment processes* are realized by the *administration system*. The *import invoice process* is realized by the *import invoice function*, and the *export order process* is realized by the *export order function*. The *interface* to access these functionalities is the *digital platform portal.*

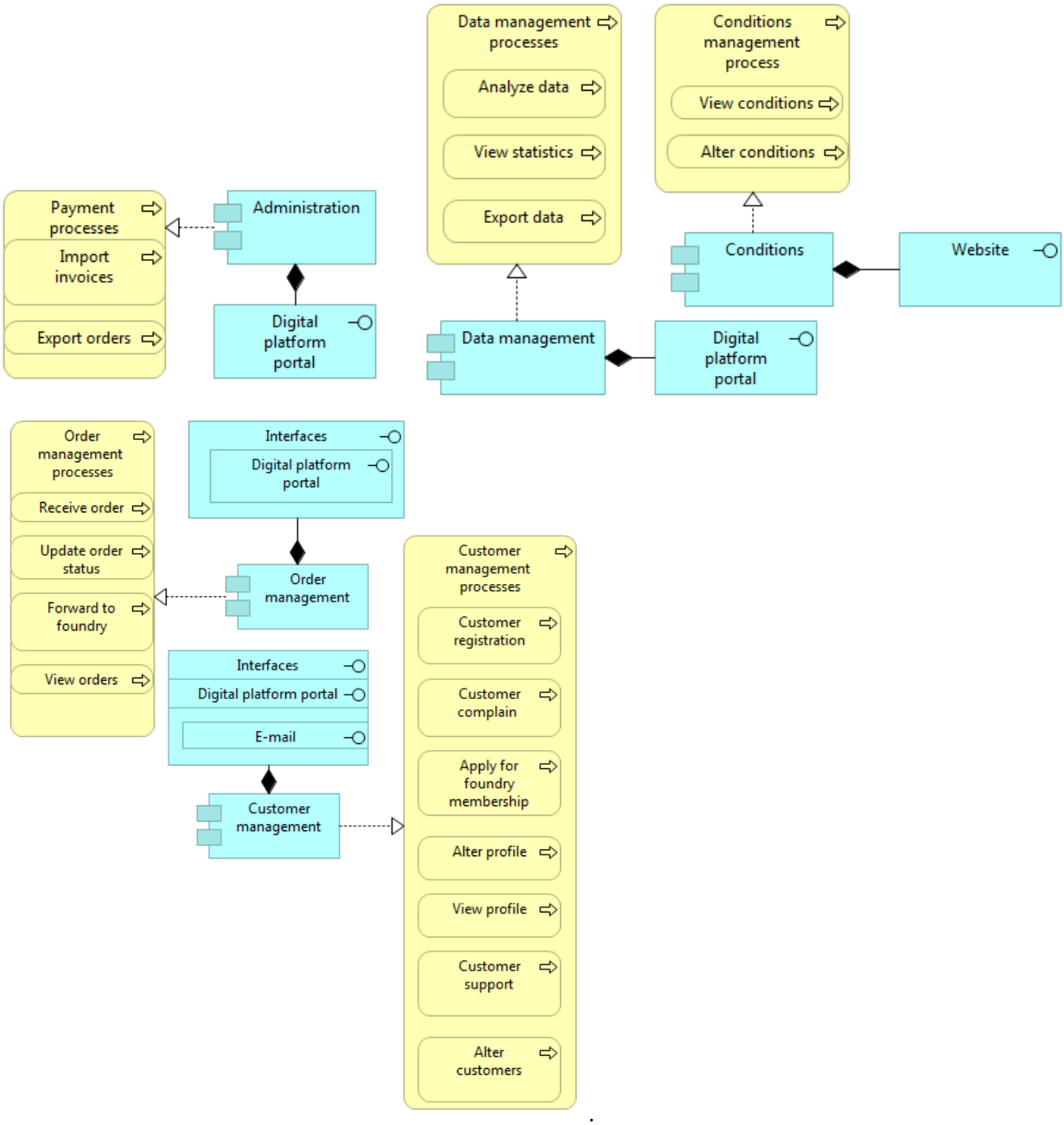
For the *contextualized business processes*, the *item/service offering process* is realized by the digital library, digital twin creation, price estimation tool, and digital intake process.

The *digital library processes* are realized by the *digital library system*. The price estimation tool is realized by the price estimation tool system. The digital intake process is realized by the digital intake system. These share the same two *interfaces* to access the functionalities*: the digital platform portal,* and *an API*. The choice that some services have an *API* is made to facilitate integration into customers' systems. A customer might not want to visit the digital platform but stay within their own systems. Therefore, there needs to be integration between the customer's ERP system and Castlab's digital platform, which is realized by the use of APIs for each service.

The *digital twin creation process* is realized by the *digital twin creation system*. The *interface* to access this service is the *digital intake service*. After a successful digital intake, the *digital twin creation process* should automatically start.

All *general digital platform business processes* and *contextualized business processes* are realized by *services or functions* provided by *contextualized systems.* In conclusion, there are no *contextualized systems* that serve no purpose, nor *business processes* that are not being supported by IT, thus there is no misalignment across the business-IT dimension.

Castlab's application usage viewpoint is illustrated in Figure 26



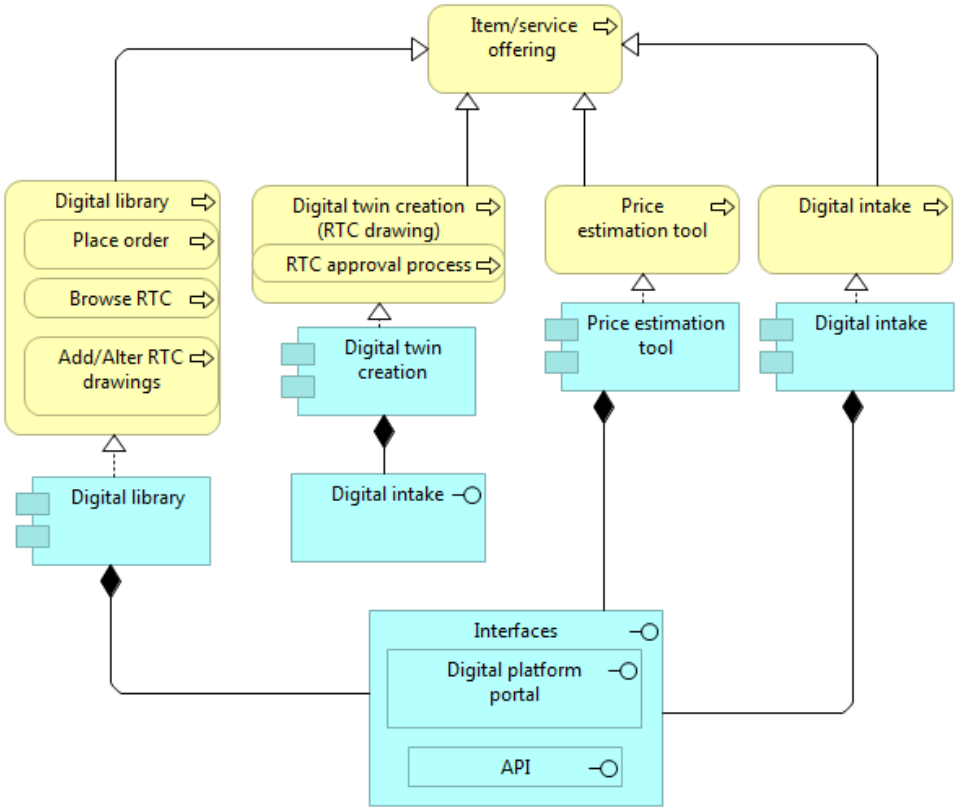


Figure 26 Castlab's Application Usage viewpoint

6.3.6 Application Communication viewpoint

There are two services or functions identified that should cooperate:

1. The Price Estimation Tool (PET) can cooperate with the digital intake. The *service initiating* is the digital intake and the *service responding* is the PET. These use both a questionnaire to acquire information about the artifact, with the PET providing cost estimation and the digital intake starting the digital twin creation process. These services need, almost, the same information, thus an *interaction* can take place to cooperative acquire this information. Then the services can use their own functions to process the information. As a result, a customer does only have to fill in one questionnaire for both services. The *data objects* involved are the *artifact information* and *casting information*, which are provided by the questionnaire.

2. The digital library can cooperate with the order management system. The *service initiating* is the digital library and the *service responding* is the receiving order service. The order management system has to validate whenever or not an order is valid. The order process takes place in the digital library, thus an *interaction* between these services takes place. The *create new order* interaction can validate, for example, the order quantity. The data involved is the *orders data object.*

These *interactions* describe a to-be situation for Castlab, based on the as-is situation.

Castlab's application communication viewpoint is illustrated in Figure 27.

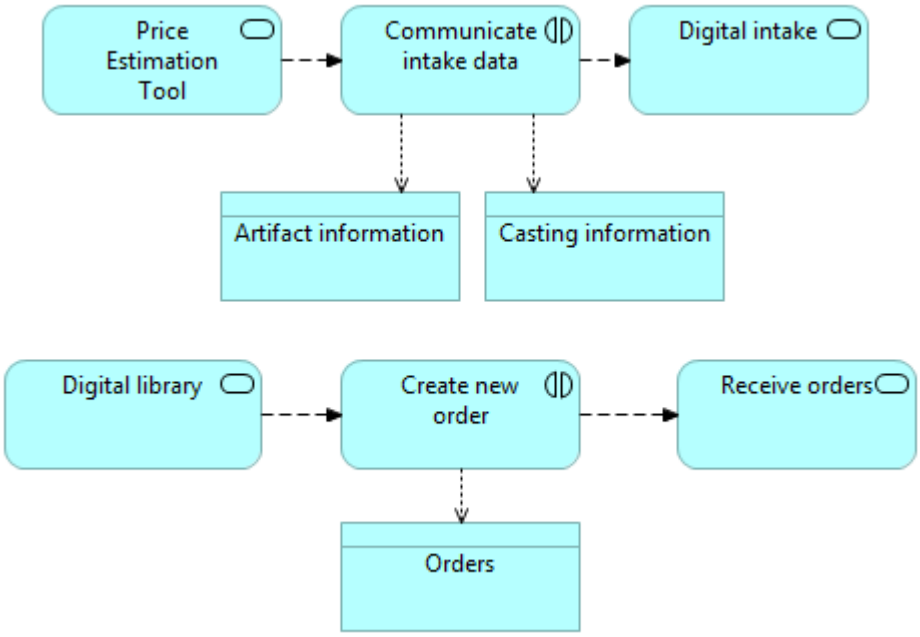


Figure 27 Castlab's Application Communication viewpoint

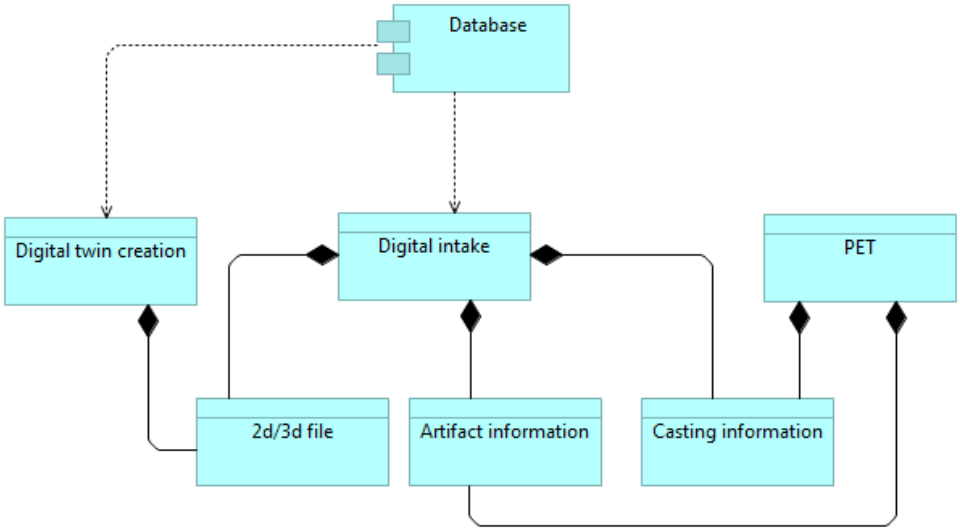
6.3.7 Data viewpoint

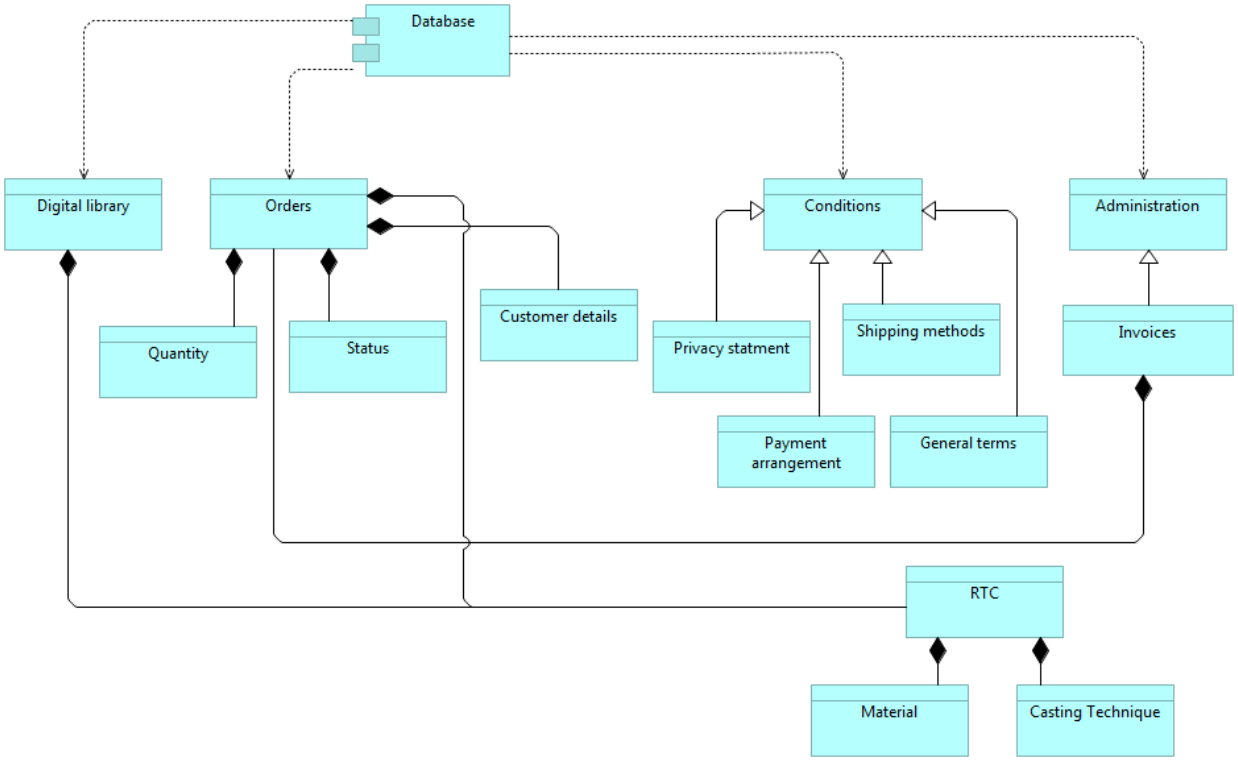
The data within the *contextualized* systems are ten *data objects*, which contain *data objects* to provide more detail.

1. The *digital twin creation data object* is composed of a *2d/3d file data object*, which is the 2d or 3d file of the artifact, and RTC *data object*.
2. The *RTC data object* contains information about the artifact and is composed of the material *data object* and the *casting technique* data object and belongs to a *customer data object*.
3. The *digital intake data object* is composed of a *2d/3d file data object,* the *artifact information data object,* and the *casting information*. The *2d/3d file* is being shared with the *digital twin creation*, and the *artifact and casting information* are shared with the *PET*.
4. The *PET data objects* are composed of *artifact information* and *casting information*. The *artifact information* captures attributes about the artifact, like weight, height, etc. The *casting information* captures attributes about the casting process, like material, quantities, etc.
5. The *digital library data objects* are composed of the *RTC data objects* and the *customer data object,* which assigns a customer to a RTC file. Since customers can only access their digital library, they only see their RTC files.
6. The *orders data objects* contain information about the order and are composed of the *quantity data object, status data object, customer details data object, RTC data object, invoice data object*, and *a customer data object*.

7. The *conditions data objects* contain specializations, like the *privacy statement data object, payment arrangement data object, shipping methods data object,* and *general terms data objects.* These specialized *data objects* capture the legislation that applies within the digital platform.
8. The *administration data object* contains *invoices data objects.* That is a part of an *order data object* and is used by the *profile information data object.*
9. The *ticket data object* is composed of a *subject data object* and a *solution data object*, which capture the subject of the ticket and the solution of the ticket respectively. These *data objects* can be used to create a FAQ based on the *subjects* that are asked a lot.
10. The *participants data object* has two specializations: the *customer data object* and the *manufactures data object.* The former is composed of *profile information, invoices, tickets, digital library.* The latter is composed of a *manufacturers information data object*, which captures the information required for Castlab to check if the foundry matches the Castlab DNA and is used to assign orders.

Castlab's data viewpoint is illustrated in Figure 28 and is split up in three parts to ensure readability, however some relationships are not shown.


Database
Digital twin creation
Digital intake
PET
2d/3d file
Artifact information
Casting information


Database
Digital library
Orders
Conditions
Administration
Quantity
Status
Customer details
Privacy statment
Shipping methods
Invoices
Payment arrangement
General terms
RTC
Material
Casting Technique

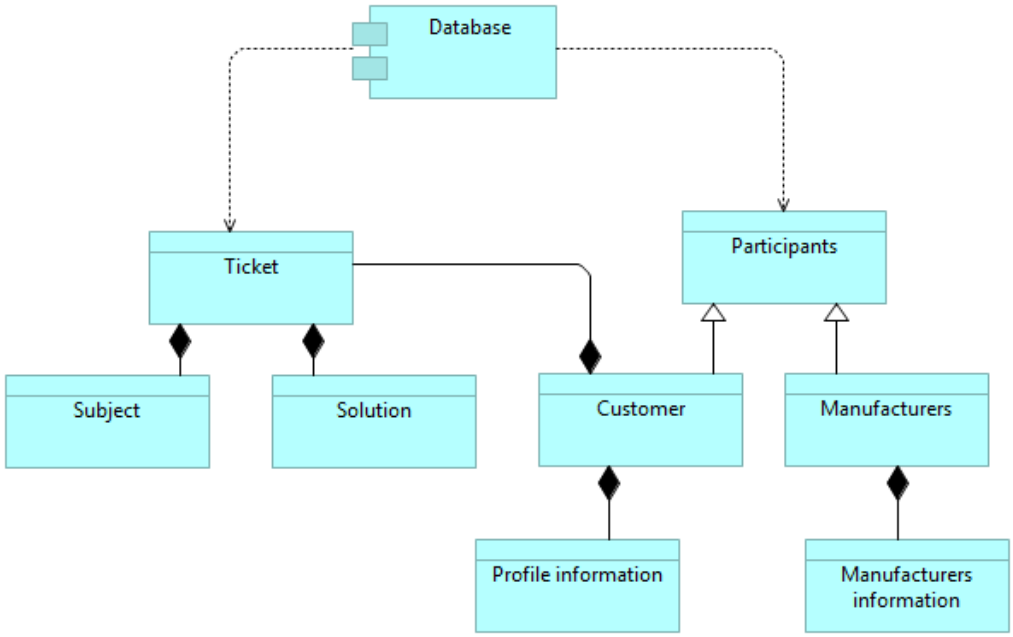


Figure 28 Castlab's Data viewpoint

6.4 Expert opinion

To validate the different viewpoints, the following question has been asked in the validation interview: Do the stakeholders agree that the views are a correct representation of the intended situation (Lankhorst, 2009)? In addition, after the validation of the viewpoints, Castlab answered questions about the reference model to assess if the knowledge topic is communicated understandably by the reference model. Castlab opinion can be considered as an expert opinion, which is defined as an expert assessing how the artifact interacts with the problem context and predicting the effects they think this would have (Wieringa, 2010).

6.4.1 Correctness validation of the viewpoints

In general, the different viewpoints covered the idea Castlab had, and the concepts were correctly modeled towards the questions asked to retrieve information from Castlab. For an example of what has been changed, one can look at the goal viewpoint *where preserve tacit knowledge about casting techniques* is a *reason for creating the digital platform*. Initially, this was called *preserve knowledge about old techniques*, which did not capture the essence that the knowledge is in the heads of people working in foundries. The knowledge will fade away if not passed on from person to person, which explicitly targets tacit knowledge.

6.4.2 Feedback

The general feedback about if the knowledge topic was communicated in an understandable manner includes that without knowing the ArchiMate language notation, Castlab representatives could follow the explanation of the viewpoints. However, the experts mentioned that it would be nice to present a legend in each viewpoint that explains what is visualized or explains the process of the viewpoint. In addition, the Castlab representatives suggested creating a total viewpoint where an abstract overview is shown, which should allow the user to understand the

core elements of the reference model. If a user of the reference model wants more detail, the user can go to the corresponding viewpoint that should clarify the details.

The question if the reference model covers the knowledge topic well enough, gives insight into the digital platform processes, and provides alignment to support the digital platform creation process, was answered neutrally. The reference model helped Castlab create a digital platform, as the questions included in the reference model guided Castlab to think about certain topics and allowed Castlab to think in implementational terms. For example, Castlab wants to do order management and the reference model provides insights to contextualize the order management within Castlab's digital platform and provided alignment with other processes. However, there was also criticism on the reference model, since it does not represent cost nor complexity. The cost aspect reflects on not providing cost estimations on any choice presented. The complexity aspect reflects on not showing where the complexity within the creation of a digital platform lies since the reference model makes it look straightforward to create a digital platform. In addition, there was a suggestion to provide more questions on the data domain, since the vision of Castlab is to use data, as an organization, to learn and grow.

Other feedback was given on the Application Usage viewpoint, as the Castlab representative noticed that a user of the reference model might not know what an API is, and why would you choose an API over e-mail? The reference model does not explain the difference between these *interfaces*. In addition, the Castlab representatives came up with the suggestion to work with implementation guidance. The viewpoints describe many concepts but do not provide the option to indicate which concept is more important to the organization than others. The reference model has no tools to define this preference. The Castlab representatives provided a suggestion to work with colors and allow for color-coding. For example, the green color would have a high priority, the orange color would have a normal priority, and the red color would have a low priority.

6.5 A viewpoint visualization tool

The feedback about understandably communicating the knowledge without knowing the ArchiMate language is the core rationale of the visualization tool. The viewpoints necessitate the creation of an artifact that enables usage without modeling in an ArchiMate program or using the language. The visualization tool is an Excel document containing the viewpoints and the corresponding questions to model the concepts within the viewpoints, which enables modeling by using natural language. The Excel document contains an introductions sheet with a total viewpoint, which describes the relation and interaction between the different viewpoints, and an explanation of the document. The explanation of the viewpoints and the introduction is given in English. As long as the explanation is understood by the digital platform creator, any natural language to fill in the different concepts for each viewpoint can be used. Figure 29 illustrates the introduction sheet and Appendix IV depicts all viewpoints sheets that the document contains.

The Excel document format is chosen to allow the digital platform creator to fill in columns by using natural language as an easy way to model. Most people are familiar with the usage of Excel. In addition, Excel can be converted into a Comma Separated Value (CSV) document.

The pictures that show the viewpoint model must be removed but could be placed in a folder that is included with the delivery of the CSV files.

The viewpoint visualization tool can be accessed on GitHub[3].

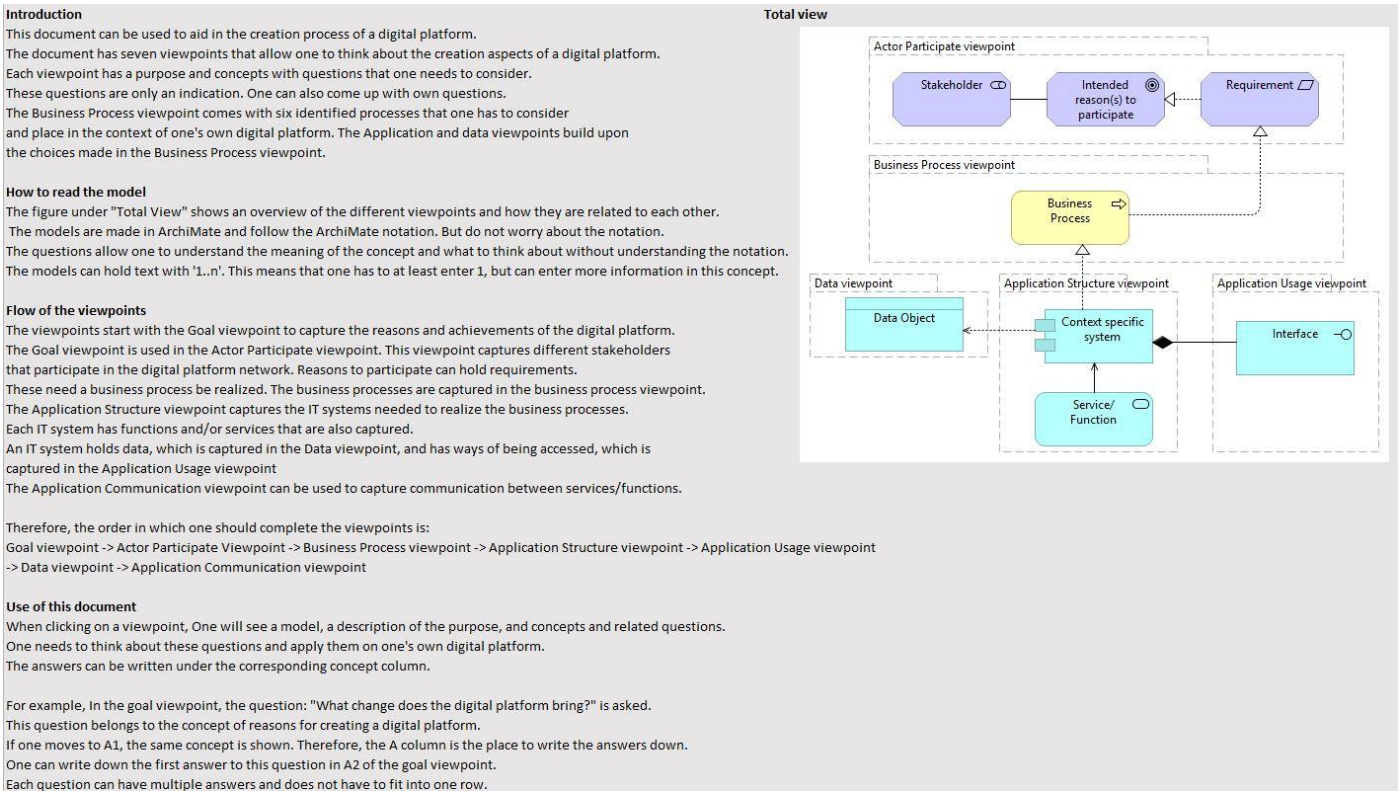


Figure 29 Introduction sheet

6.5.1 Viewpoints template

To describe each viewpoint systematically, a template is created, which differs from the template used to describe viewpoints in the previous chapters, as the sheet would become too large. The template contains a picture of the viewpoint's model, a description of the viewpoint's purpose, and the concepts and related questions.

Picture

The picture section shows the viewpoint's model and is the same picture as shown in the previous chapters when illustrating the viewpoint. For example, Figure 20 of the Data Viewpoint is the picture that is shown in the Data Viewpoint sheet. The picture allows one to see how the concepts relate to each other.

Purpose

The purpose section provides a brief description of the viewpoint's objective based on the previous chapters' abstract description of the viewpoint.

[3] Vist https://github.com/ernstdevries/digitalplatformvisualizationtool

Concepts& related questions

The concept and related question section explains the concepts of the meta-model and poses questions a digital platform creator has to consider and apply on their digital platform. These questions relate to concepts and should provide support for applying the concepts to a digital platform. This section can also hold general notes about the viewpoint. For example, the requirements from the Actor Participate viewpoint are used in the Business viewpoint.

Figure 30 illustrates the Excel document viewpoints.

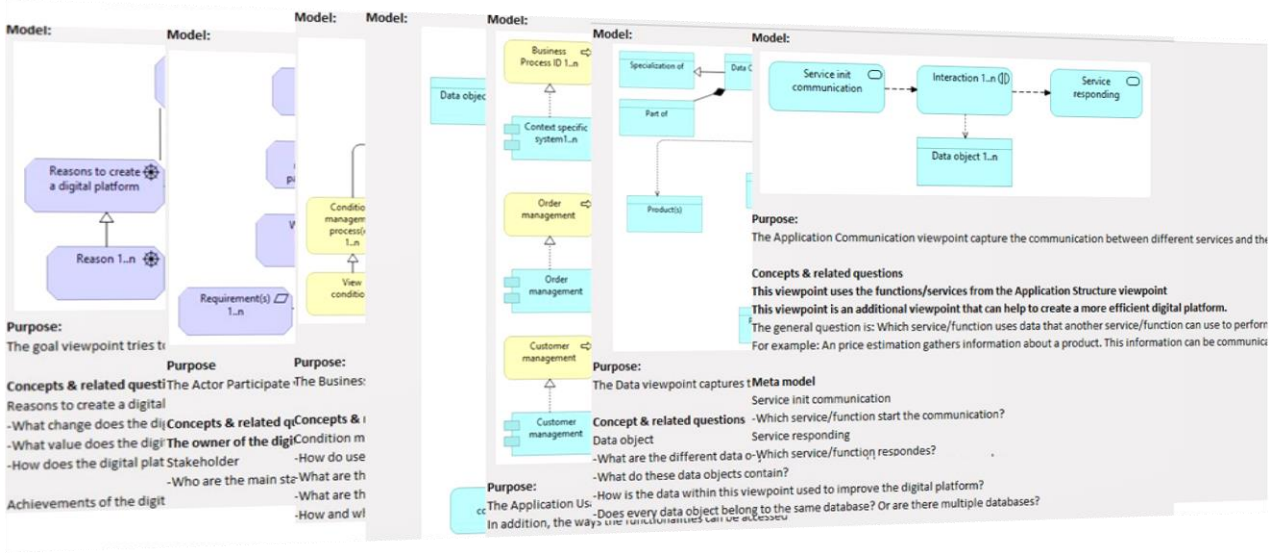


Figure 30 Collection of viewpoints and their description.

6.5.2 Conclusion

To answer the fourth sub-research question: the reference model is presented in an Excel document that contains the different viewpoints with a description of each viewpoint, which covers the purpose of the viewpoint, the concepts of the viewpoint with the related questions, and a picture of the model. The Excel document contains a total view explaining usage. A company can use the columns under each concept to answer the questions related to the concept. The document could be converted to CSV if a company does not support Excel. The pictures of the viewpoint's model can be included in a separate folder.

7 Generalization validation of the reference model

The Just Eat Takeaway case study validates the generalization of the reference model, in other words, can the reference model be used on other digital platforms that offer services. The main goal is to validate if the reference model can be applied to other digital platforms that offer services.

7.1 Just Eat Takeaway description

Just Eat Takeaway is a leading online global food delivery marketplace provider, connecting consumers and restaurants through its digital platform. Just Eat Takeaway (JET) classifies as a B2C platform for exchanging goods and services. According to its website, JET has over 580,000 connected restaurants offering consumers a wide variety of food choices (Just Eat Takeaway, 2020). As an online food delivery marketplace, Just Eat Takeaway facilitates the online ordering, payment, and occasionally the fulfillment of orders. Just Eat Takeaway was created in January 2020 by bringing together two of the world's most successful food delivery companies being Take away.com and Just Eat (Just Eat Takeaway, 2020).

7.2 Case-study setup

To validate the generalizability of the reference model an existing digital platform is modeled. To acquire information about JET, various websites have been found that provide information about the motivation and business part of JET. It was not possible to find information on the different systems used to model the Application Structure viewpoint. Therefore, the application layer has been excluded, which influences the data layer as well. There could be assumptions made about data objects. Although the assumptions might be wrong, this would validate the reference model wrong. Therefore, no assumptions are made about the data or application layer. This case-study uses information about Takeway.com and Just Eat in combination with Just Eat Takeaway.

7.3 Viewpoints applied

All viewpoints can be found in Appendix III in a larger format.

7.3.1 Goal viewpoint

The *creator of a digital platform* is Just Eat Takeaway and they have one *reason to create a digital platform*: the limited amount of online food providers. The director of Takeaway.com wanted to order food in 2000, but the only restaurants offering food were located in Amsterdam, which wasn't remotely close (Thuisbezorgd.nl, n.d.-b). This resulted in the registration of the domain on which the website and digital platform were created. Takeaway.com was called thuisbezorgd.nl

The following three *achievements of the digital platform* are identified (Thuisbezorgd.nl, n.d.-b) :

1. Increasing the number of online food providers.
2. An easy and fast ordering process.
3. Simplifying the logistics of the order process for food providers.

This is illustrated in Figure 31.

7.3.2 Actor Participate viewpoint

There are three identified *stakeholders* in the digital platform eco-system of JET being JET, food providers, and hungry customers. There are more *stakeholders* in the digital platform eco-system, but these three represent the most important roles.

The *stakeholder* Just Eat Takeaway (JET) has the *intended role in the eco-system* of the owner. As the owner, *the intended reason for participation* is captured in the goal viewpoint. The *expected value gained by participating* is the Gross Transaction Value (GTV) of food ordered through the marketplace, as JET gets a percentage of the revenue of orders, promoted placement of food providers in the marketplace, and the delivery of food when a food provider uses the JET delivery services (Thuisbezorgd.nl, n.d.-a). Just Eat Takeaway has one *way to realize the participating reason* the creation of a digital platform that connects the food providers with the hungry customers, which allows JET to promote food providers, offer food delivery services, and get a GTV of food orders. The *requirements* for *the way to realize the participating reason:* food providers are needed to increase the offering of online food choice, easy and fast order process, tools to provide logistic support, and employees to deliver food to consumers, which has the *limitation* that legislation might be against constructions of false self-employment (Vries de, 2021).

The *stakeholder* food provider has the *intended role in the eco-system* of the manufacturer and provider of the food. As the *manufacturer role,* they prepare the food and as the *provider role* they offer the prepared food on the digital platform. *The intended reasons for participation* are to acquire more orders, an increase in sales, and customers to know your store. In addition, a lot of customers expect food providers to be found on JET (Cleverism.com, n.d.; Thuisbezorgd.nl, n.d.-a). The *expected value gained by participating* is increasing the revenue by having more customers and better brand recognition by customers. The *way to realize the participating reasons* is by becoming a partner with Just Eat Takeaway, which has the *limitation* that people expect food providers to be found on Just Eat Takeaway. Therefore they are giving a certain percentage of the revenue created to JET. Although a *requirement* is that the food providers get additional benefits, which are provided by JET like marketing, paying commissions to websites, bloggers, and social media marketers that promote and generate sales for the Takeaway.com service (Cleverism.com, n.d.). However, a food provider competitor also enjoys these promotion events.

The *stakeholder* hungry customers have the *intended role in the eco-system* of a consumer with the *intended reason for participating* being that they want to get rid of the hungry feeling without doing much effort, which includes that a customer does not have to cook and touches on the *intended achievements* of the digital platform that the order process must be easy. *The expected value gained by participating* is food. The *way to realize the participating reason* is by ordering through the Just Eat Takeaway digital platform. The digital platform provides a wide range of options for consumers, spanning a variety of cuisines, from local restaurants that otherwise may not have online ordering services. Takeaway.com also provides its customers with deals and discounts that are not available elsewhere (Cleverism.com, n.d.). The *ways to realize*

the participating reason has a *requirement* that the type of food the customer is looking for is available, which has a *limitation* that not all food might be available due to supply issues.

Just Eat Takeaway's actor participant viewpoint is illustrated in Figure 32.

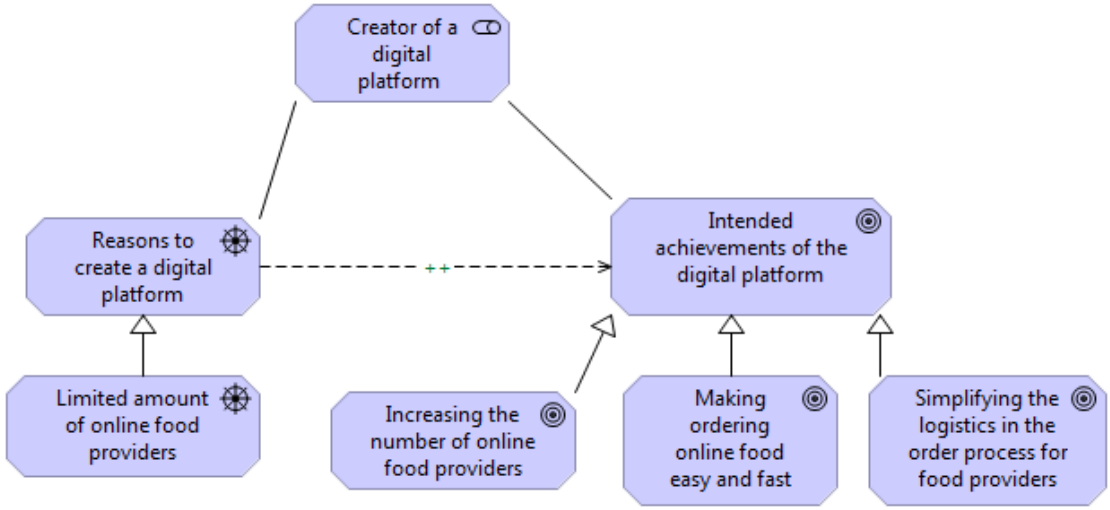


Figure 31 Just Eat Takeaway's Goal viewpoint

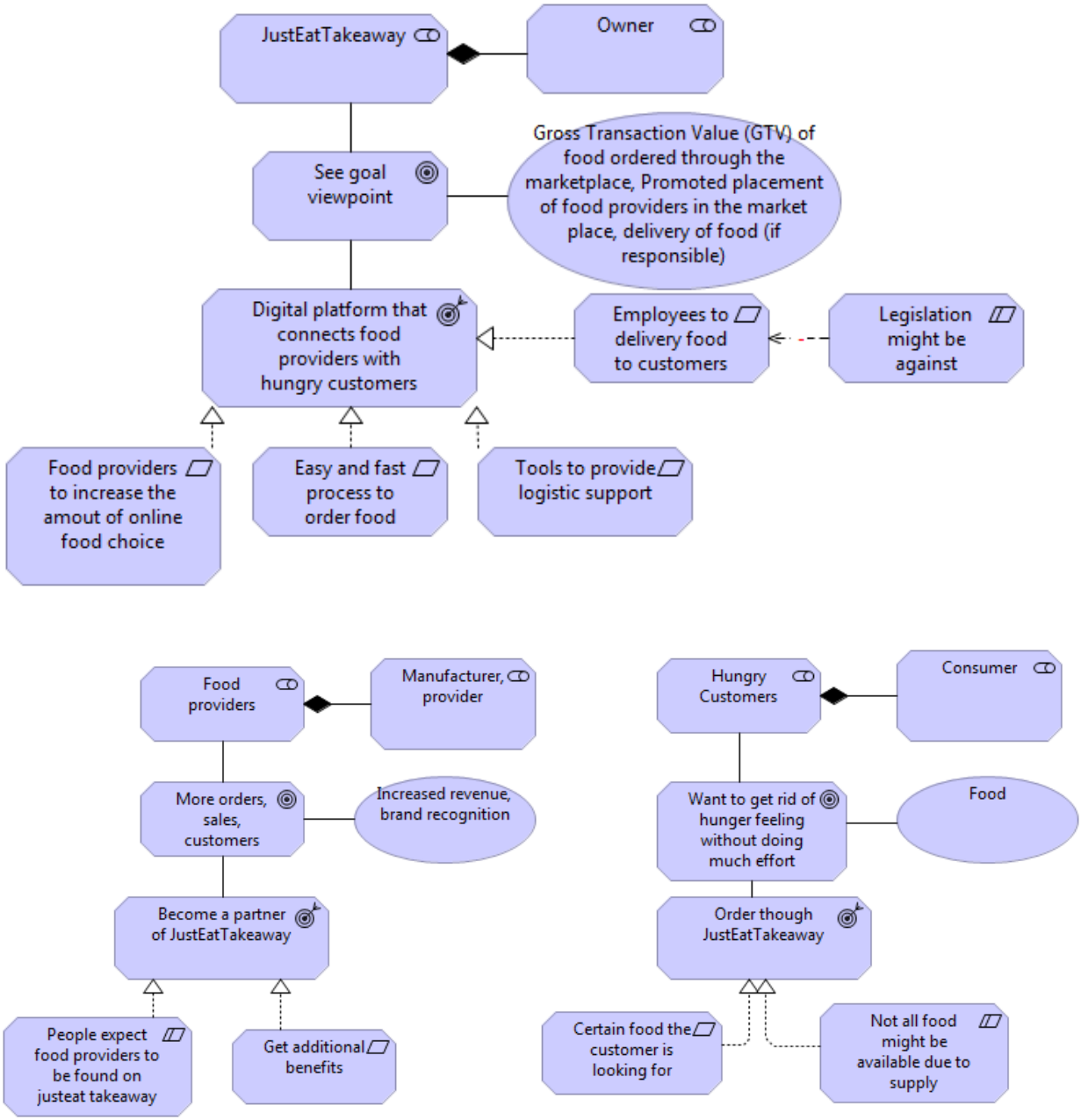


Figure 32 Just Eat Takeaway's Actor Participant viewpoint

7.3.3 Business Process viewpoint

There are processes identified for the *general digital platform business processes:*

1. The *condition management processes* include an ethic-hotline, which is an external party that handles internal incidents and employees can use the hotline to report them, and the ability to view the different documents that capture the legal statements of JET.

2. The *item/service offering processes* include a food catalog that provides the amount of food choice to the customer and the service for delivery. A food provider can specify the

delivery options. The customers can retrieve their order at the store or the order is delivered to the customer (or both). In the latter option, the food provider can do the delivery themselves, or use the delivery service of JET. There should be more services that are offered to food providers, but to identify these a food provider's account to login is required (Thuisbezorgd.nl, n.d.-a).

3. The *order management process* includes a process that allows JET to send an order to the food provider that offers the food, which allows the food provider to prepare the food, and a process to inform the delivery service to fetch and deliver the order to the customer. This is only done if the food provider uses the delivery service of JET.

4. The *payment processes* include that customers can pay for their orders and food providers receive payment for each order completed through JET. Customers have a scope of payment methods, like paying in real money, or through payment providers like PayPal, Visa, MasterCard, etc. Payments can also be made in bitcoins, on which no exchange expenses are charged. Takeaway.com also offers its customers exclusive deals and discounts that are not available anywhere else (Futureworktechnologies.com, n.d.).

5. The *customer management processes* include the options for food providers to register, to apply for the partner program, and for customers to register and subscribe to a newsletter. The option for food providers to register allows JET to create an account for them, thereby giving them access to the digital platform food marketplace. A food provider can't create an account on their own (Thuisbezorgd.nl, n.d.-e). The application for the partner program allows partners to acquire additional benefits like buying items through the JET shop (Thuisbezorgd.nl, n.d.-d) . The customer registration process allows a customer to sign up for an account, browse menus, place orders, and make payments directly through the Takeaway.com website (Cleverism.com, n.d.). Customers can subscribe to a newsletter, which allows JET to inform the customers about updates, vouchers, etc. In addition, JET has a loyalty program where they reward customers with vouchers if they subscribe to the newsletter and order through the digital platform of JET (Thuisbezorgd.nl, n.d.-c).

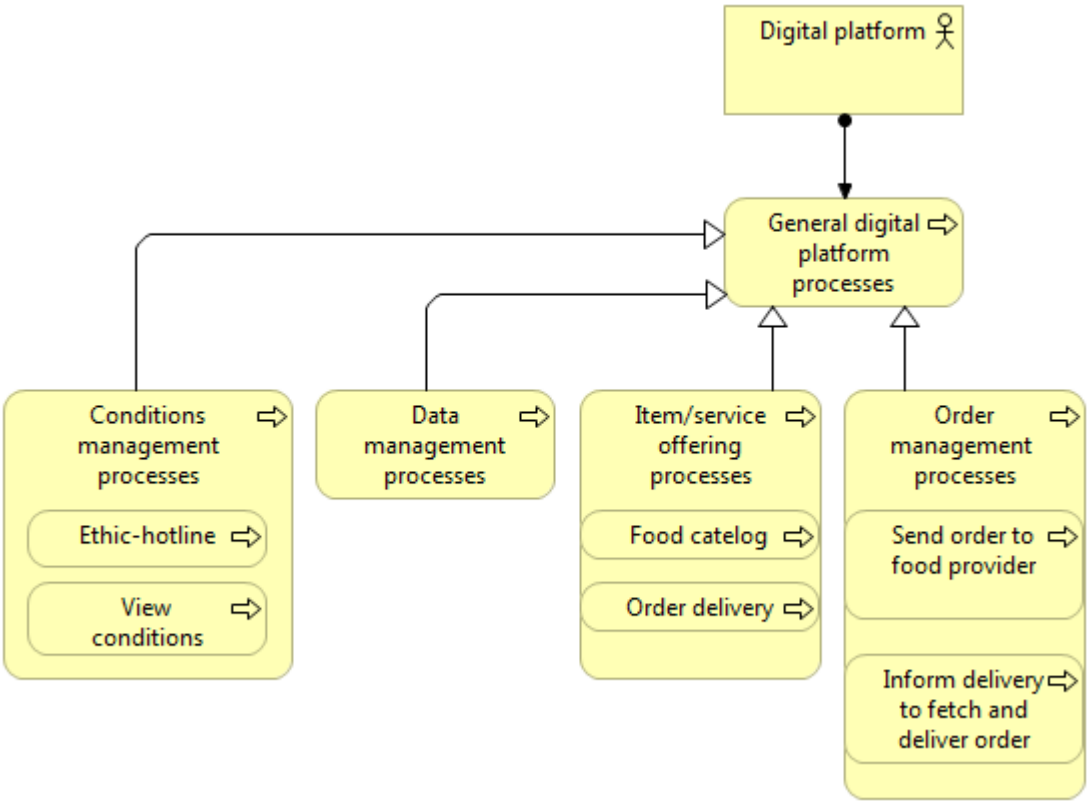
There are three *contextualized business processes* that realize three requirements: 1) food providers increase the amount of food offered, 2) tools to provide logistic support, and 3) additional benefits.

1. The *recommend food provider* is a method for increasing the number of online food options for customers. Everybody can recommend a food provider to JET, although one can question the necessity of this function as JET is a key market player in the food ordering and delivery business.

2. The *food delivery* process provides logistic tools to companies that require them. This can be the delivery of food, the processing of orders, or insights into frequently ordered dishes.

3. The *partner program* provides additional benefits to food providers that join the digital platform. Initially, this could be used to overcome the chicken-and-egg problem. As additional benefits might persuade the food provider into participating, thus it serves as a strategic tool to attract food providers. In the light of JET being a key market player, the strategic use is to keep food providers within the digital platform of JET. A food provider has access to the JET shop, which allows buying various items like a microwave or allowing buying items in bulk for a cheaper price.

Just Eat Takeaway's business process viewpoint is illustrated in Figure 33.



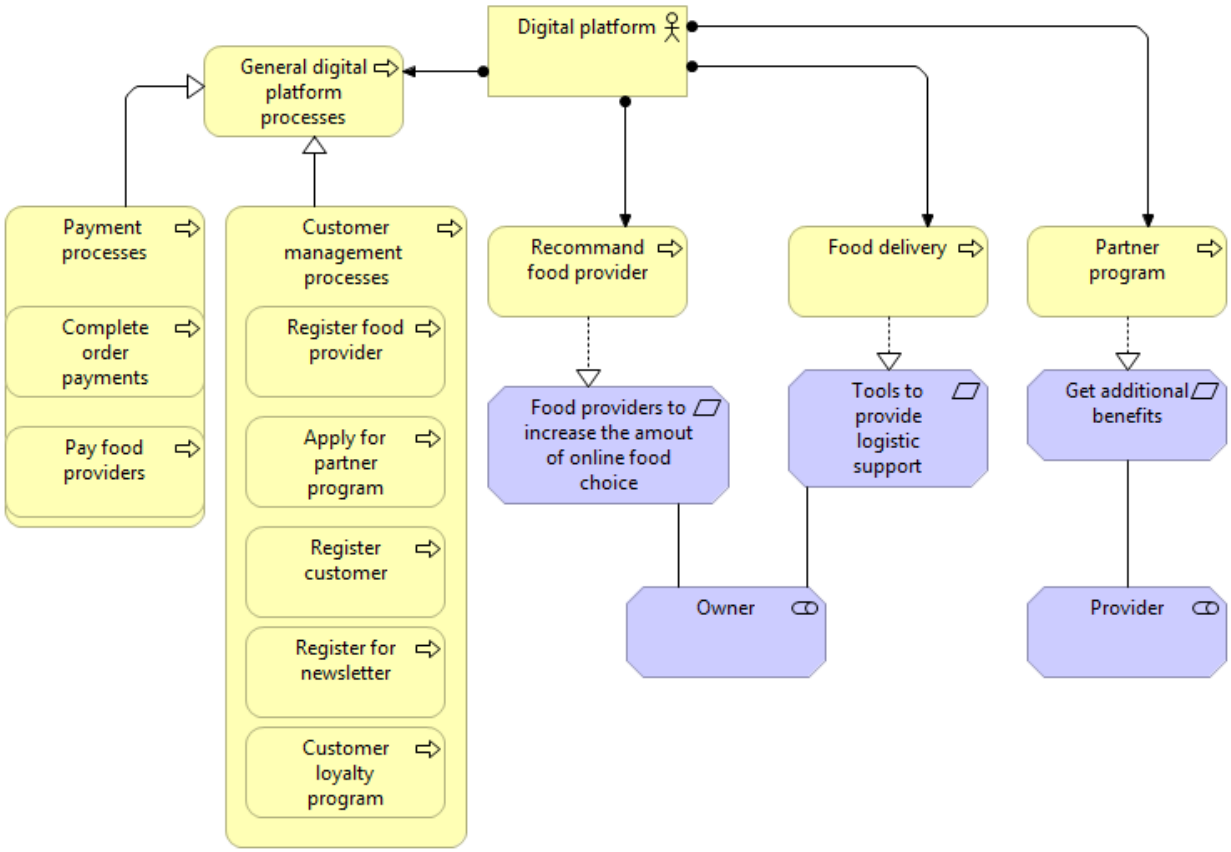


Figure 33 Just Eat Takeaway's Business Process viewpoint

7.3.4 Data viewpoint

The data within the *contextualized* systems are seven *data objects*, which contain *data objects* to provide more detail. The *contextualized systems* could not be identified.

1. The *food provider data objects* are composed of an *expected delivery time, rating, delivery fee,* and *the minimum amount for an order.* The *food provider data object* is composed in *an order data object.*
2. The *order data object* is composed of a *food provider* and the *food data objects.*
3. The *food data objects* are composed of a *category, name, and ingredients.*
4. The *product data object* could not be analyzed due to a lack of data.
5. The *conditions data object* hold specializations of legal documents, like the *privacy statement, payment methods, shipping methods,* and *general terms.*
6. The *administration* and *customer information data objects* are not modeled in more detail as no information could be found.

Just Eat Takeaway's data viewpoint is illustrated in Figure 34.

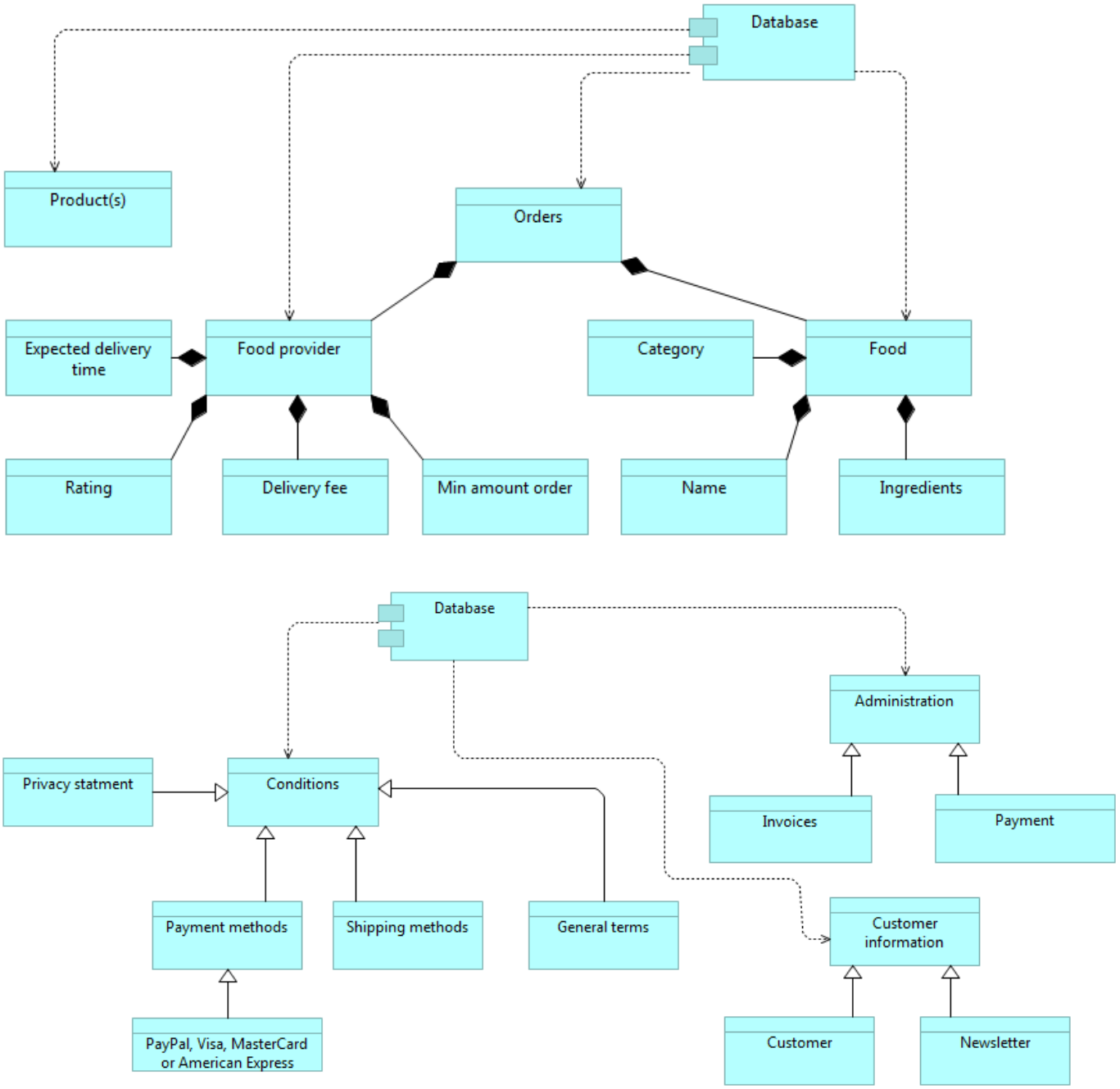


Figure 34 Just Eat Takeaway's Data viewpoint

7.4 Analysis of result

The Just Eat Takeaway study shows that the reference model holds when applying it on an existing digital platform. However, three viewpoints could not be modeled as there was no information available. Of the existing viewpoints, the goal and actor participate viewpoints provide evidence that these viewpoints can be used on an existing digital platform. Although, in the business process viewpoint there is a problem with processing the requirements into business processes, for example, the recommending of a food provider process is excellent to have at the beginning of a digital platform, which can help by dealing with the chicken-and-egg problem,

although one can question the use of this process when the digital platform has a strong brand name and has a strategic position where providers have to join the digital platform. The business process provides an overview of all processes and can be used for alignment purposes within existing digital platforms. JET can acquire the resources needed to upkeep the recommended food provider process and the benefits of the process. Based on this evaluation, JET can decide whether to keep it or stop the process. The data viewpoint could not be fully modeled since the application structure creates the data object by defining the various systems the digital platform has. The lack of information to create this viewpoint causes the data viewpoint to lack information as well, which is a logical consequence of the resulting context of the data viewpoint.

Overall, our reference model is able to model an existing digital platform. The value is not in providing support with business choices in the creation process, since this is already completed, but in providing an overview of the digital platform that can be used to create alignment in the different domains. In addition, the overview can be used to improve or remove processes within the digital platform. The JET study is conducted with the support of information on the JET website with information on other websites. There is no scientific literature used in this study because literature that describes the business and revenue model of JET could not be identified. Therefore, this study might lack quality but is not considered useless as it uses the reference model to validate and provide insight into the generalizability. The reference model works on digital platforms that offer services, but if they already exist the use is limited.

8 Discussion

This chapter discusses the choices made in the design and the findings from the validations.

8.1 Digital platform providers

The assumption that platform providers are big enterprise companies is a bias created by example. Ask a random person to name a digital platform provider and names like Uber, AirBnB, and Just Eat Takeaway show up. To assume that all digital platform enterprises are large companies that are dominant in their market section would be a mistake. Firstly, these companies are pioneers. For example, JET started in 2000, which allows these companies to establish themselves as technology emerges. Secondly, as a new digital platform, you have to start small and build upon your core layer to overcome a lot of problems, like the chicken-and-the-egg problem. This means that not all SME digital platforms will survive and make a name for themselves. But, there are SME digital platforms that are fulfilling the role of digital platform providers, like the social media platform clubhouse or service provider uitgekookt.nl. However, it does not always make sense for an SME to become a digital platform provider, for example, if an existing digital platform provider already exists. In this case, an SME can join an existing digital platform network.

8.2 Eco-system and digital platform layer model

The created digital platform eco-system assumes that the concepts are applicable to be assigned to a layer, which is not directly validated. The only validation was combining existing literature, thus, a change to the digital platform eco-system could affect the result of this master project. The digital platform eco-system is used to create the digital platform layer model, which is used to create the different viewpoints that are described in Chapters 4 and 5. Changing a layer or concept within the digital platform eco-system means that this change needs to be reflected in the digital platform layer model and the viewpoints.

In the light of the digital platform layer model, one might point the model's generality out. The digital platform layer model has a general structure of motivation, business, applications, and data. Indeed, one might point out that it could be used in many IT projects. Since projects have a business case and a motivation aspect, in combination with the IT structure captured by applications and the data within these applications. However, the digital platform layer model does not come with a technical layer to include things like IoT sensors, servers on which software is hosted, or deployment processes. As a result, the reference model cannot be used in these IT projects as these do not belong in the scope or context of this research.

Taking context into consideration, two questions emerge: a sensitivity question and a trade-off question (Wieringa, 2010). The former assesses what would happen if the context became larger, which would include webshops. The reference model is inspired by the vending machine pattern (Perroud & Inversini, 2013), which describes how to set up an e-commerce shop. The border of the context is drawn if there is no value exchange between a consumer and manufacturer facilitated by a provider. The latter assesses the behavior of another artifact in the same context, for example, the use of another enterprise architectural framework, like the Zachman framework.

The viewpoints of this framework can be used to create viewpoints in the digital platform layer model, for example, the motivation layer can include the motivation scope, business model, and the system model viewpoints of the Zachman framework. As a result, another enterprise architectural framework or languages that specify viewpoints can be used to create viewpoints for the digital platform layer model.

8.3 Feedback Castlab validation

Castlab provides suggestions on which this section reflects:

- The suggestions to include a legend and have a total viewpoint are the main reason for the creation of the visualization tool, the Excel document. To provide support in using the reference model and have a total viewpoint, allowing users with no knowledge of ArchiMate to work with the reference model and incorporate the questions behind the concepts, as the text "order management processes" does not communicate what aspects a user has to consider. The Excel document contains a total view that allows one to quickly grasp how the different viewpoints relate, however, this is in ArchiMate notation. Hence, there is also a text description of the (total) viewpoint. The ArchiMate model in each viewpoint only serves as an illustration, thus completing a viewpoint without understanding the notation is possible. The different concepts and questions are written down in text, which should ensure that users can work with the reference model as long as they understand Excel and can read English. The requirements for the reference model are gathered during his validation session; therefore, they are not gathered prior to the design phase. As a result, it should not be a surprise that the minimum requirements are satisfied.

- The suggestion to include cost and complexity aspects to the reference model is not taken into account, as result, the reference model is not altered. Estimating the cost of a digital platform is a very hard task. In general, the estimation of software is a very hard task. There are three parameters involved in the estimation of software costs: hardware and software costs, including maintenance, travel and training costs, and effort costs (the costs of paying software engineers) (Sommerville, 2008). The effort costs are determined by how long the software engineers take to develop the digital platform, which can be estimated in two ways: size-related and function-related. These come with different techniques like algorithmic cost modeling, expert judgment, and estimating by analogy, amongst others and each technique has are best practices. For example, the expert judgment technique is described by Jørgensen (Jørgensen, 2005). In addition, some books describe how to estimate the software cost, for example, Software Estimation: Demystifying the Black Art (McConnel, 2006). This demonstrates that cost estimation is a complex subject that is time-consuming to establish and validate. As a result, the decision is made to exclude these aspects from the reference model.

  The complexity of a digital platform is created by several elements, like the digital platform type, chicken-and-egg problem, and knowledge. The first element is not included as the reference model is designed for service offering digital platforms, however other

types should be possible. The second element is not within the scope of this master project. The third element is the focus of the reference model, to communicate knowledge to a knowledge carrier, by providing pre-defined concepts and questions about the interpretation of these concepts. This allows a user to think about various elements of a digital platform, which deals with the element of complexity.

- The suggestion about more questions concerning the data elements is implemented. The Excel document holds questions to let a user think about how the digital platform and company benefit from using data. For example, in the Business Process viewpoint under the data management concept, the following question is asked: How does the digital platform use data to improve or learn?

- The suggestion that users might not be familiar with terminology like API is addressed. In the Application Usage viewpoint, the following description is added: An application programming interface (API) is a connection between computers or between computer programs. It is a type of software interface that offers a service to other pieces of software. This is used for direct communication, so there is no website on which a user goes[4]. In addition, the reference model does not concern itself with the creation of an API specification, as this would be too technical. A user has to consider if there is machine-to-human communication, in which case a webpage or e-mail would be the interface, or machine-to-machine communication, in which case an API is needed.
- The suggestion to use color-coding is not implemented but given as a recommendation, which touches on TOGAF ADM phase F, called Migration and Planning, which describes how to move from the baseline to the target architectures by finalizing a detailed implementation and migration plan (The Open Group, 2018b). The target architecture is the outcome of the reference model. With the support of color-coding, a user can create work packages and assign priorities to them based on the color. See the recommendation section in Chapter 9 for more explanation.

In the light of recommendations, the Excel document is not directly validated. There has been no technical action research (Wieringa, 2010), which is a limitation and discussed in Chapter 9 in the limitation section. Nevertheless, there is an indirect validation of the Excel document since the questions in the document are in line with the questions asked to Castlab for the case study, which has shown that the information acquired through these questions is correct. As a result, the questions can subtract the relevant information from a user. Therefore, we assumed that if a user of the Excel document can read English and use Excel, the Excel document allows using the reference model.

8.4 Requirement validation

Chapter 3 describes the identified requirements for the digital platform stakeholders, the digital platform structure, and the reference model. According to Wieringa (2010), if the requirements for the treatment, solution, are specified and justified, then the treatment can be validated by

[4] See https://en.wikipedia.org/wiki/API for more information.

showing that it satisfies its requirements. Table 6 provides an overview of the requirements, an explanation, and if they are satisfied in the validation Chapters. The non-functional requirements in the digital platform structure are excluded as they rely on the implementation of a digital platform.

For the requirements with ID 1 (N = 13), 100% of the must requirements (N = 5) are satisfied, 100% of the should requirements are satisfied (N = 5), and 33% to 66% of the could requirements are satisfied (N = 3). The latter depends on requirement 1.4. For the digital platform structure requirements (N = 5), 100% of the must requirements (N = 2) are satisfied, and 66% to 100% of the should requirements are satisfied, also caused by the plausible outcome of requirement 2.5. There are no could requirements this category. For the reference model (N =10), 100% of the must requirements (N =5) are satisfied, 33% to 66% of the should requirements (N =3) are satisfied, and 0% of the could requirements (N =2) are satisfied. In the last category, the absence of achieving the should and could requirements looks severe, but that is not the case. The should requirements can be satisfied based on how one looks at the requirements. In the end, the must requirements have been satisfied not only for reference model requirements, but also for digital platform stakeholder and structure requirements.

Table 6 Requirement validation

ID	Requirement	Satisfied	Explanation
1.1	The user must be able to retrieve clear and consistent information about the digital platform on topics of interest, like policies.	Yes	Condition management specifies that one has to think about this issue. In the Data view different condition data objects are specified like the privacy statement that should include how to deal with the GDPR.
1.2	The user should have the ability to integrate their third party service with the digital platform.	Yes	The Application Usage viewpoint allows to create interfaces and when needed the Application Communication view can describe the communication. In addition, these services can be identified in the Actor Participate viewpoint and a business process can be created to realize the requirement, which results in the Application Structure viewpoint for various IT related processes that aid in the integration of the 3rd party service.
1.3	The user should have the option to view statistics concerning the provided service.	Yes	The data management concept should allow one to come with an analysis of performance and to visualize these statistics.
1.4	The user could have the option to provide another company to fulfill their service.	Plausible	A provider can hire another provider, without the intervening of the digital platform. But the digital platform can create conditions within the condition management concept that allow or disallow the requirement.
1.5	The user must be able to access the	Yes	The reference model has an Application Usage

	service.		viewpoint that should show how the item/service concept, where the different services are placed, is accessible.
1.6	The user must receive money once a service is purchased.	Yes	The payment concepts allow to model these processes. This is done in the JET case-study in the Business Process viewpoint.
1.7	The user should have the option to pay for the service.	Yes	This can be captured in as a payment process.
1.8	The user should have the option to register to the digital platform.	Yes	The customer management concept in the Business Process viewpoint comes with an example process which is the registration. The Excel document comes a question concerning the registration process.
1.9	The user could have the opportunity to share his/her experiences of the service on the digital platform.	Yes	The customer management concept in the Business process can capture this requirement. In the JET case-study the Data viewpoint holds a ratings data object.
1.10	The user must have the ability to monitor the digital platform.	Yes	The data management concept allows to visit data and manage data. Since items, services, performance, etc. are captured in data. The digital platform can be monitored in this manner.
1.11	The user must have the option to manage offered services.	Yes	The item/service offering concept should offer the space to model such functionality.
1.12	The user should have access to performance statistics of the digital platform.	Yes	The data management concept has a view statistic which should be accessible for the user.
1.13	The user could have a list of current bugs in the digital platform software.	No	There is no concept that captures the maintenance processes.
2.1	The digital platform must have storage capacity to store data.	Yes	The data view allows one to model the storage of data and how these data objects are called and relate to other data objects.
2.2	The digital platform must be able to modify services/information from storage.	Yes	The data can be used by the system, for example in the Castlab case study the status update of an order modifies the data.
2.3	The digital platform should be able to execute specific processes like payment.	Yes	The reference model allows to model context specific processes. In addition, payment is a concept that allows one to model all payment processes.
2.5	The digital platform should have an interface to facilitate adaption by third-party providers.	Plausible	The reference model does not come with such interface, although in the Application Usage viewpoint one can be created.
2.6	The digital platform should be able	Yes	The Application Communication viewpoint

	to transfer data between different systems.		allows one to model the communication between two services. These can be on different systems.
3.1	The reference model must contain concepts to create a digital platform.	Yes	The Castlab and JET case study have shown that these identified concepts can be used to create a digital platform.
3.2	The reference model must increase the knowledge of digital platforms for companies.	Yes	In the case study with Castlab the experts stated that they had a better understanding of the digital platform processes.
3.3	The reference model should explain each concept with an example.	No	The reference model holds concepts and for the Business Process viewpoint, Application Structure viewpoint, and Data viewpoint examples are provided. But other viewpoints do not show examples.
3.4	The reference model should show why alignment between business and IT is complex.	Plausible	The alignment is shown in the Application Usage viewpoint and the reference model states various questions to make it easier to understand this in the creation process. But it is not shown why it is complex, therefore, this is plausible.
3.5	The reference model could evaluate alternative options and provide cost estimates.	No	The reference model does not evaluate alternative options and does not explain cost. See the discussion section for more information about why costs are not being explained.
3.6	The reference model must have a clear visualization.	Yes	The model comes with clear visualization of each viewpoint in ArchiMate and with an Excel document that shows the questions to answer these.
3.7	The reference model must explain concepts presented.	Yes	The Excel document explains the concept by asking questions one can answer to get an idea what the concept is about.
3.8	The reference model visualization must allow the users to use the EA patterns.	Yes	The Excel document is created to allow users to use the reference model that contains the EA patterns.
3.9	The reference model visualization should have an option to be used outside Excel.	Yes	The different viewpoints can be converted to CSV, which is a format that is supported by a lot of programs.
3.10	The reference model visualization could contain a validator for the model.	No	The reference model does not contain a validator as this depends on how the model is presented. As there needs to be a validator for ArchiMate and for Excel.

9 Final remarks

This research covered the development of our reference architecture to transfer knowledge about the business model choices and business-IT alignment for a digital platform that exchanges service, which is designed as a set of Archimate patterns. Section 9.1 describes what we learned by answering the research question, Section 9.2 describes the limitation of the study, and Section 9.3 describes future work based on the limitations of the study and recommendations as result of the discussion.

9.1 Lessons learned

Our main research question was: How to create a reference architecture that communicates EA patterns which explain the business model choices and provide business-IT alignment in the design of a digital platform, so that knowledge carriers can create a digital platform design to offer services in the context of a digital servitization offering? In order to answer it, the four sub-questions are answered below w.r.t what we learned:

- The first sub-research question was: What are current solutions identified in the literature and how do they relate to the knowledge topic, we identified frameworks that describe important concepts and their domain within the creation of a digital platform? In our search for literature, we found eco-systems (Drewel et al., 2020; Poniatowski et al., 2021) tailored to digital platforms. Based on these we described our interpretation of a digital platform eco-system, which contains three layers with different stakeholder roles. We analyzed the important concepts and their domain with the goal of assessing which layer of the digital platform eco-system is affected, then we created a mapping between the digital platform eco-system and the concepts. As a result, we learned the important concepts and their domains within the knowledge topic, and by mapping it onto the eco-system we learned how they relate to each other within the knowledge topic.

- The second sub-research question was: what are the general requirements for a digital platform that exchanges services? To answer this we used the digital platform eco-system and took each layer with the corresponding roles to assess, with the support of literature and Castlab, and defined requirements for each layer. We learned that there are three categories of requirements: digital platform stakeholder requirements, which capture requirement a stakeholder might have in a particular role, digital platform structure requirements, which capture functional requirements and qualitative requirements (non-functional) of a digital platform, and reference model requirements, which capture requirements for the concepts within the reference model and the presentation.

- The third sub-research question was: how should the reference model be structured? To answer this we used the requirements and the concepts of the digital platform eco-system. This sub-question reflects on how the knowledge topic is communicated. As the communication device is the reference model, the question concerns the structure of the model. Therefore, we used a basic architectural technique called layering to apply structure. We learned that the requirements and concepts can be structured in four layers: motivation, business, application, and data:

    - The motivation layer contains two viewpoints: the goal and actor participate viewpoint. The former captures the reasons to create of the digital platform, and its intended achievements, the latter captures the different stakeholders with their intended role and their intent to participate, which can generate requirements.
    - The business layer contains the business process viewpoint, which captures the different processes within the digital platform.
    - The application layer contains three viewpoints: the application structure, usage, and communication. The first one captures the IT systems required to realize the business functionalities and describes the functions or services of these systems. The second one captures the alignment between the business and IT by visualizing each business process, IT system, and their relation. In addition, an interface for each system is specified to define the accessibility of the IT systems. The third one captures the communication between systems, which allows services to be combined.
    - The data layer contains the data viewpoint, which captures the data elements and their relations within the digital platform.

  We learned that these layers with the viewpoints containing EA patterns allow proper communication of the reference model in order to model business choices and create business-IT alignment.

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- The fourth sub-research question was: how can the reference model transfer knowledge to knowledge carriers in a usable manner? To answer this we learned that ArchiMate alone is not adequate to transfer knowledge in a usable manner, as users might not be familiar with ArchiMate. Therefore, we created a visualization tool in an Excel document format, which allows the use of natural language to model the concepts. Each viewpoint is represented in a separate sheet with a picture of the model, the concepts, and the related questions to answer. These answers model a concept, thereby, defining a viewpoint. In addition, the visualization tool contains a total viewpoint that provides context on how the viewpoints are related and an explanation of the usage of the tool.

The main research question has been answered by identifying concepts in the literature, identifying requirements, creating a layer model, creating viewpoints, and validating the requirements. The result of this research is the reference model with a visualization tool, which allows companies to gain knowledge about choices they need to consider and provides business-IT alignment within the creation process of a digital platform.

9.2 Limitations

This research has some limitations concerning the reference model.

- The reference model does not include all concepts that can pertain to a digital platform eco-system:
    - The reference model does not describe the maintenance processes of the digital platform, for example, a process of fixing bugs, registration of bugs, updating

system software, etc. There is no concept that represents these processes in the business viewpoint, despite their importance to the digital platform.
    - Strategy concepts are not represented in the reference model, like the resources and capabilities of the digital platform. The ArchiMate language supports basic viewpoints, like the strategy viewpoint, and the capability map viewpoint, amongst others that can be used to describe strategy concepts. These can be used to enable capability-based resource planning within the digital platform.
    - As the feedback of Castlab indicated, planning and migration concepts are not represented in the reference model. The ArchiMate language supports some basic viewpoints that cover these concepts, which would allow a user to plan the creation of the digital platform, indicate which business processes and IT systems need to be realized first, and create work packages to manage the project.
    - Organizational concepts are not represented in the reference model, to represent the organization at a detailed level, which allows assigning responsibilities to work packages.
    - The reference model focuses on servitization but does not offer concepts to model each service in detail. The business viewpoint supports the working of services, but there is neither a concept nor a viewpoint that supports modeling services in detail, for example, by showing which elements a service contains. In ArchiMate, a product could be used for that.
    - There is no technical layer that covers the deployment of the systems, the software used on the systems, etc. These concepts are technical, thus not all users might understand them. However, the IT systems need to be deployed.

- The reference model only covers digital platforms that exchange services, which limits the applicability and generalizability of the artifact, despite being the scope of the research. Other digital platforms, like asset and social media digital platforms, could use the same EA patterns or parts to aid in the creation process, however, this is not validated.

- The validation has a small sample size of one company and one analysis of an existing company. A small sample size might provide wrong insights (Kahnman, 2011b), which limits the creditability of the study.

9.3 Future work

The study provides a reference model as well as a visualization tool that can be built upon to better inform about digital platforms and create business-IT alignment. Hence, there are some suggestions for future work directions one can look into:

- The patterns described by Perroud and Inversini (2013) can be used to model parts of various viewpoints in more detail. This would provide more information about how to engage with a subject. For example, in the Business Process viewpoint, the concept of order management is introduced. The supplier-to-consumer pattern by Perroud and Inversini can be used to define the order management concept in more detail. One might come up with different levels of order management, and each level defines more about

setting up a supply chain. These levels might be captured in a maturity model. There are multiple concepts from different viewpoints that can use different patterns to provide more detail and can be used to create a maturity model. For example, the WorkTogether pattern is used for condition, data, and customer management; the KnowYourCustomer pattern is used for customer management; and the Financials pattern is used for payment concept, among other things.

- One could also look into other digital platform types like assets, social media, and knowledge-based digital platforms and adjust the defined viewpoint to fit these types of digital platforms. In addition, the patterns by Perroud and Inversini can be used to further refine the concepts. For example, on a social media digital platform, the ForYourEyesOnly pattern can be implemented, which allows users to only receive information from those who they follow or give permission to receive it, and for the knowledge digital platform, the InformationChest pattern, which aggregates and stores data, allows the digital platform to find data more easily. This would help get a clear picture of what knowledge is present on the digital platform and would also support answering questions and preventing duplicate questions. These digital platform reference models could also come with maturity models to provide guidelines on how to define a concept and how to improve this concept to the next level.

- With the current reference model one could use color-coding in the implementation of a prioritizing tool. Currently, the concepts are equal in importance. The color coding would allow us to create a baseline architecture and a target architecture with various stages (also called plateau in ArchiMate) in between, for example, green for this stage and red for the next stage. These plateaus can be used to define deliverables and work packages, allowing project management to use them in their project planning. The color coding can be used as maturity levels. For example, blue is level one, green is level two, and red is level three. The baseline corresponds to the TOGAF as-is situation and the target architecture with the TOGAF to-be situation. The planning element should be in line with TOGAF ADM phase F planning and migration (The Open Group, 2018b).

- Another suggestion for the current reference model is to add a maintenance concept to the Business Process viewpoint. This concept would cover the most relevant maintenance processes like collecting and fixing bugs in the digital platform, ensuring IT systems keep running, and backup planning, amongst others. One could also add a new viewpoint called the organizational viewpoint. This viewpoint would describe how the company is structured by describing the departments in the front-office and back-office. As a basic ArchiMate viewpoint, the Organization Viewpoint can be used as a starting point. These offices could be in line with (Cenamor et al., 2017) stating that the back-office task is to develop blueprints of services, and the front-office is to fit the service into the specific context. The reference model needs more validation to assess whether it holds in other companies, and to assess if users understand the Excel document that describes the digital platform and are able to create digital platform architectures with the document. In addition, a product viewpoint or strategy concepts could be added as mentioned in Section 9.2.

- In the end, the current reference model is the first step towards a larger reference model in the creation of a digital platform. This framework should contain multiple digital platform types. Every digital platform type has its own set of perspectives that work specifically for that platform type. The viewpoints follow the layers of the digital platform layer model. In light of the organization viewpoint suggestion, this viewpoint would belong under the motivation and business layer. Each viewpoint should come with a maturity level for all concepts that are presented. These levels range from having nothing in place to state-of-the-art, and should contain a description of what the concept is, how to move from the current level to the next level, and why one should move a level. All these viewpoints need to be validated with case studies. The result would be a reference model for the creation of all kinds of digital platforms, just like the Supply Chain Operation Reference (SCOR) model for supply chain management.

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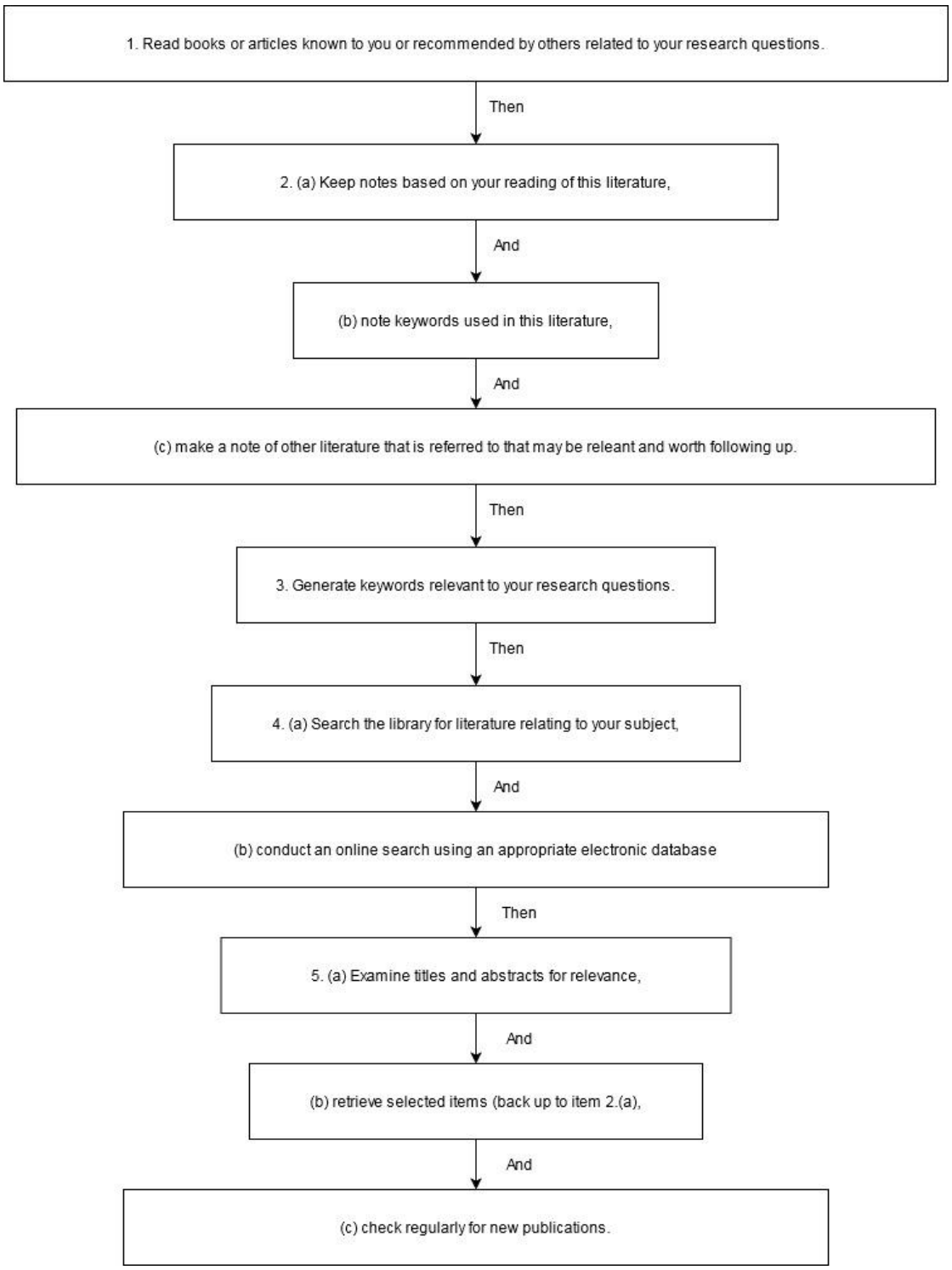
Appendix I Research methodology

The following picture resembles a research methodology to perform a literature study for a master thesis (Bryman & Bell, 2015).



Appendix II Web technologies

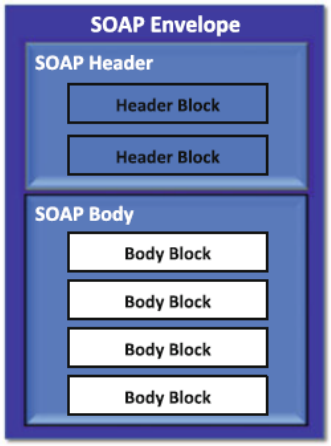
Technologies

A digital platform uses the internet as information technology protocol to connect participating sides through the platform with each other. There are at least two prominent technologies that facilitate the internet protocol by using services. These are web services using SOAP and RESTful services. Paik et al. describe these technologies in the context of web service implementation and composition techniques, and is used for the following section (Paik et al., 2017).

Web services using SOAP

Simple Object Access Protocol (SOAP) is used by Web services to construct and understand the messages they exchange. SOAP is at the heart of Web services architecture in that it allows the interacting parties in the architecture to communicate with each other using a standard, well-understood message format. The specification defines an XML-based standard message format, describing how the message metadata and payload should be packaged into an XML document.

Each message consists of SOAP Header and Body sections. The payload is included in the body section. The additional processing instruction details, such as the transaction protocol or security policies, go into the header section of the message. Figure 9 is an example of a SOAP message and a SOAP request.




```
<?xml version="1.0"?>
<soap:Envelope
  xmlns:soap="http://
  www.w3.org/2003/05/soap-envelope/"
  soap:encodingStyle="http://
  schemas.xmlsoap.org/soap/encoding/">
  <soap:Body xmlns:m="http://
                  www.test.org/stock">
    <m:GetStockPrice>
      <m:StockName>IBM</m:StockName>
      <m:StockPrice>126</m:StockPrice>
    </m:GetStockPrice>
  </soap:Body>
</soap:Envelope>
```

Figure 35 Example of SOAP message and request (Paik et al., 2017)

A SOAP message can be bound to a transport protocol, for example HTTP. The term 'SOAP binding' is used to indicate the transportation mechanism by which a SOAP is transmitted. SOAP also provides a message processing model that allows adding customized headers which can be processed at different processing nodes. One can add a security header, which will be processed at the security handler.

SOAP is a message standard that can be used to communicate by using web services description languages (WSDL). WSDL is a machine-processable specification of the web services interfaces, a document that the service provider would write to inform the client about what kind of services

there are offered and how to use these services. This document contains two parts: abstract and concrete. The former defines the operations and messages exchanged through them; the latter contains information about the network deployment specifics and data format bindings. Thus the abstract part can be bound on HTTP protocol or SMTP, or another transfer protocol depending on the concrete part.

SOAP supports two different message communication styles, namely RPC and document. The Remote Procedure Call (RPC) with SOAP uses the client to express its request as a method call with a set of parameters. The service then returns a response containing a return value. The client and service are tightly coupled as this is a synchronous request-response interaction. The SOAP body must conform to a structure that indicates the method name and contains a set of parameters. The response always has response appended after the request method name. Using the method GetProductQuantity, would return a response with GetProductQuantityResponse. If one needs a loosely coupled structure, the document style fits. The document style is message-oriented. The WSDL definitions contain XML scheme definitions of request and response messages. Then a SOAP message contains XML data, like a purchase order, as request to an endpoint; Compared to method and parameters as done by RPC style. The endpoint on the server side is capable of forwarding and dispatching the request to the right service operation that can process the message.

RESTful services

Representational State Transfer (REST), first introduced in Architectural Styles and the Design of Network-Based Software Architectures (Fielding, 2000), is an architectural style of networked systems. There is no official standard or protocol to adhere to, but in general there are key concepts for building services over the web:

1. Resource identification: all resources have a unique identifier using a Uniform Resource Identifier (URI), using a web standard naming scheme.
2. Unified resource interface: all resources are accessible to client applications via a set of HTTP operations, facilitating a uniform interface.
3. Links and hypermedia: Resources in a REST-based system are linked via relation link types. These links are used by clients to navigate between different states of the resource.

A resource is defined as “A resource must contain one or more attributes beyond the unique ID that can describe the resource. These attributes may also have a formal schema to define them ” (Paik et al., 2017). In REST a resource has multiple representations; this can be an XML format of data, or a picture describing data, or JSON structure of data. Normally, it is up to the client to decide which representation is required of a resource. The server can offer two access paths. One is to assign a distinct URI for each representation of a resource, like data/json or data/xml to get the data in JSON or XML respectively. Another way is to use HTTP HEAD and set the type of data one would like to return. The first principle, resource identification, says that a resource has at least one URI. The most common forms of URI are Uniform Resource Locator (URL) and Uniform Resource Name (URN). The URN scheme is meant to allocate a unique name to a resource and there are a few well-known URN schemes such as ISBN for books or ISAN audio/visual recordings. A URN might be “urn: ISBN: 0451450523” and a URL

“file:///home/username/mybooks/TheLastUnicorn.pdf’. Every URI identifies one resource, although a resource can be identifies by multiply URI’s.

The second principle, addressability, concerns with the idea that all resources are individually accessible. This is achieved if a dataset of a service can be exploded as resources. As example one can think of a search engine that has a search page and uses a parameter, “?q=”, to find the correct results. All resources are individually accessible on one page, based on the query parameter.

The third principle, Statelessness, takes into account that every request happens in complete isolation. The interaction context between REST service and the client application is maintained by the client and not by the server. Therefore, the client is responsible for including all necessary information for the server to fulfill the request at any given state. As an example, using PHP session ID would go against the statelessness principle as PHP is processed on the server and the server keeps track of this data, not the client. Thus a HTTP request needs to contain the relevant client state and information that the server needs, rather than relying on a session key. However, a RESTful service is responsible for managing the state of its resources. That is, the resource states live on the server.

The fourth principle, standard operations, describes four basic operations one can apply on a resource. These operations are:

1. PUT: Create a new resource or update an existing resource
2. GET: Retrieve a resource
3. POST: Modify a resource
4. DELETE: Delete a resource and URI

These are referred to as “Uniform Interface” because they are the standard HTTP operations performed on resources and they follow the same operation syntax and semantics.

Kutera & Gryncewicz also draw attention to the Representational State Transfer (REST) architecture. This architectural style emphasizes the scalability of component interactions and promotes the reuse and generality of interfaces (Kutera & Gryncewicz, 2017). It decreases also coupling between components. The basic principle of loose coupling is to reduce the assumption that two parties (components, applications, services, programs, users) exchange information with one another (Kutera & Gryncewicz, 2017). Although REST is usually chosen to build simple CRUD (create, retrieve, update and delete) services, there is a possibility to develop REST web services offering complex services and stateful behavior (Rauf et al., 2013). REST comes with 4 basic principles like: using HTTP methods explicitly, being stateless, exposing directory structure-like URIs and transferring XML, JavaScript Object Notation (JSON), or both (Fielding, 2000).

RESTful service design

The defined principles help with designing an API as implementation for RESTful service. The first issue that needs to be designed is URI. The name of the URI should not contain operation names like createOrder, instead a separate resources and the use of appropriate nouns to

represent the resource, like order. A URI should have clear identifiers that lead to individual resources, one can use ID to gather a specific order, or else return all orders. The action a URI preforms is based on the operation given. For example: a GET on /orders/{order} can be /orders/1 if one would like to do something with the order that is associated with order id 1. But a DELETE would remove ID 1.

The second issue that needs to be designed is the response. In other words, what is the response of the server based on different input scenarios? Using the HTTP specification there is a guideline for codes. In table 4 some status codes are given. By designing response that adheres to these status codes, the client will understand the interactions better and faults are easier to solve. Besides status codes, a REST service should support a wide range of client applications by providing multiple formats in its response. One can think of support for JSON response or XML response. If a response is to return multiple objects, it should return a collection as the container of the objects. This can be done by creating a results array which contains the objects.

Table 7 Status codes

Code	Description	Event
200	OK	Normal response
201	Created	The client request created new resources
304	Not Modified	The request resource is cached
401,403,404	Unauthorized, Not Found, Forbidden	Managing authentication and authorization on requesting resources
500	Internal Error	The server encountered internal errors by processing the request.

The last design issue is to create an API that follows HATEOAS principle; this is an acronym for Hypermedia As The Engine Of Application State. The principle is that a client interacts with an application entirely through hypermedia provided dynamically by the server. A REST client needs no prior knowledge about how to interact with any particular application or server beyond a generic understanding of hypermedia. HTTP uses Hypertext to navigate a site using links; this is the same for an API. It allows the clients to navigate the service using links. This is shown in Figure 10. One can see that in the results section of /coffeeOrders a href is given for the id, this allows a client to dynamically retrieve /coffeeOrders/100 and in the result the payments of the order.

Although REST principles are well understood, the implementation is different in practice. One approach to equalize the different is the maturity model by Richardson. This maturity model contains four levels increases the implementation of REST. The entry level, level 0, is not RESTful and has one URI exposed, requests contain operation details. level 3 is fully complying with REST principles by using HATEOAS, self-documenting responses, and responses include links that the client can use. The levels in-between as the exact criteria are given in table 5.

/coffeeOrders

```
{
   "resultSize": 25,
   "links": [{
         "href": "/coffeeOrders"
         "rel": "self"
      },
      { "href": "/coffeeOrders?page=1",
         "rel": "alternative"
      }
      {  "href": "/coffeeOrders?page=2",
          "rel": "nextPage"
      }
   ],
   "results": [ {
                  "id": "100",
                  "type": "latte",
                  "links": [ {
                        "href": "/coffeeOrders/100",
                        "rel": "details"
                   }]
               },
               { ... },
   ]
}
```

/coffeeOrders/123

```
{
   "Id": "123",
   "type": "latte",
   "extra shot": "no",
   "payment": {
        "date": "2015-04-15",
        "credit card": "123457"
    },
   "served_by": "mike"
   "links": [ {
         "href": "/coffeeOrders/123",
         "rel": "self"
         },
         {
         "href": "/payments/123",
         "rel": "next"
         }
    ]
}
```

Figure 36 HATEOAS response in JSON

Table 8 Richardson Maturity Model for RESTful services

Level	Criteria
0	One URI exposed, requests contain operation details
1	Expose resource URIs- individual URIs for each resource. Request still contain some operation details
2	HTTP methods are used, status codes are used with the resource URIs
3	HATEOAS, self-documenting responses, responses include links that the client can use

Web composition

Web service composition is defined as: "The activity of aggregating Web services to build a new Web service" (Paik et al., 2017). Each task in a workflow can represent a Web service, and the flows in the workflow represent how the Web services are composed. Workflows describe the conversation rules and protocols between the services. In Figure 11, one can see multiple services composed into one new web service. By defining the process as a web service composition, the logic is expressed in a self-describing manner. This allows templates to be created and can be used in multiple instances where a process is involved. Hence, this approach generates an integrated system that offers a flexible solution (Paik et al., 2017). There are two ways to compose a web service: service orchestration and service choreography. The former, describes that web services interact with each other at a message level from the perspective of a single endpoint. This includes the business logic and the execution order of the interactions. The latter, tracks the sequence of the message and is described from the perspective of all parties, see Figure 12.

In (a), of Figure 12, the choreography point of view is given. The process is in the perspective of all parties, which are shown by pool 1, pool 2, and pool 3. There is a global view of the protocols and the data exchange between them. In (b) of Figure 12, the orchestration point of view is given. The process is in the perspective of one partner. The connections among the other services are not considered.

In general, the following basic characteristics with regard to composition of web services have been identified:

Web services are not application libraries which have to be compiled and linked as part of an application.
The basic components remain separated from the composite service. A web service is used by another web service, not consumed by it.
A composition of web services involves which service needs to be invoked, in what order, and how to handle exceptional situations. This is a workflow of a web service.
A web service can be seen as building blocks that can be assembled. Building allows the creation of complex applications by aggregating components.

By the use of these characteristics and the web service composition techniques, one can build a system that is effective and flexible (Paik et al., 2017).

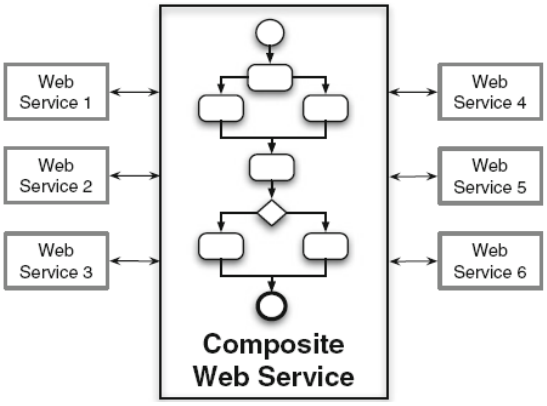


Figure 37 Multiple web services composed (Paik et al., 2017)

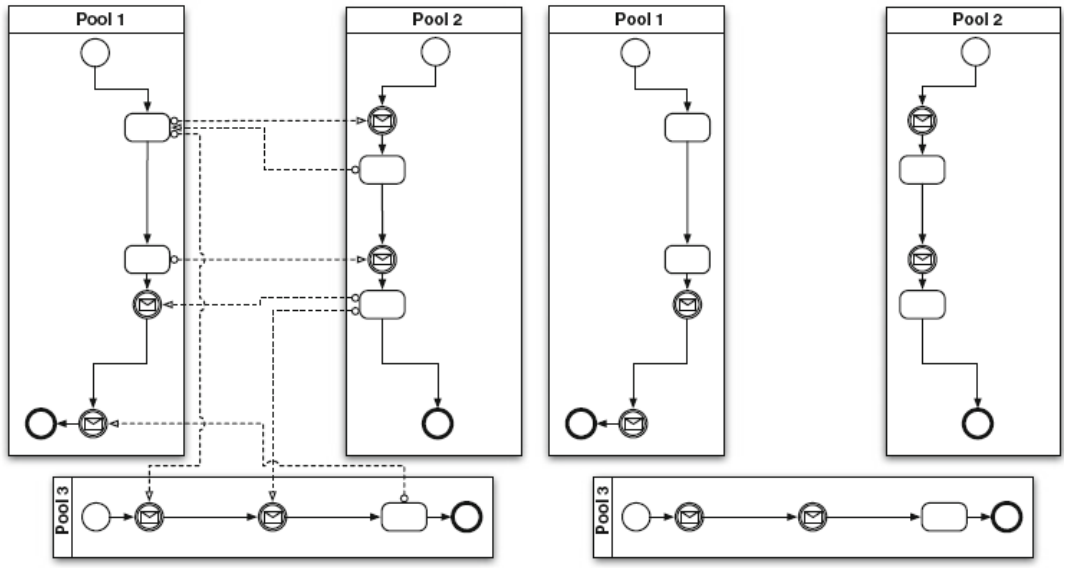
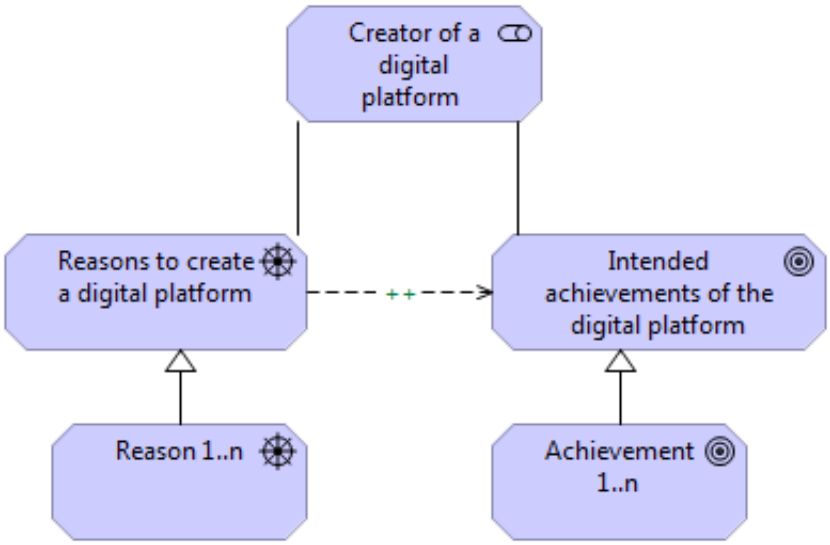


Figure 38 Choreography vs. orchestration view (Paik et al., 2017)

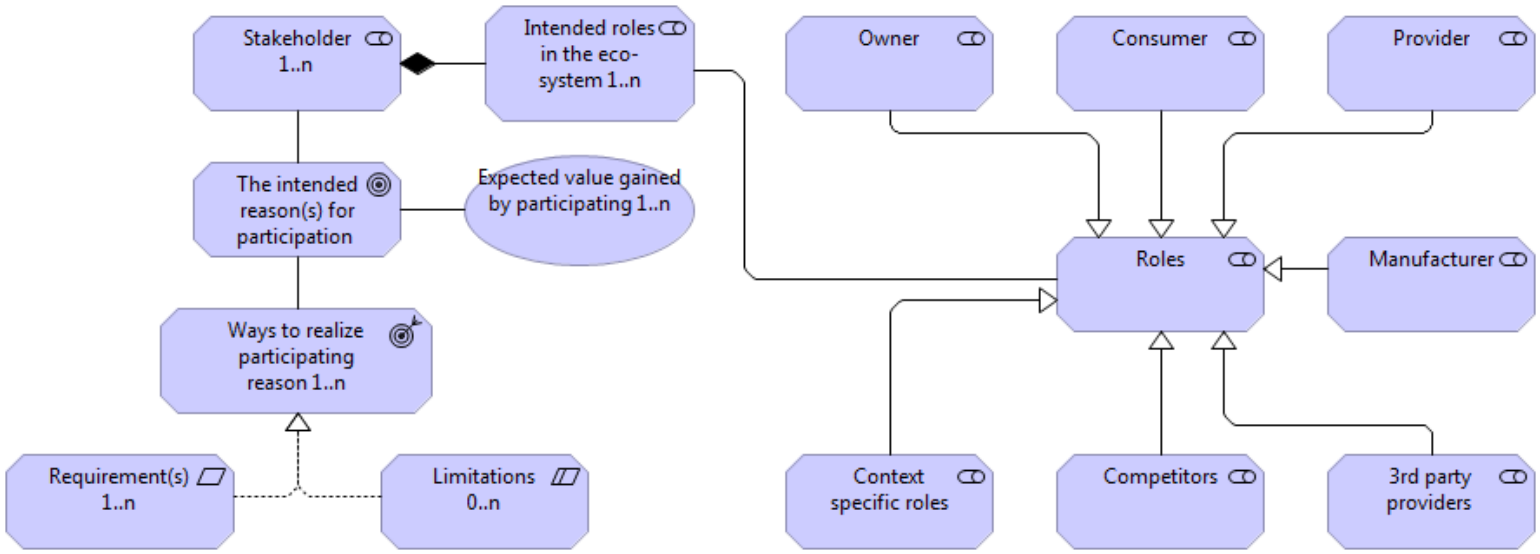
Appendix III Viewpoints

The different viewpoints of the models and the models of Castlab and Just Eat Takeaway are illustrated in a larger size.

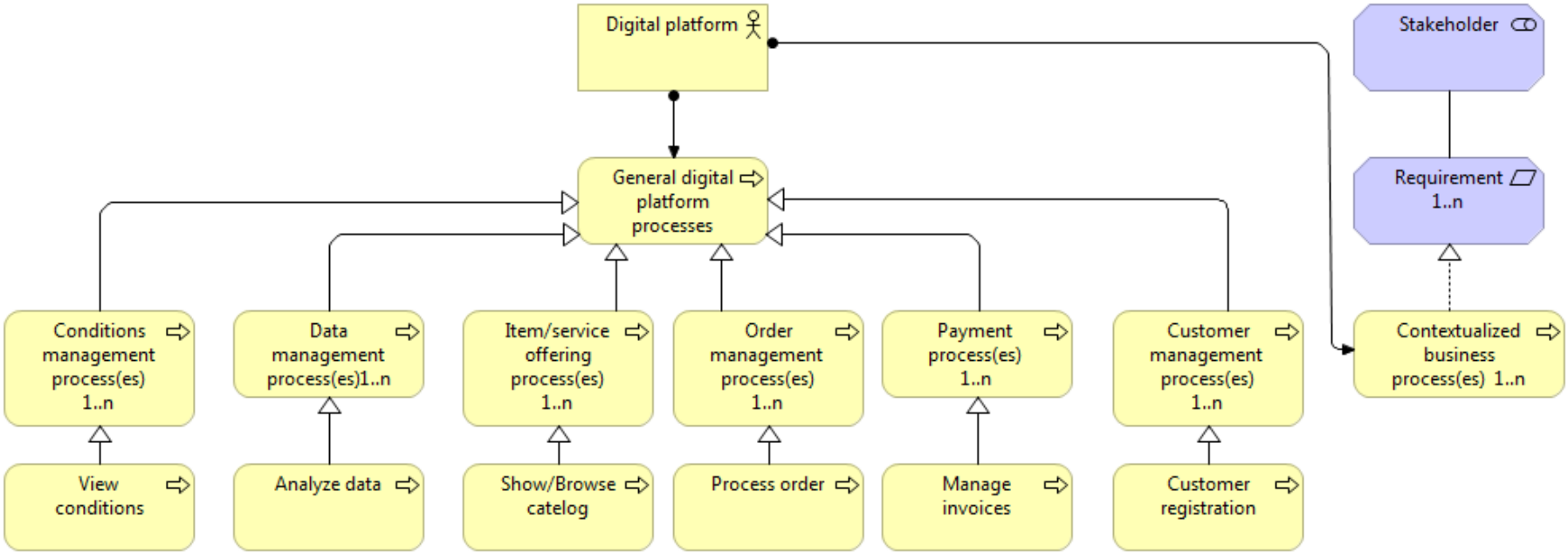
Design



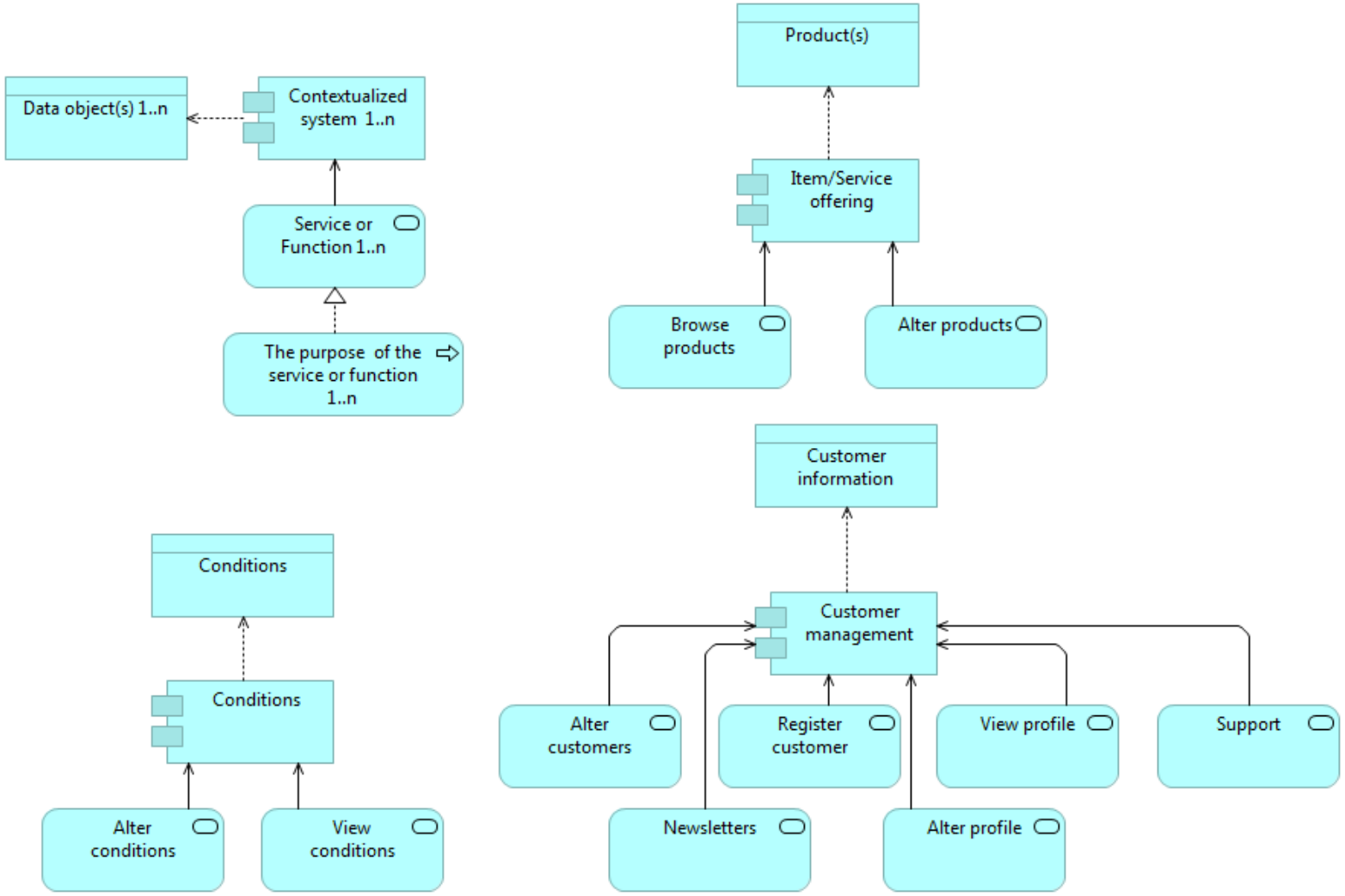
Goal viewpoint



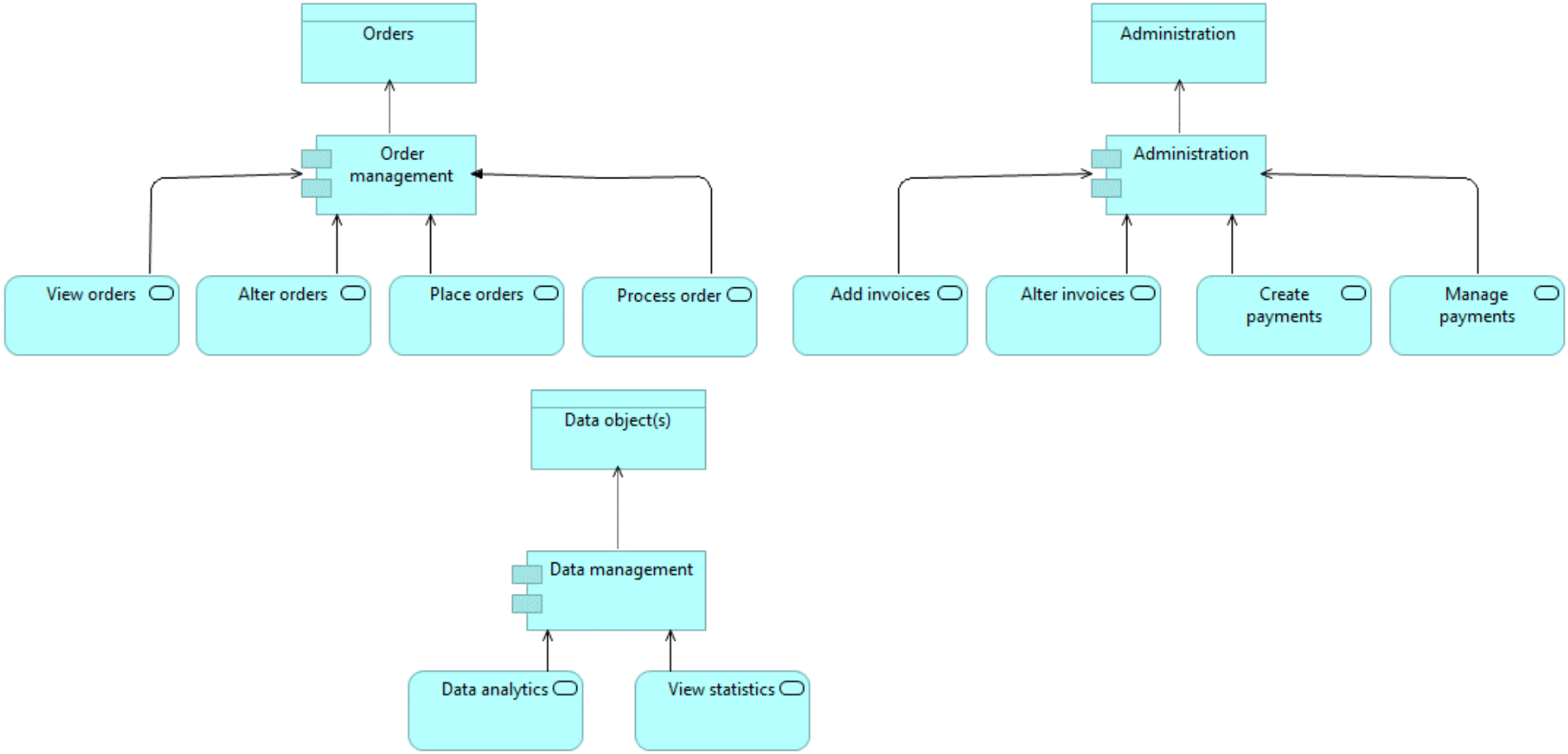
Actor Participate viewpoint



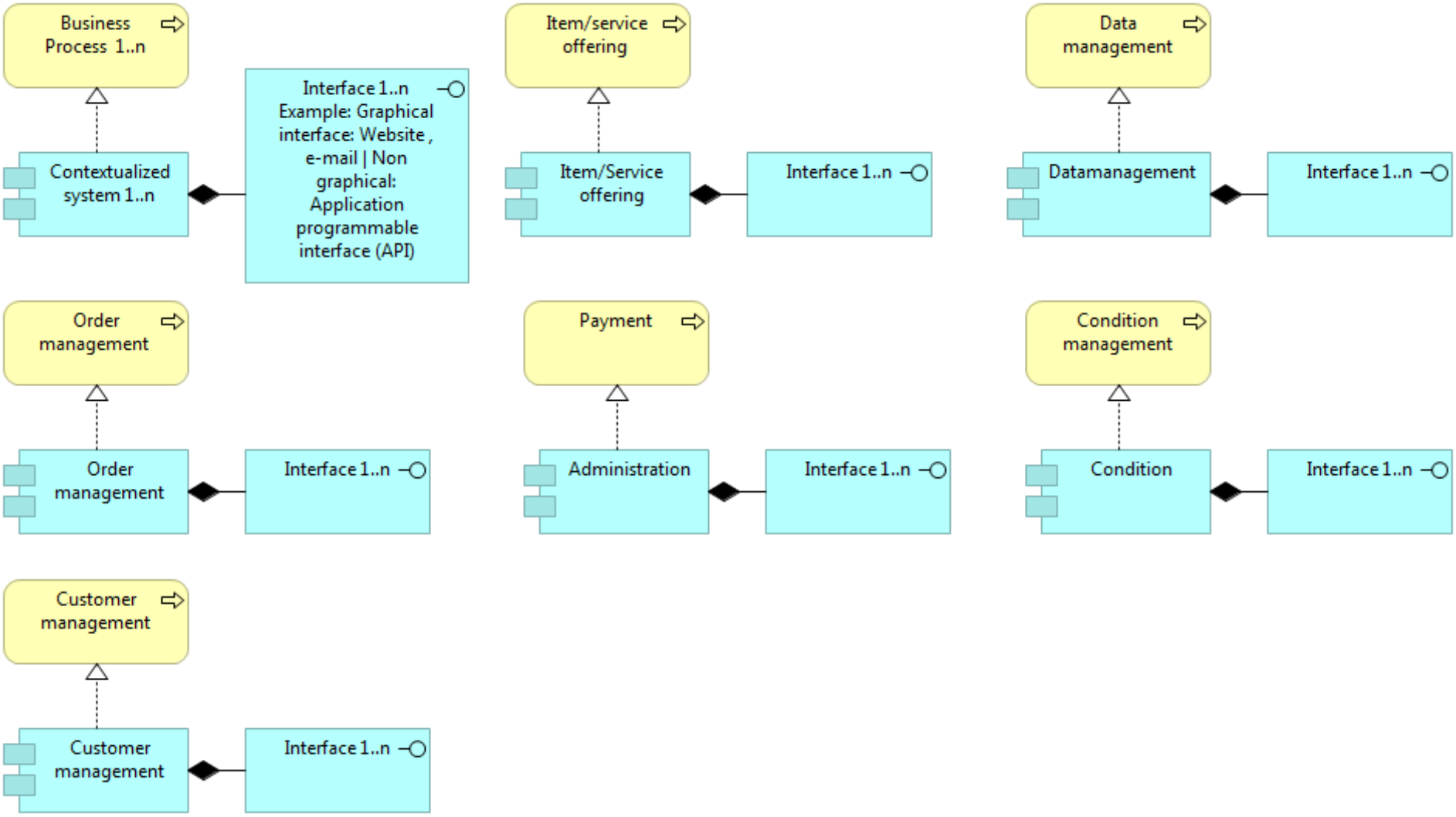
Business Process viewpoint



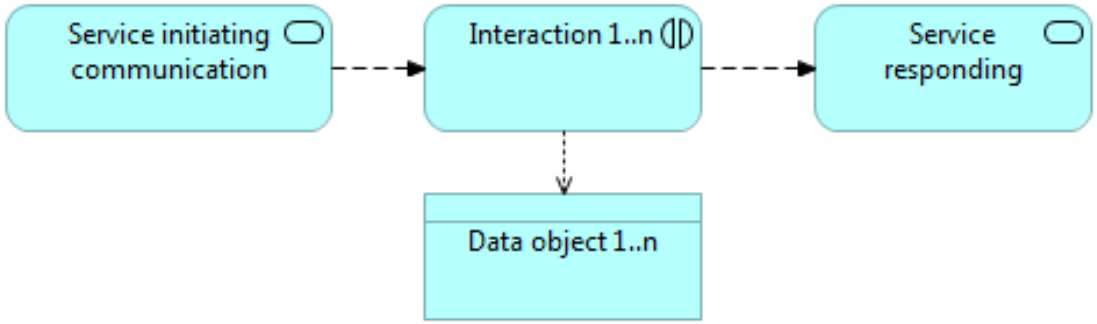
Application Structure viewpoint (Part 1)



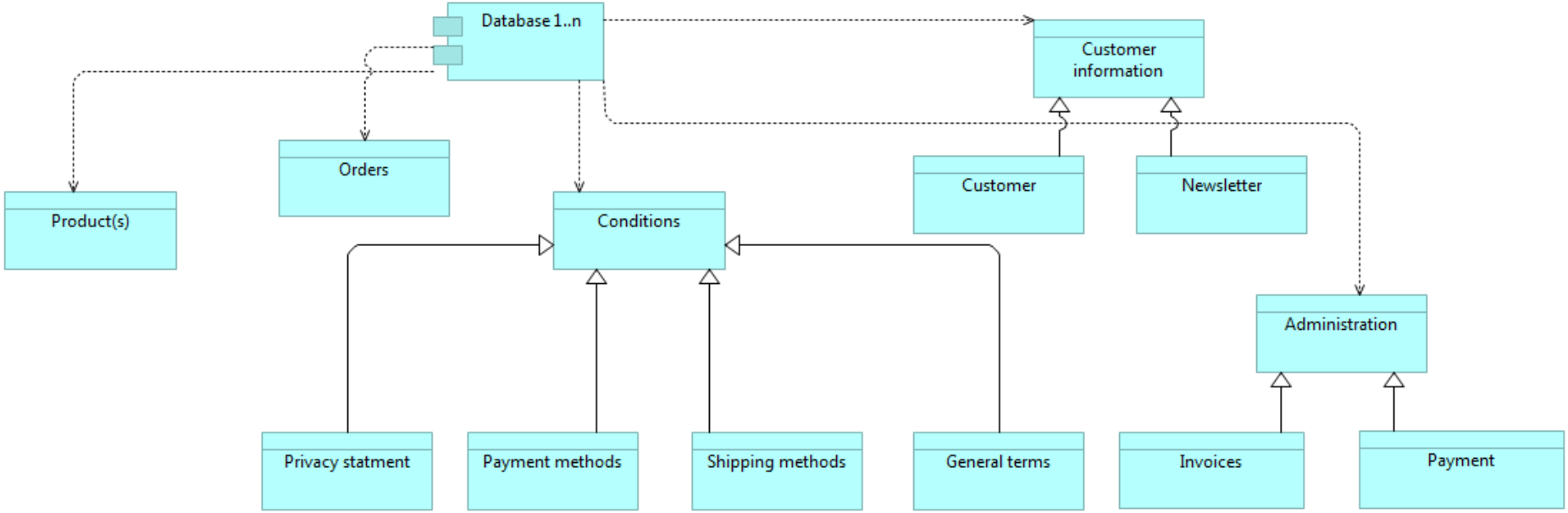
Application Structure viewpoint (Part 2)



Application Usage viewpoint

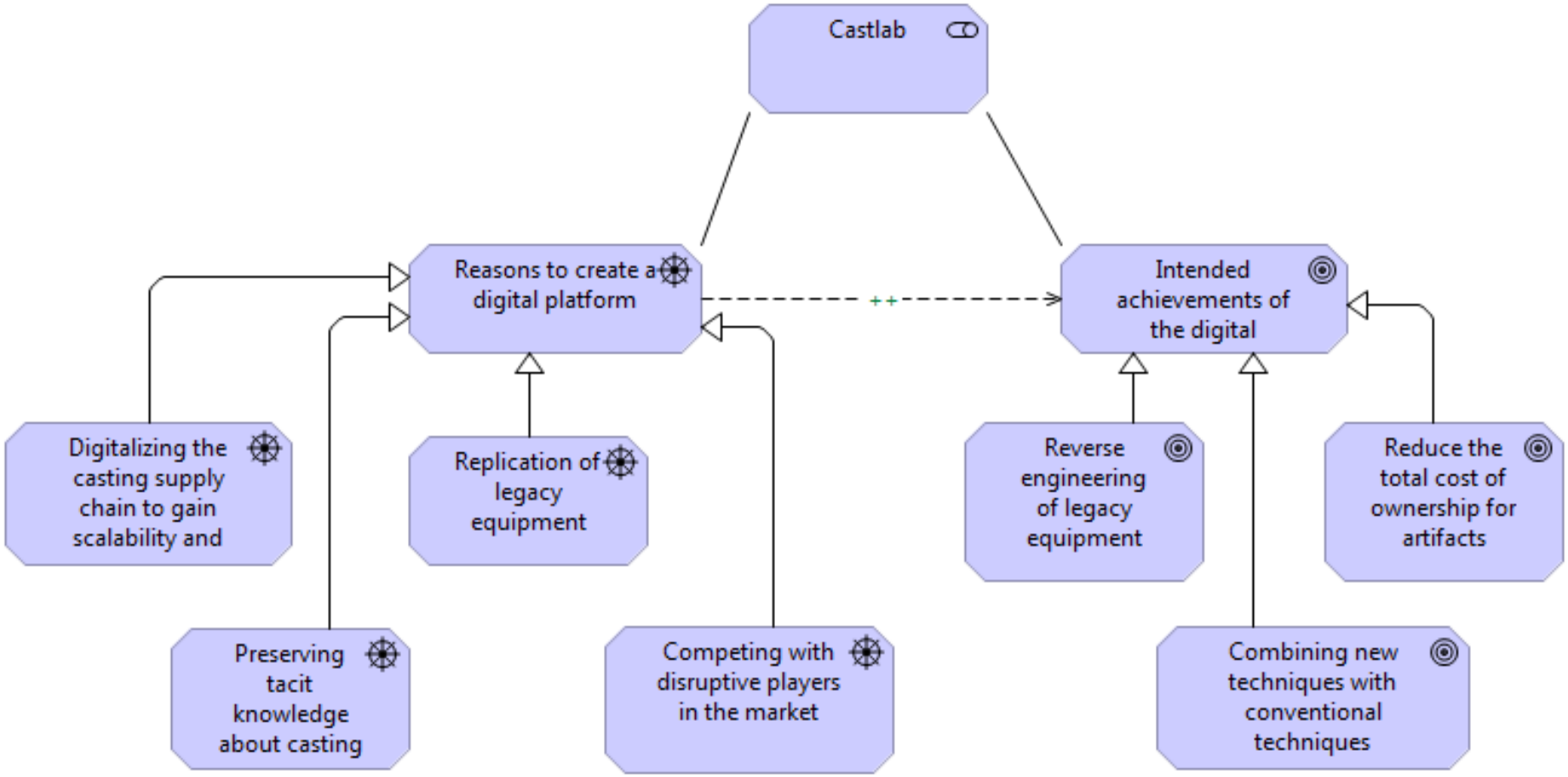


Application Communication viewpoint

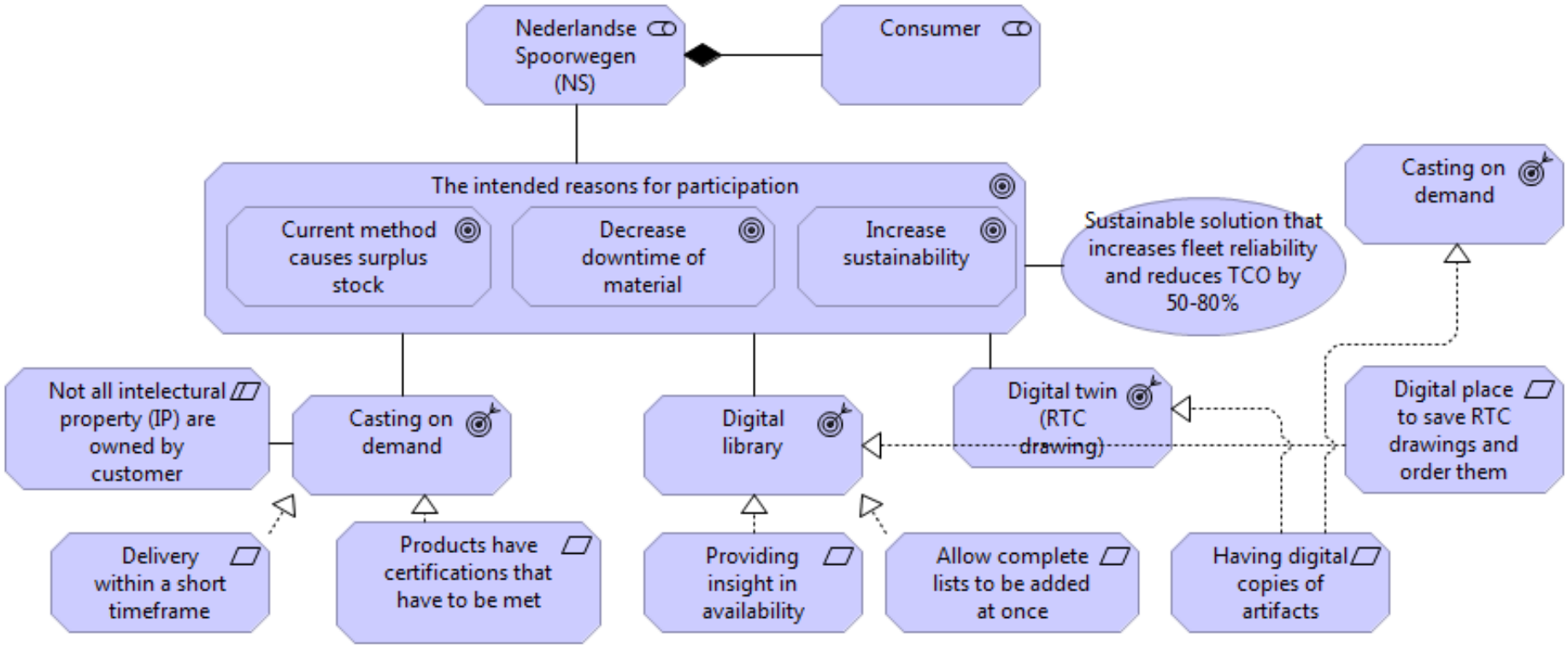


Data viewpoint

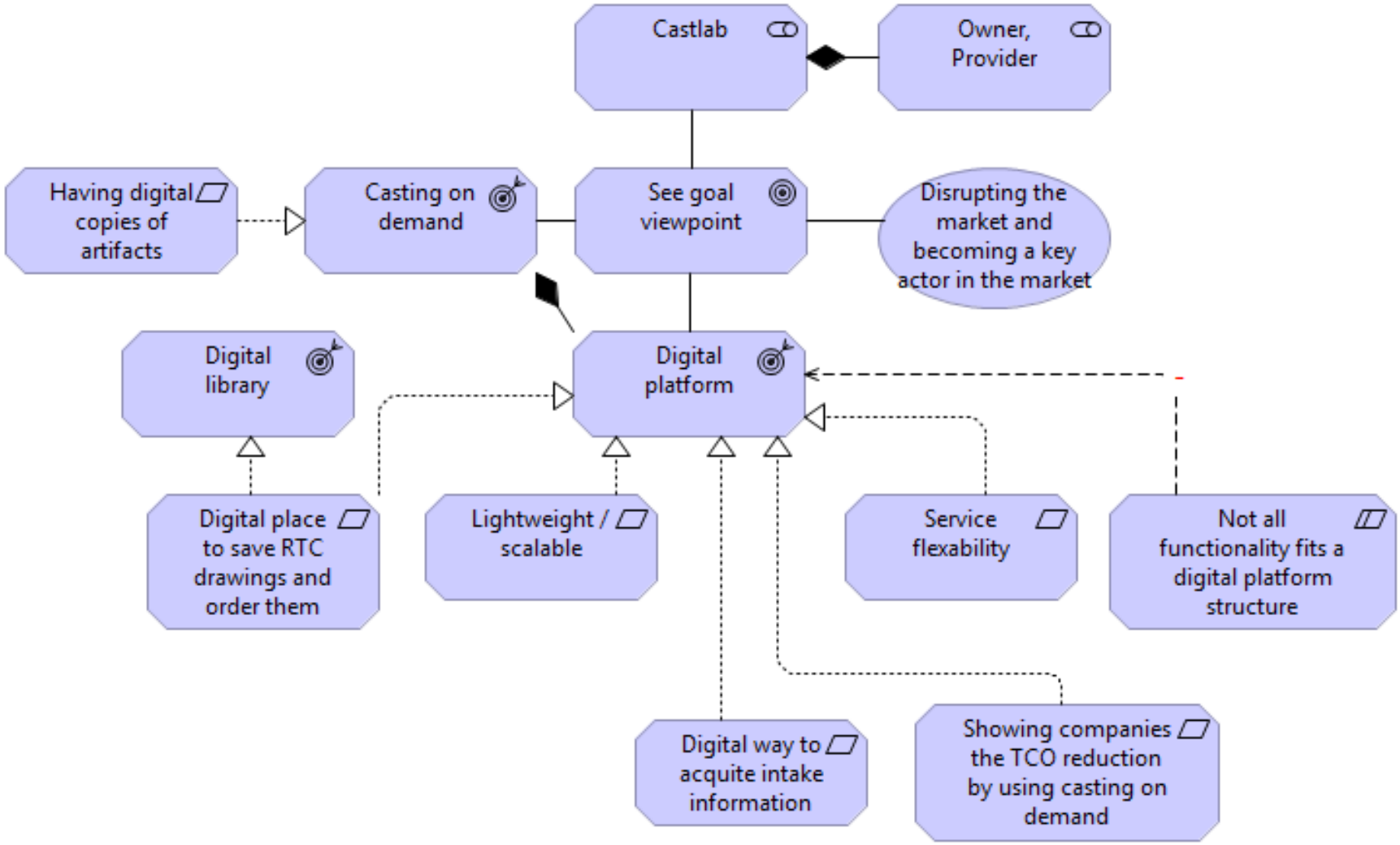
Castlab


Castlab
Reasons to create a digital platform
Intended achievements of the digital
++
Digitalizing the casting supply chain to gain scalability and
Replication of legacy equipment
Reverse engineering of legacy equipment
Reduce the total cost of ownership for artifacts
Preserving tacit knowledge about casting
Competing with disruptive players in the market
Combining new techniques with conventional techniques

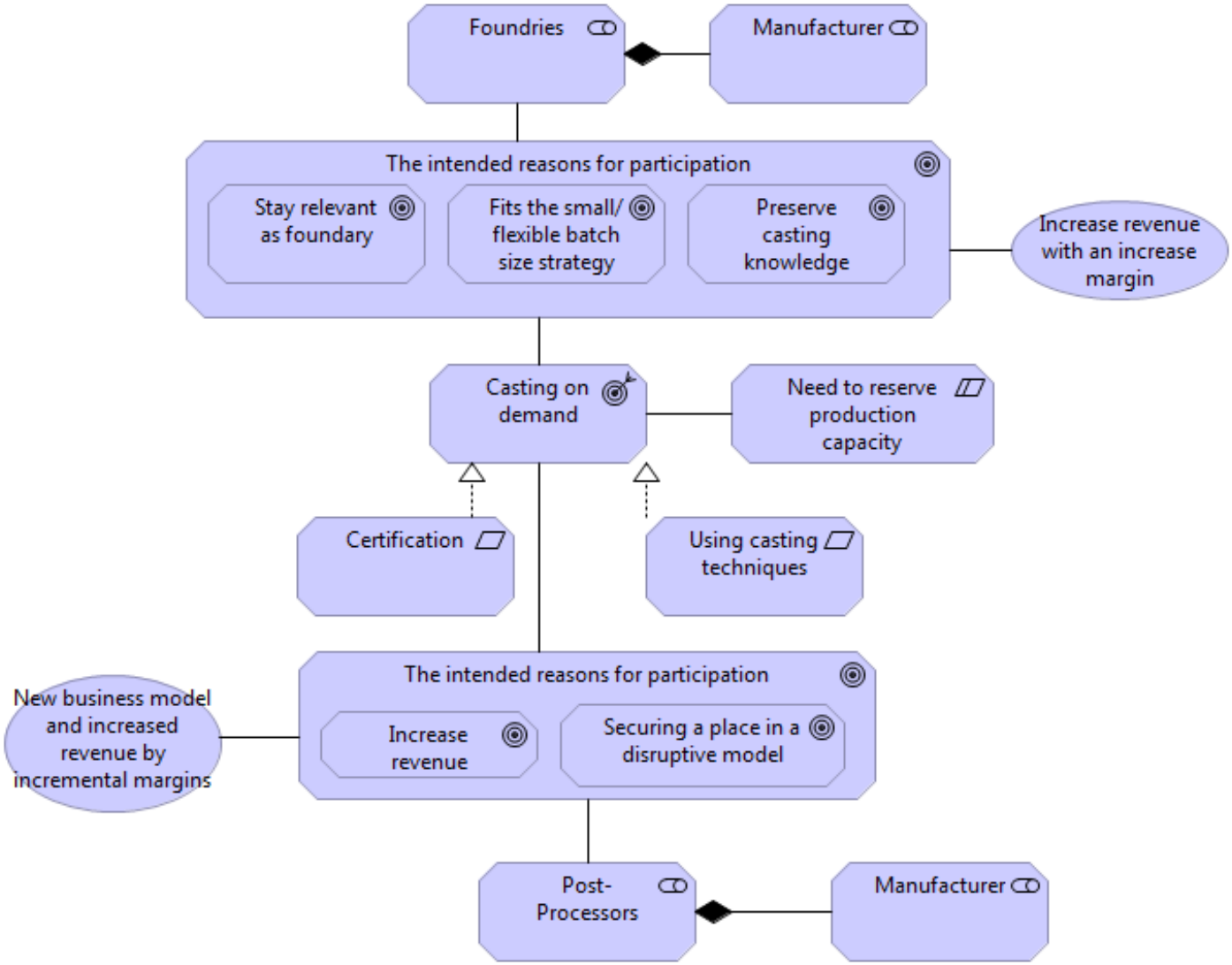
Goal viewpoint Figure 22



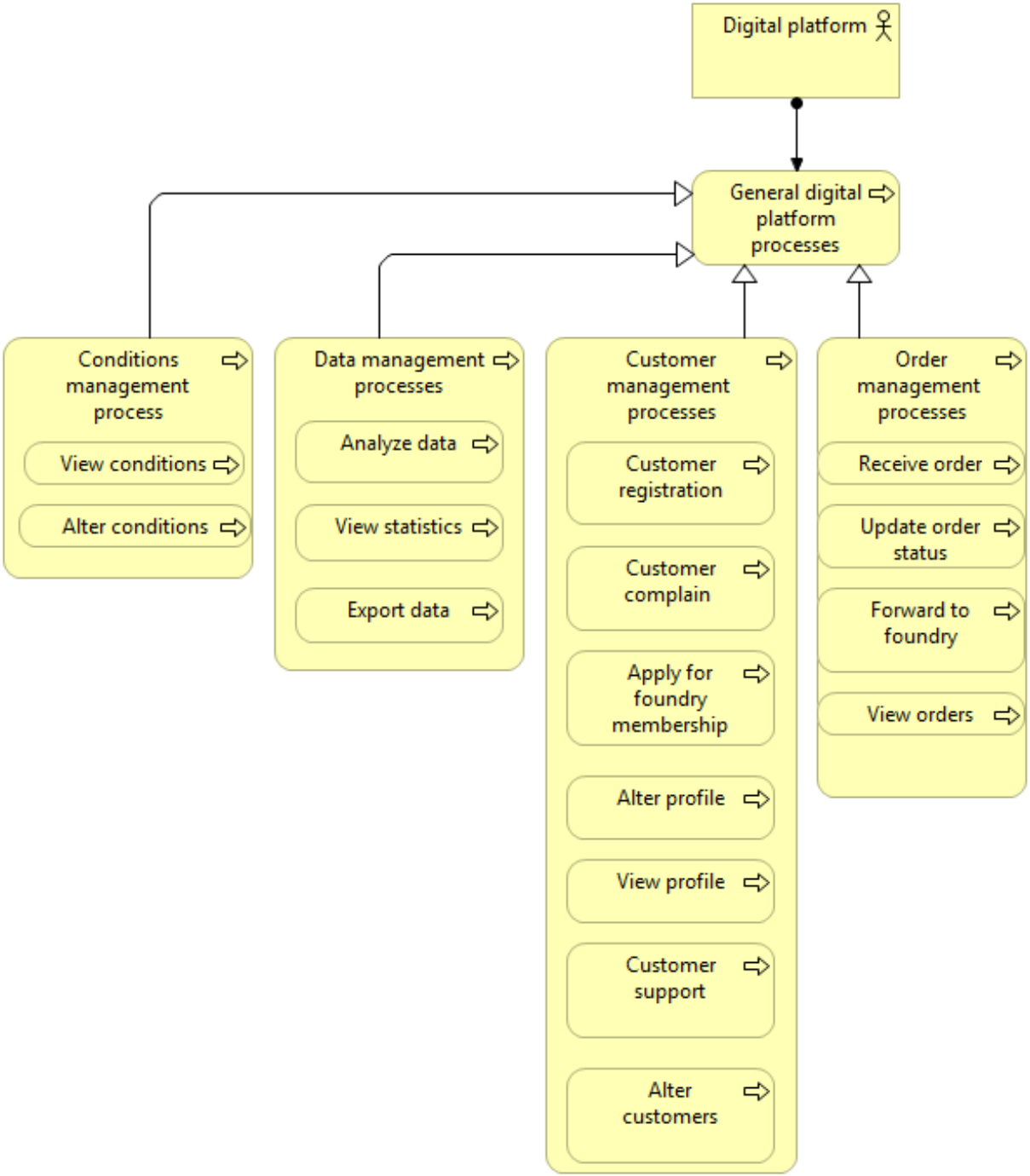
Actor Participate viewpoint (Part 1) Figure 23



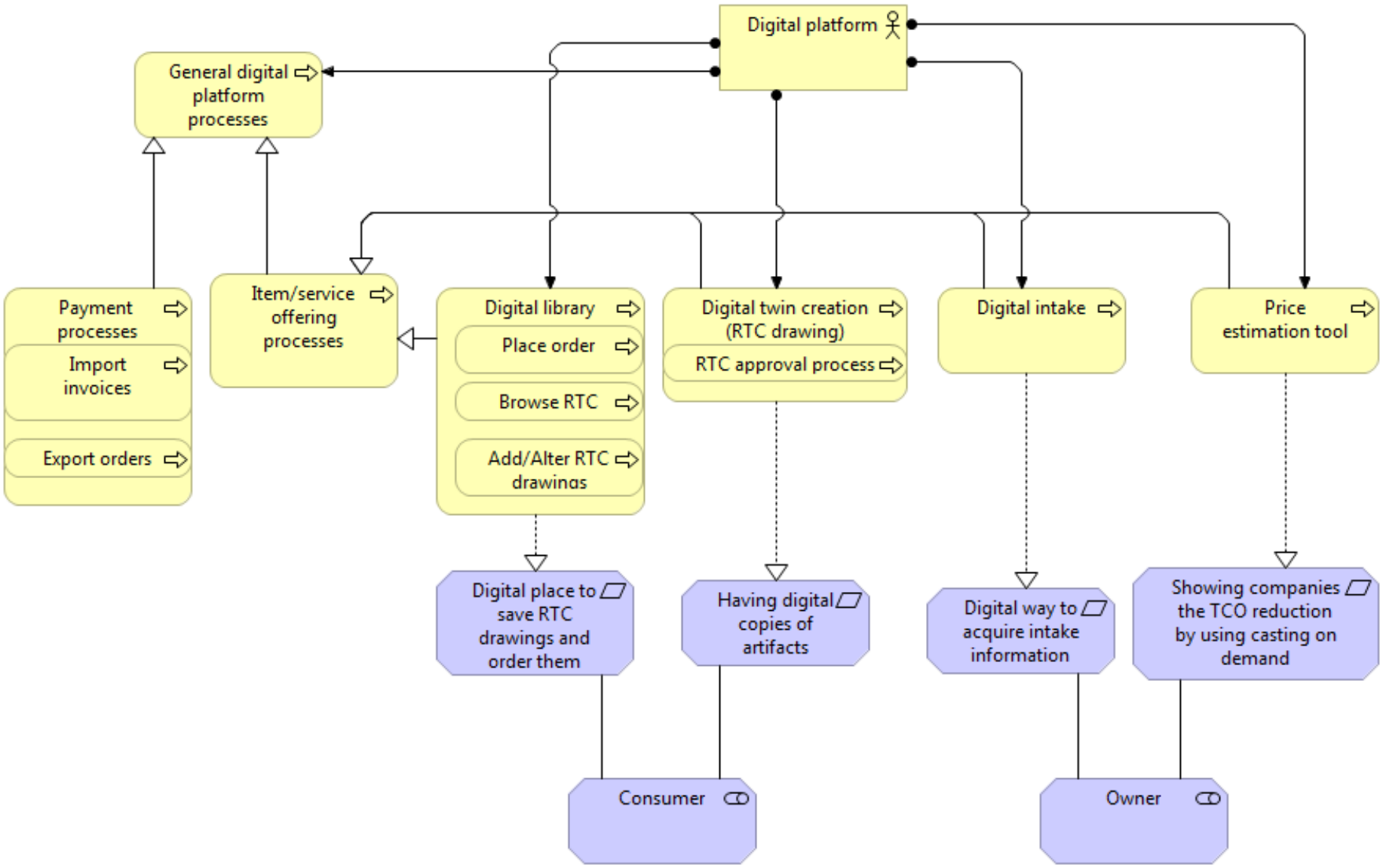
Actor Participate viewpoint (Part 2) Figure 23



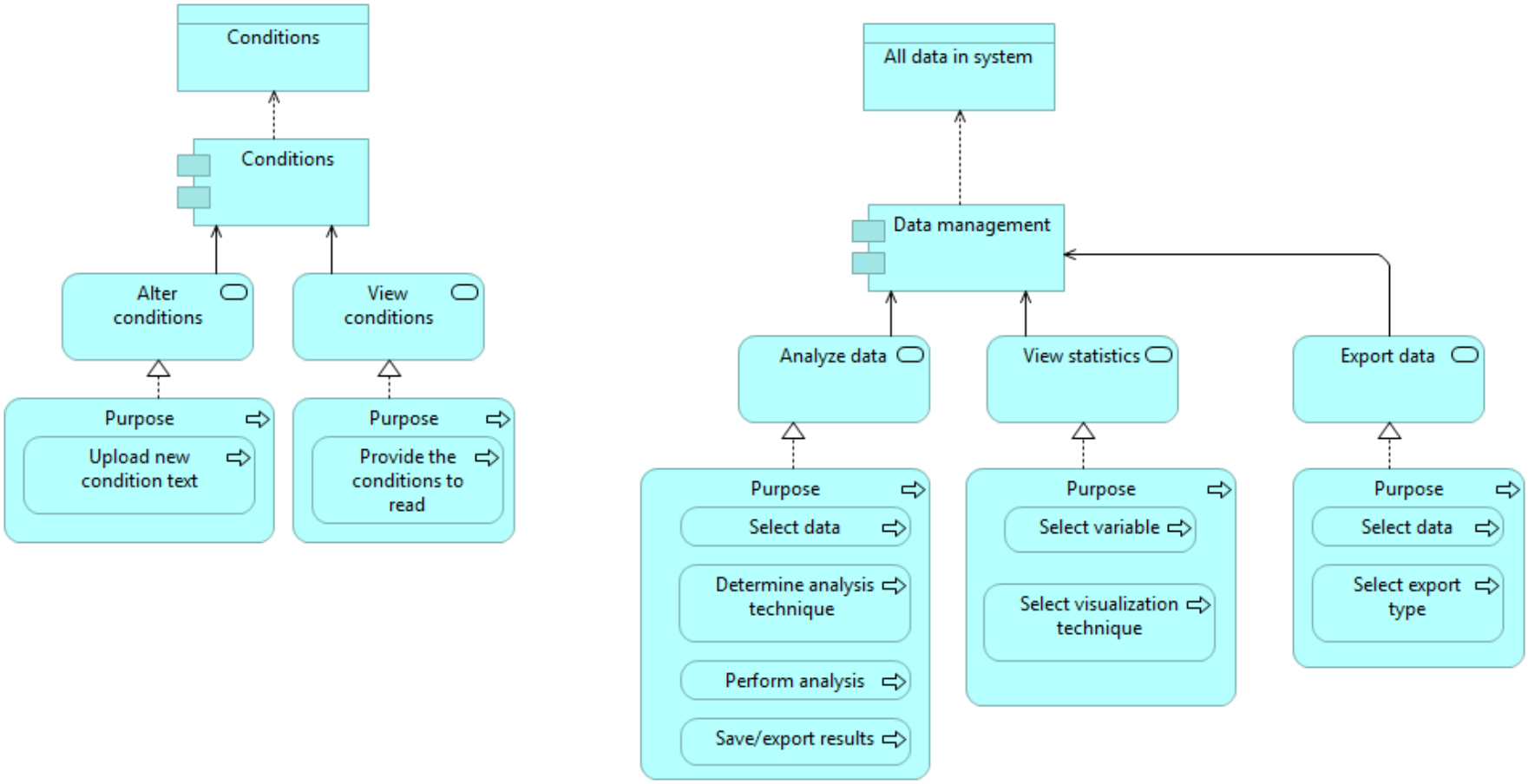
Actor Participate viewpoint (Part 3) Figure 23



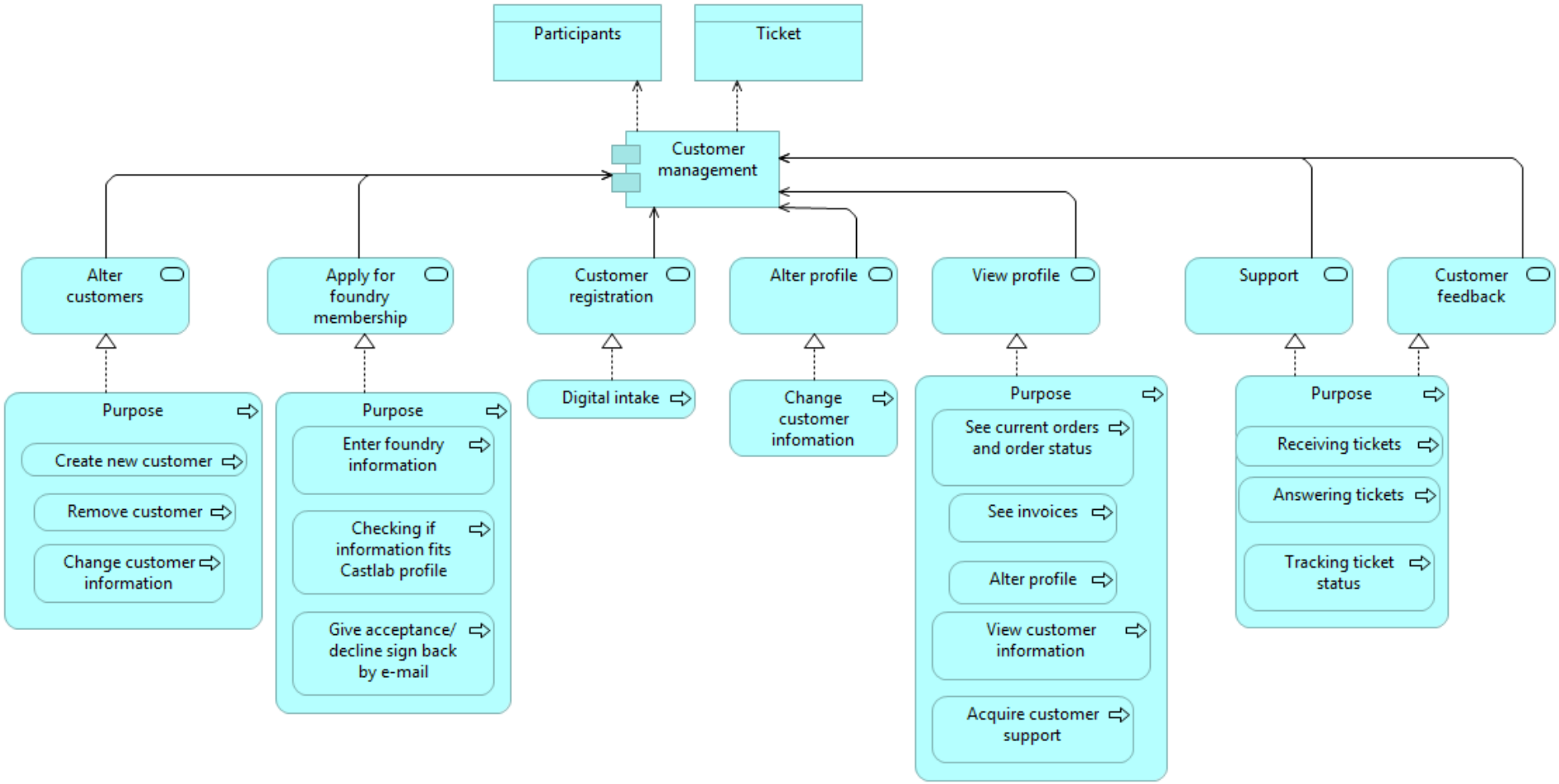
Business Process Viewpoint Figure 24 (part 1)



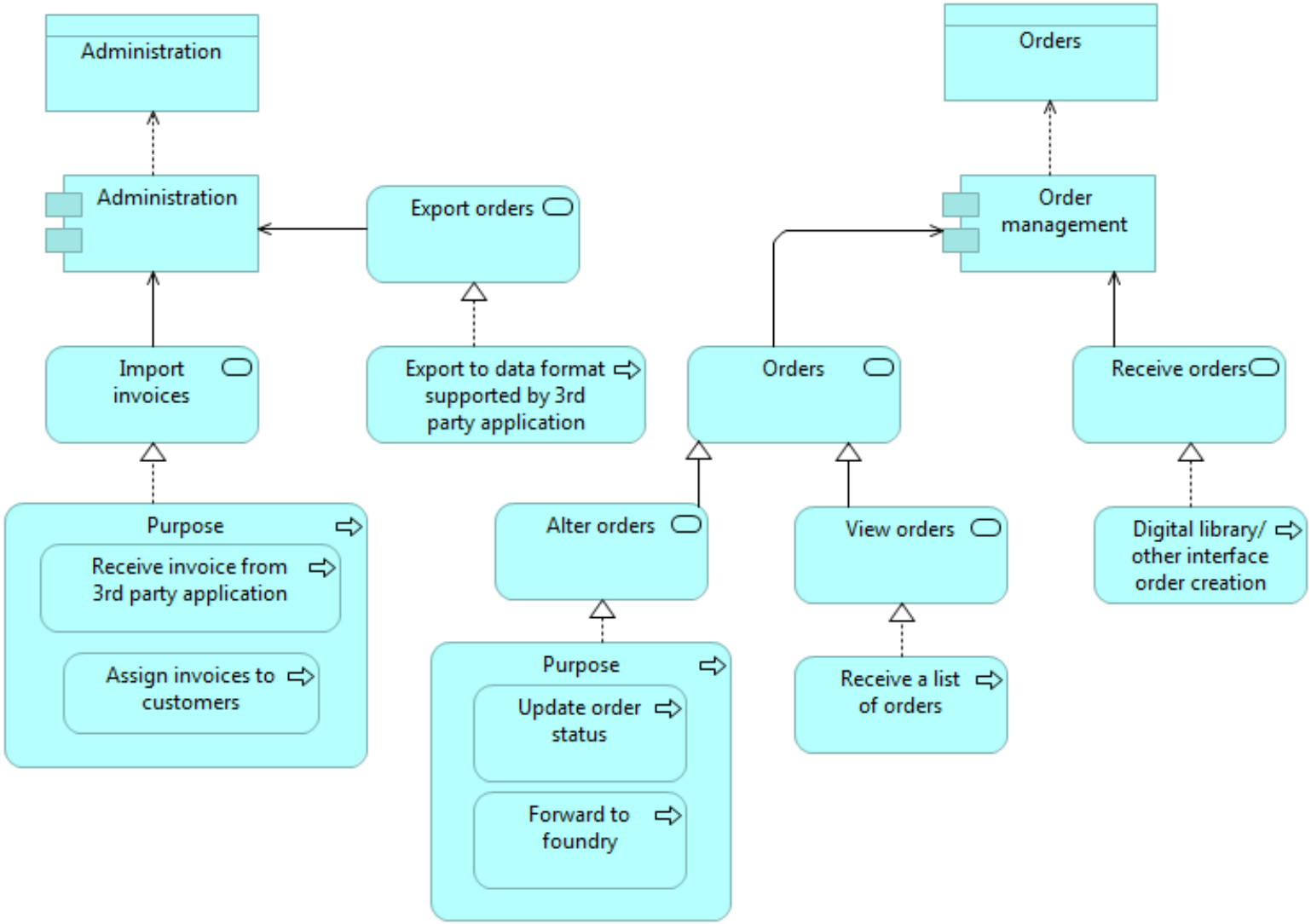
Business Process Viewpoint Figure 24 (part 1)



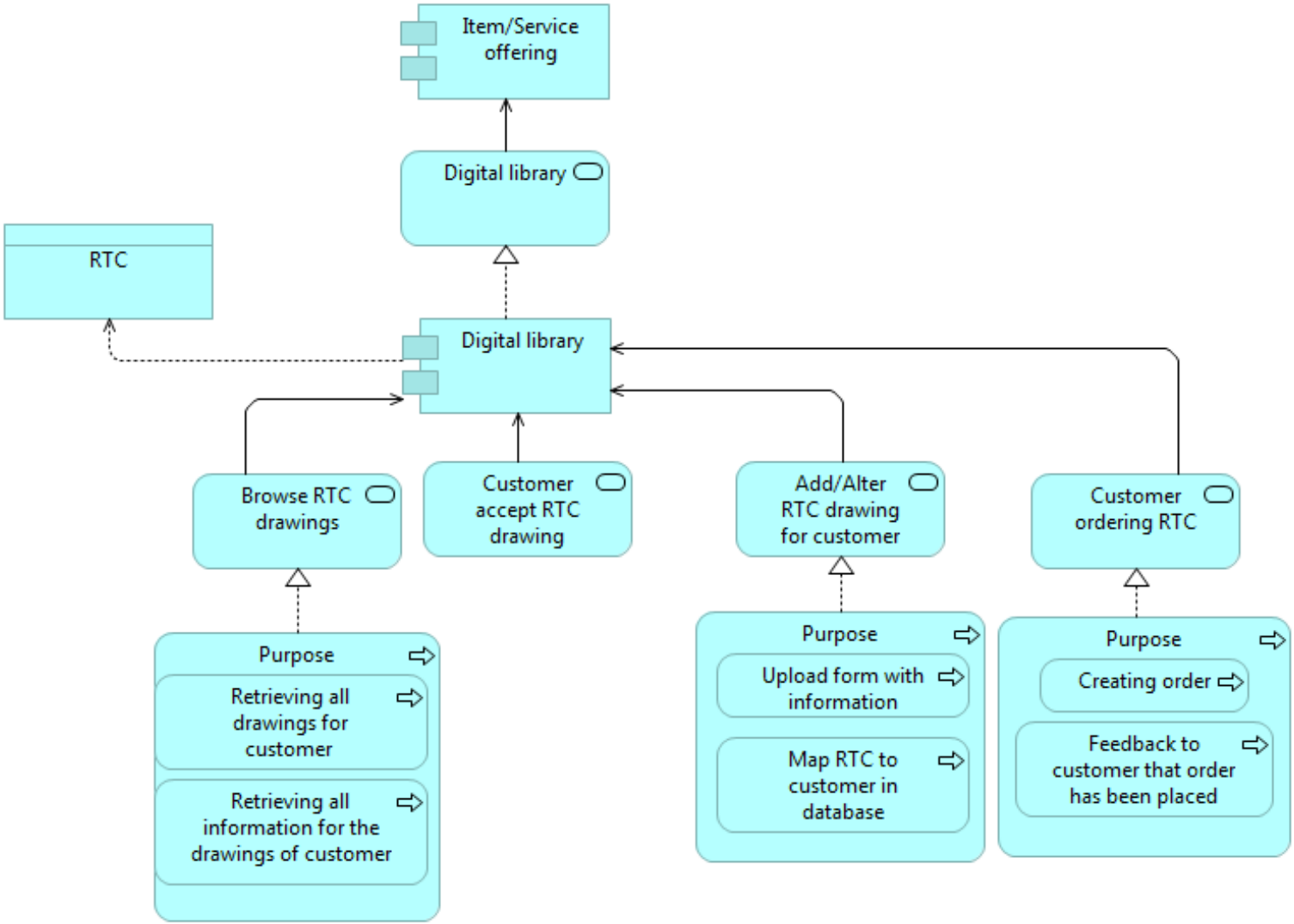
Application Structure viewpoint (Part 1) Figure 25


Participants
Ticket
Customer management
Alter customers
Apply for foundry membership
Customer registration
Alter profile
View profile
Support
Customer feedback
Purpose
Create new customer
Remove customer
Change customer information
Purpose
Enter foundry information
Checking if information fits Castlab profile
Give acceptance/ decline sign back by e-mail
Digital intake
Change customer infomation
Purpose
See current orders and order status
See invoices
Alter profile
View customer information
Acquire customer support
Purpose
Receiving tickets
Answering tickets
Tracking ticket status

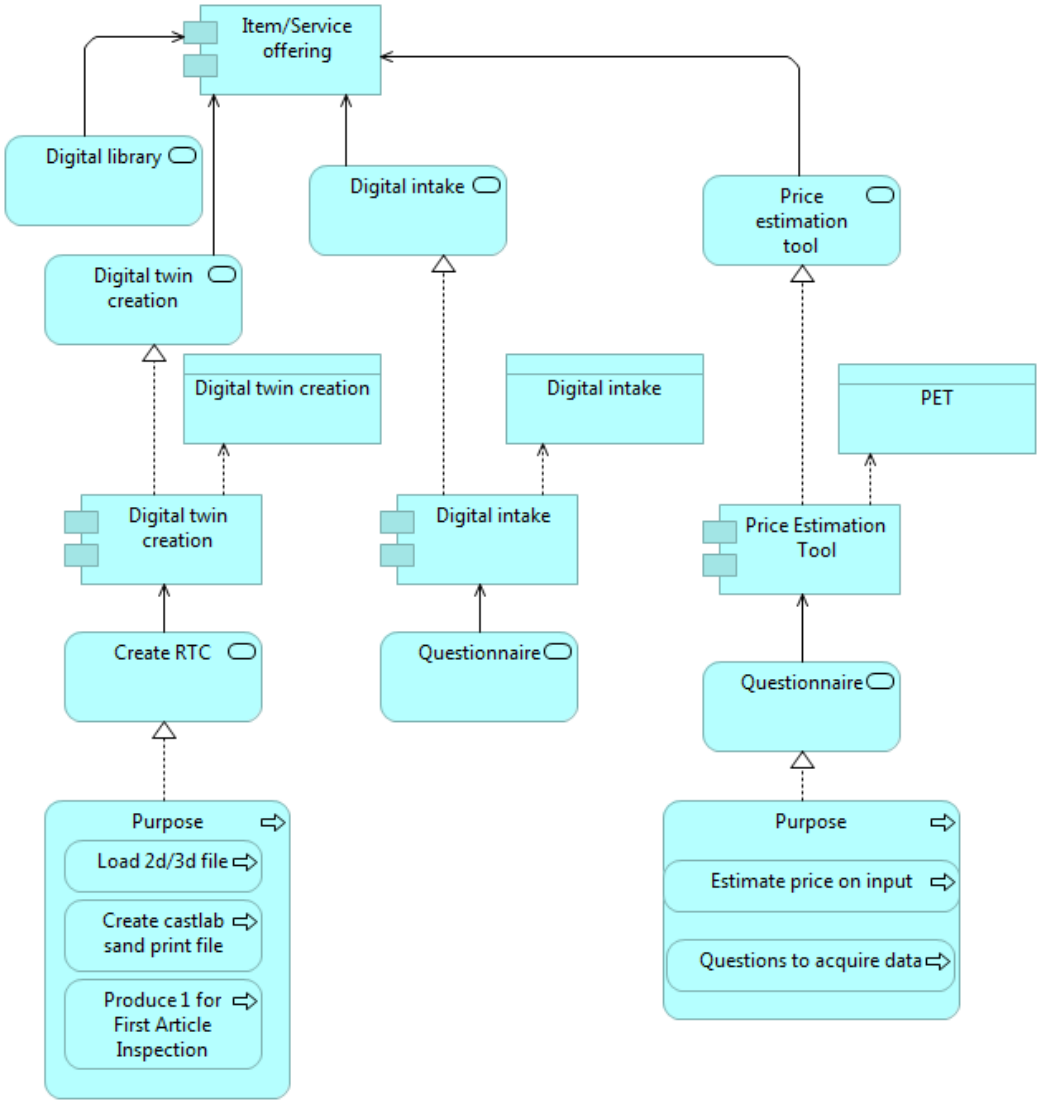
Application Structure viewpoint (Part 2 previous page) Figure 25



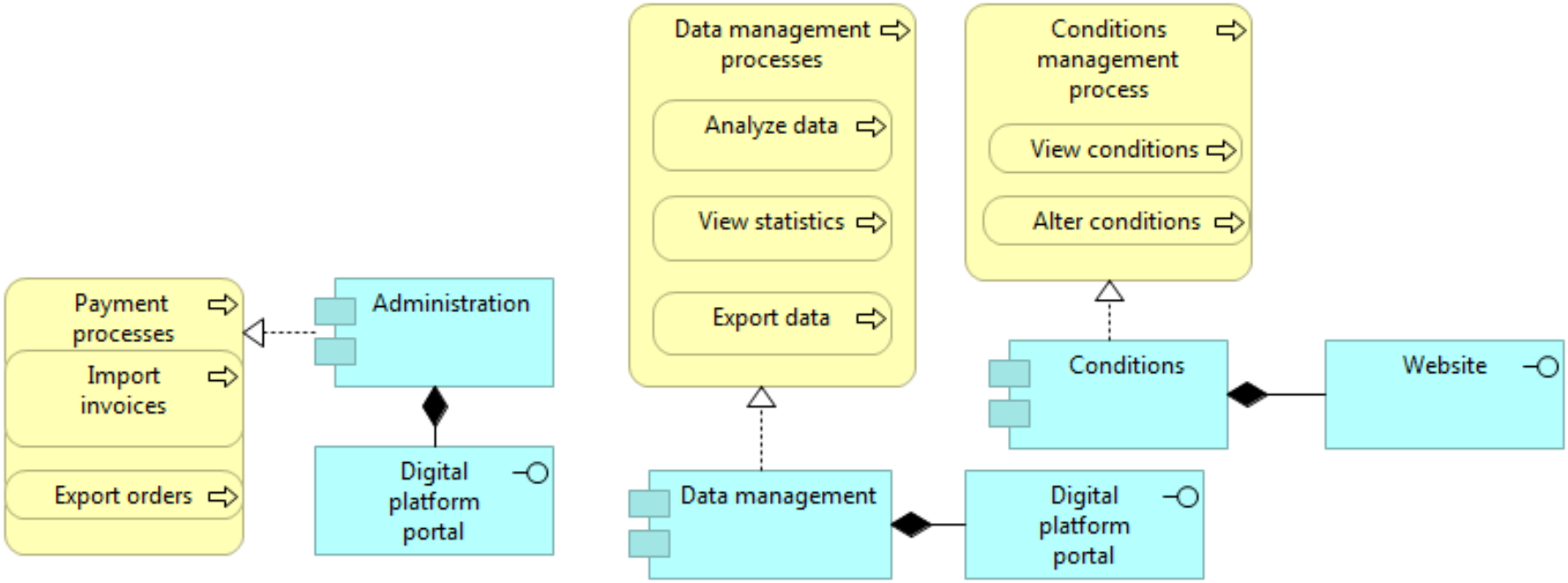
Application Structure viewpoint (Part 3) Figure 25



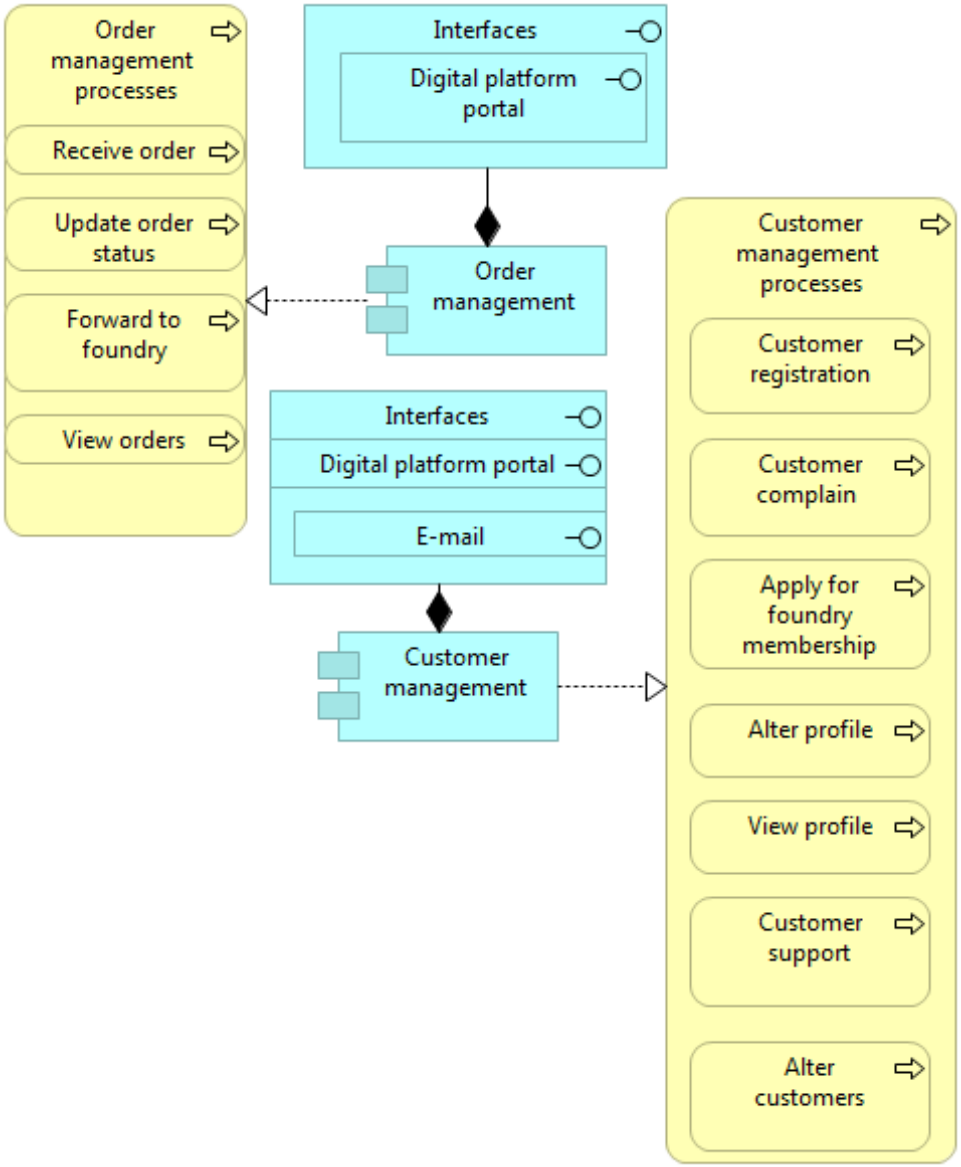
Application Structure viewpoint (Part 4) Figure 25



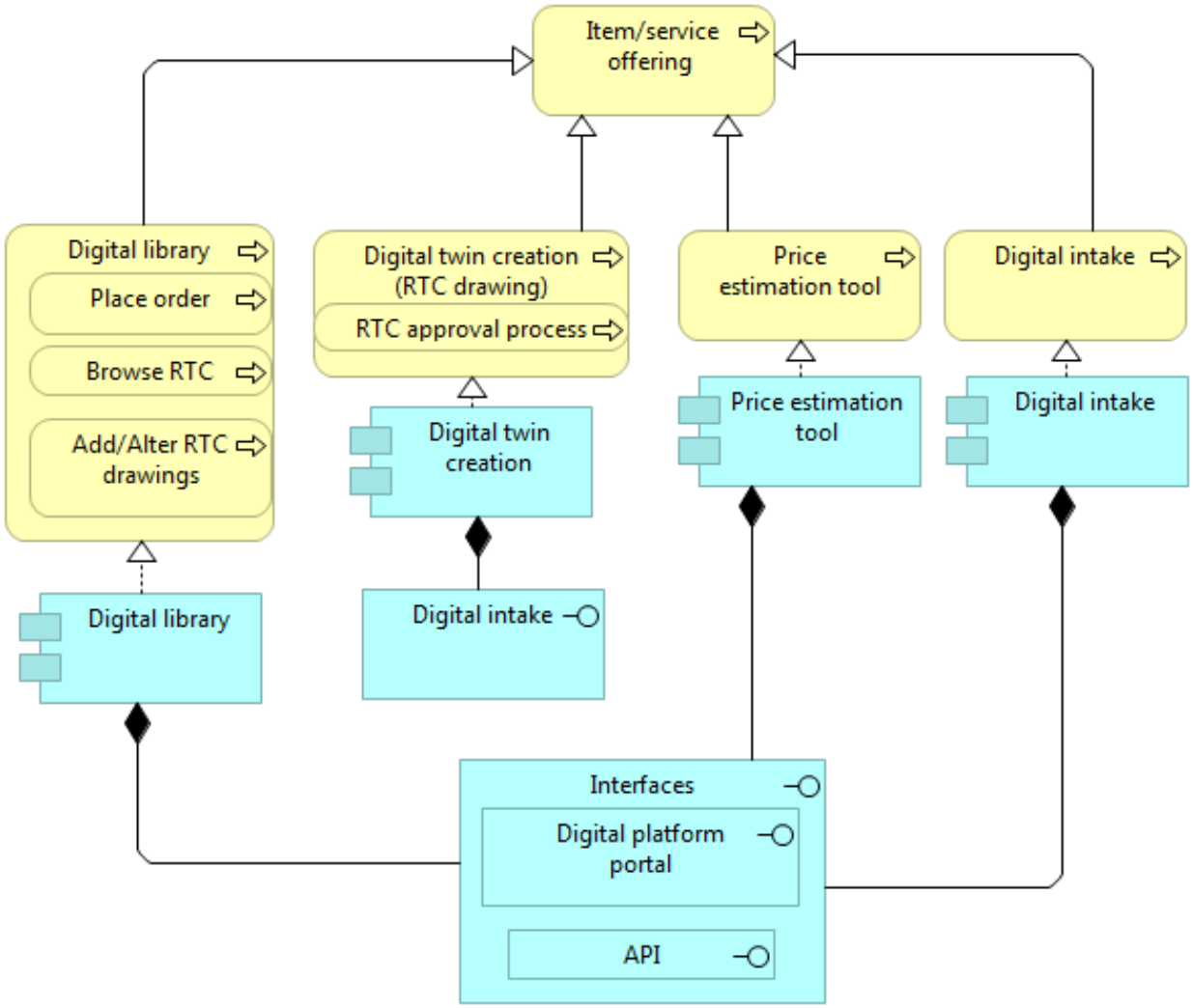
Application Structure viewpoint (Part 5) Figure 25



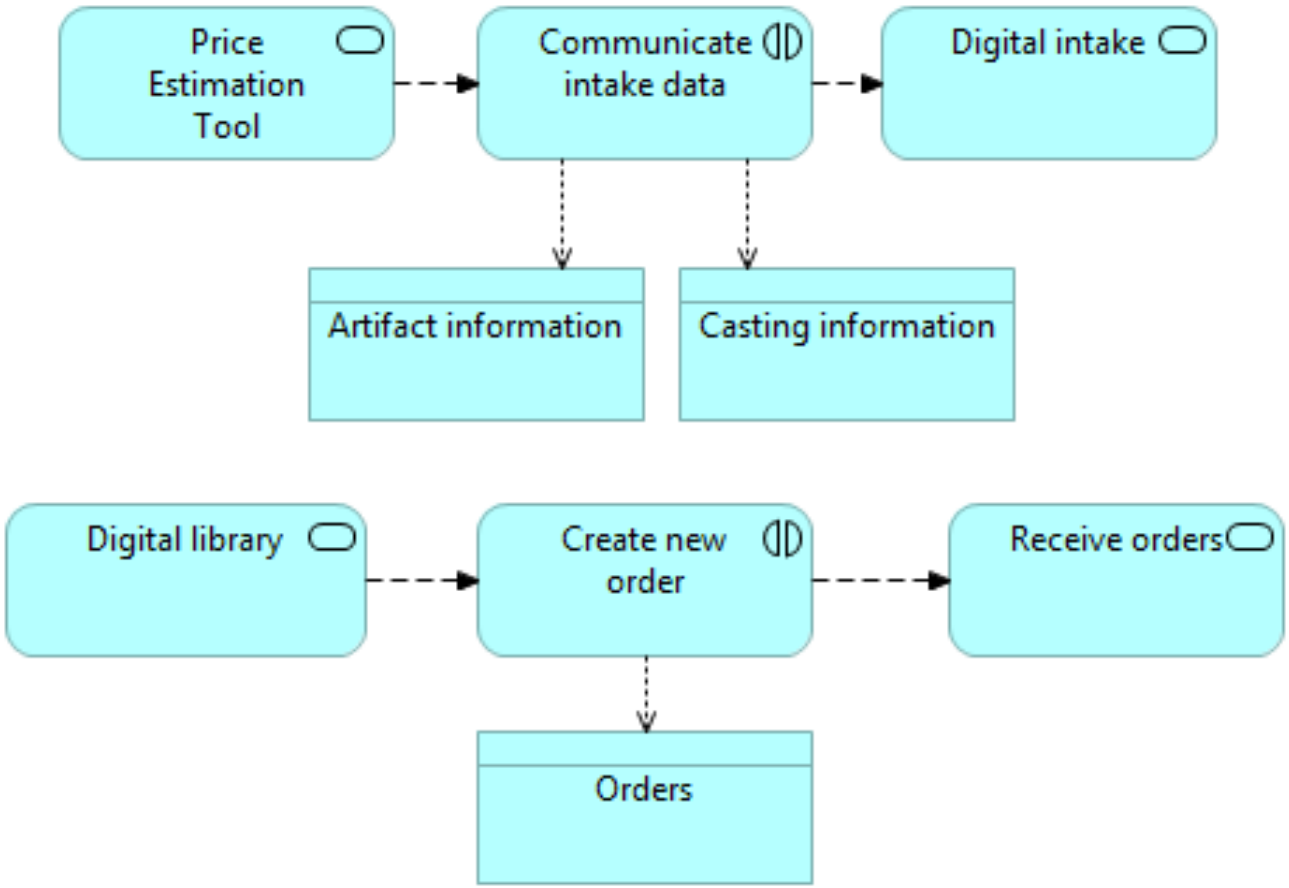
Application Usage viewpoint Figure 26 (part 1)



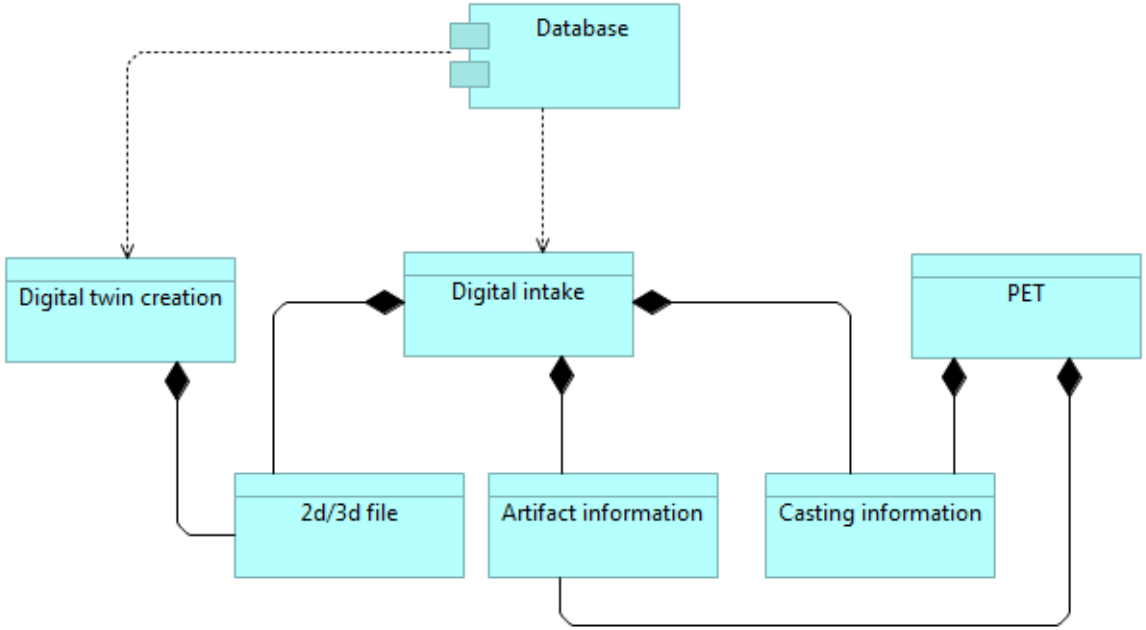
Application Usage viewpoint Figure 26 (part 2)



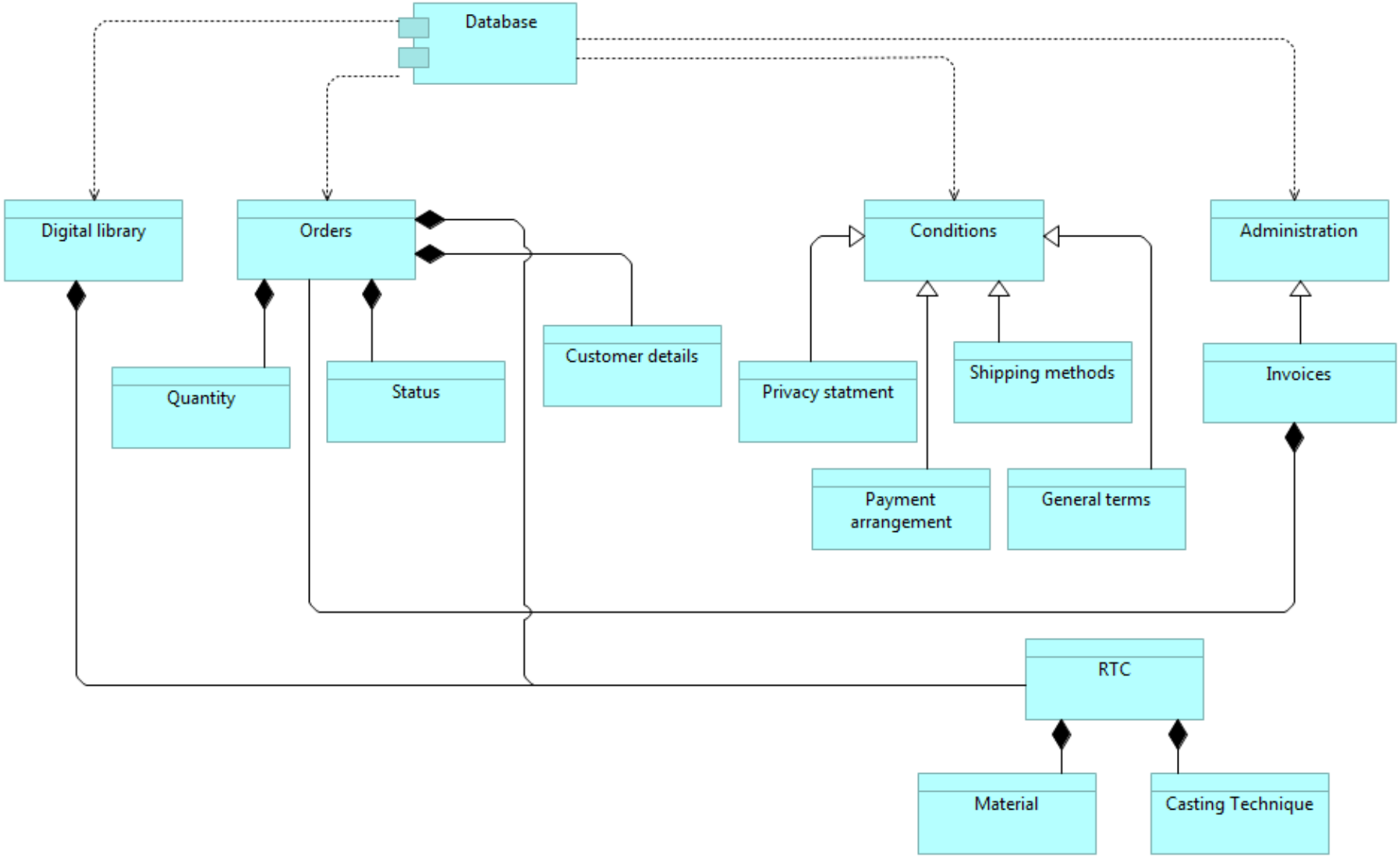
Application Usage viewpoint Figure 26 (part 3)



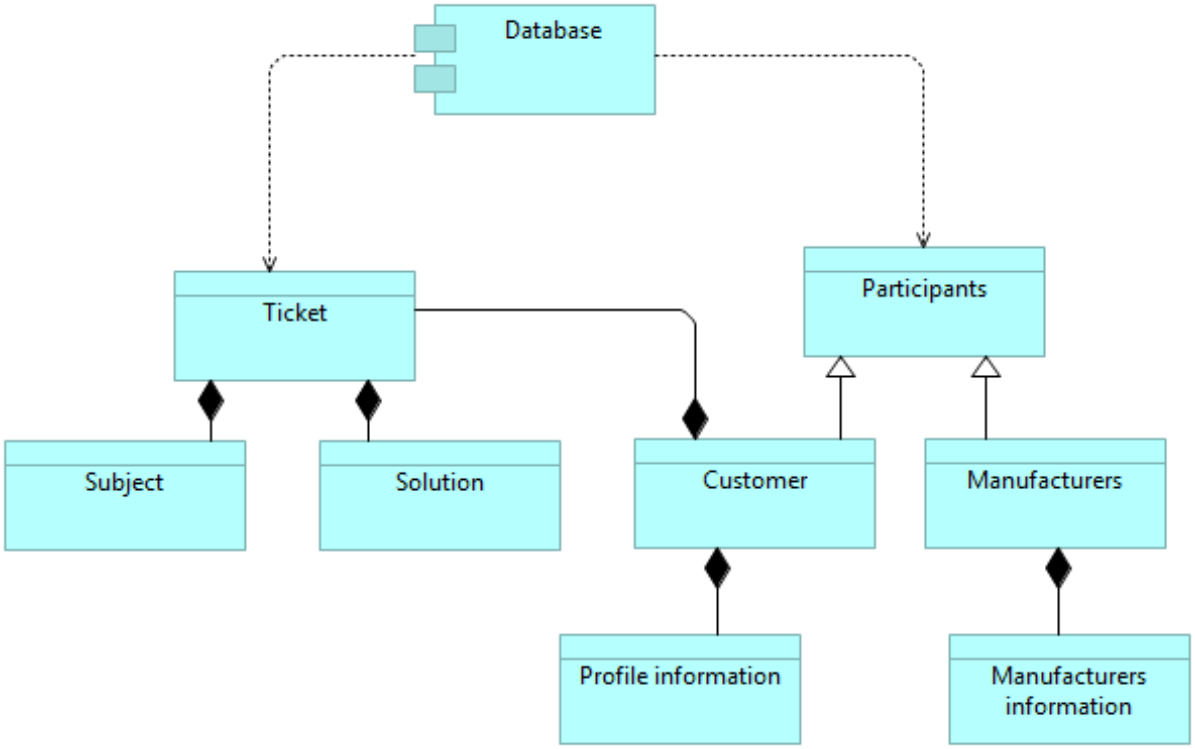
Application Communication viewpoint Figure 27



Data viewpoint (Part 1) Figure 28

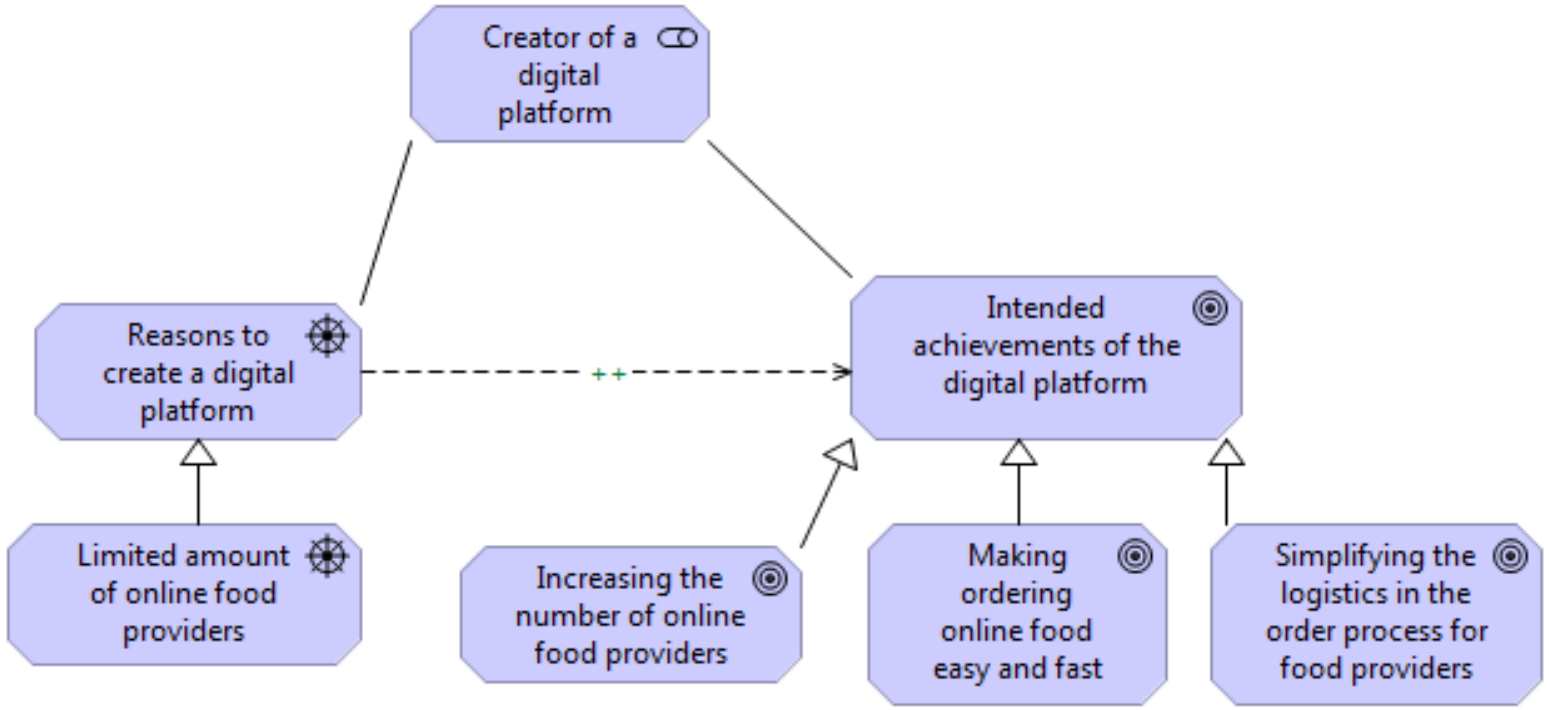


Data viewpoint (Part 2) Figure 28

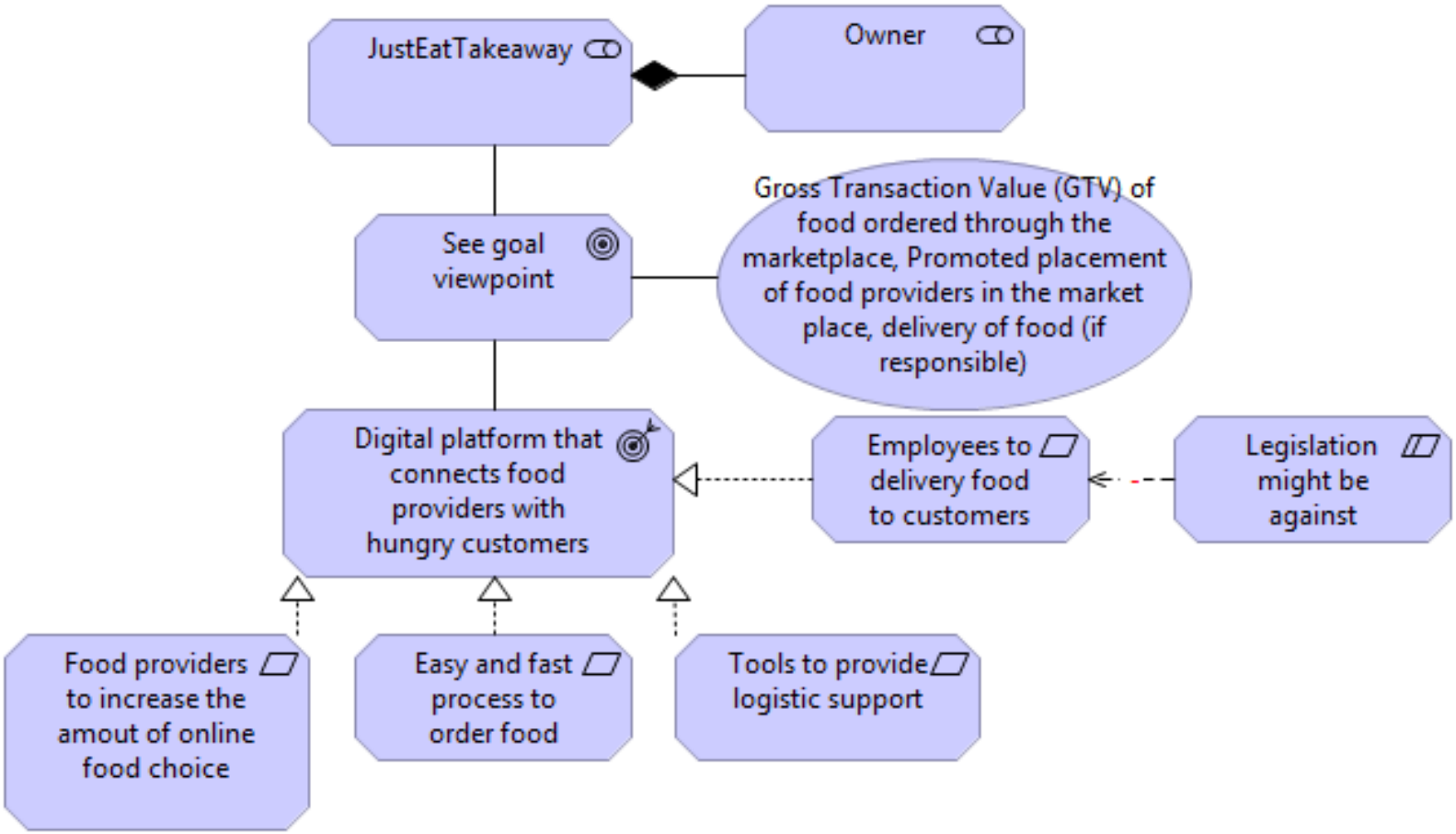


Data viewpoint (Part 3) Figure 28

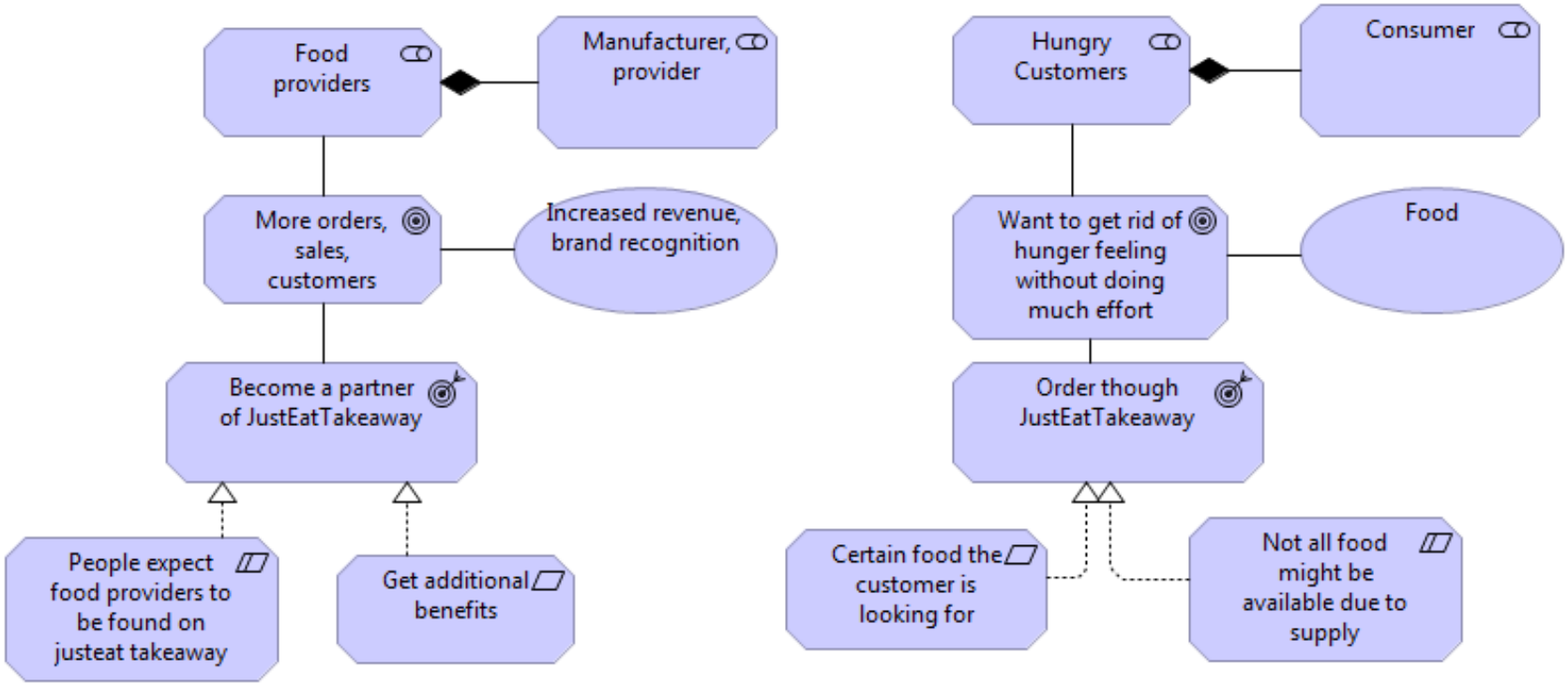
Just Eat Takeaway



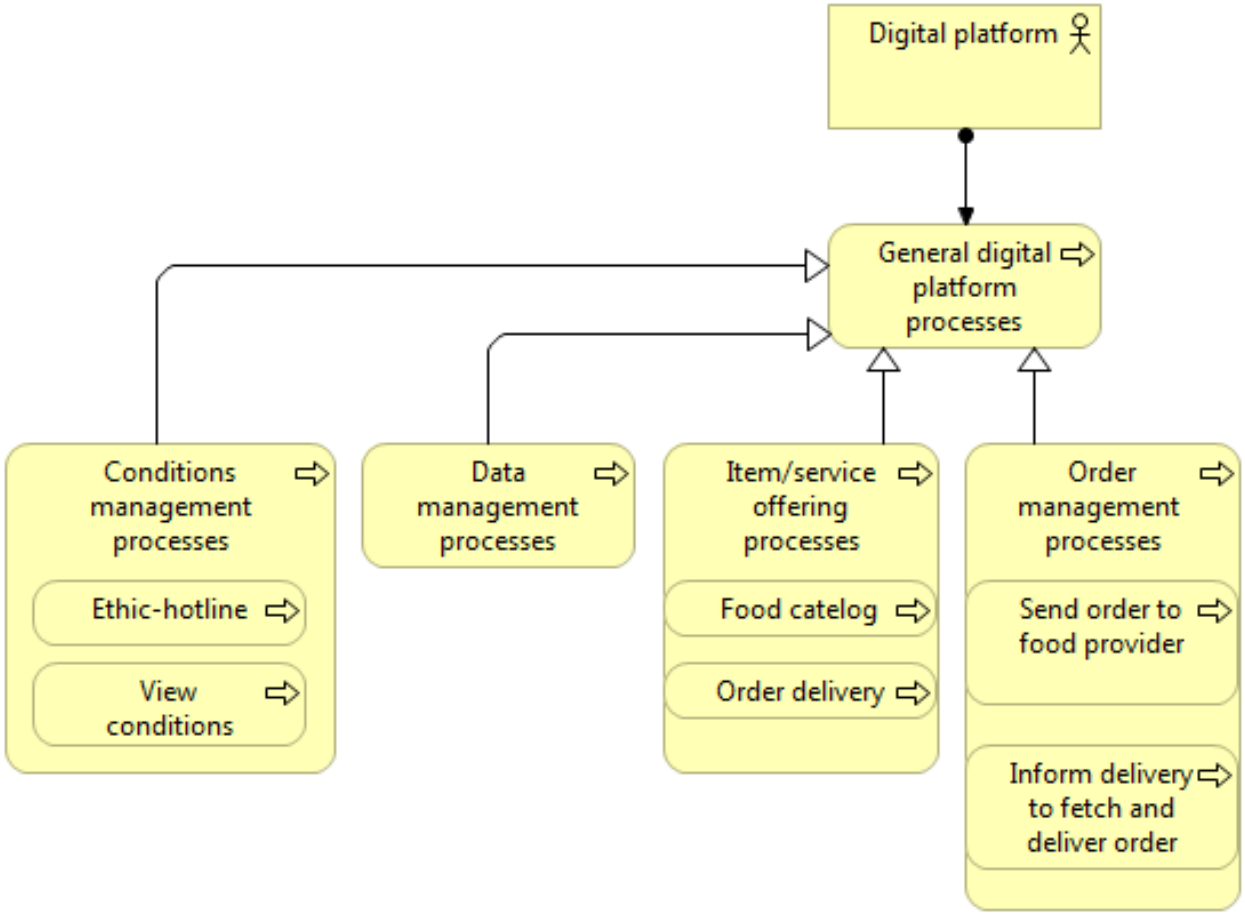
Goal viewpoint Figure 31



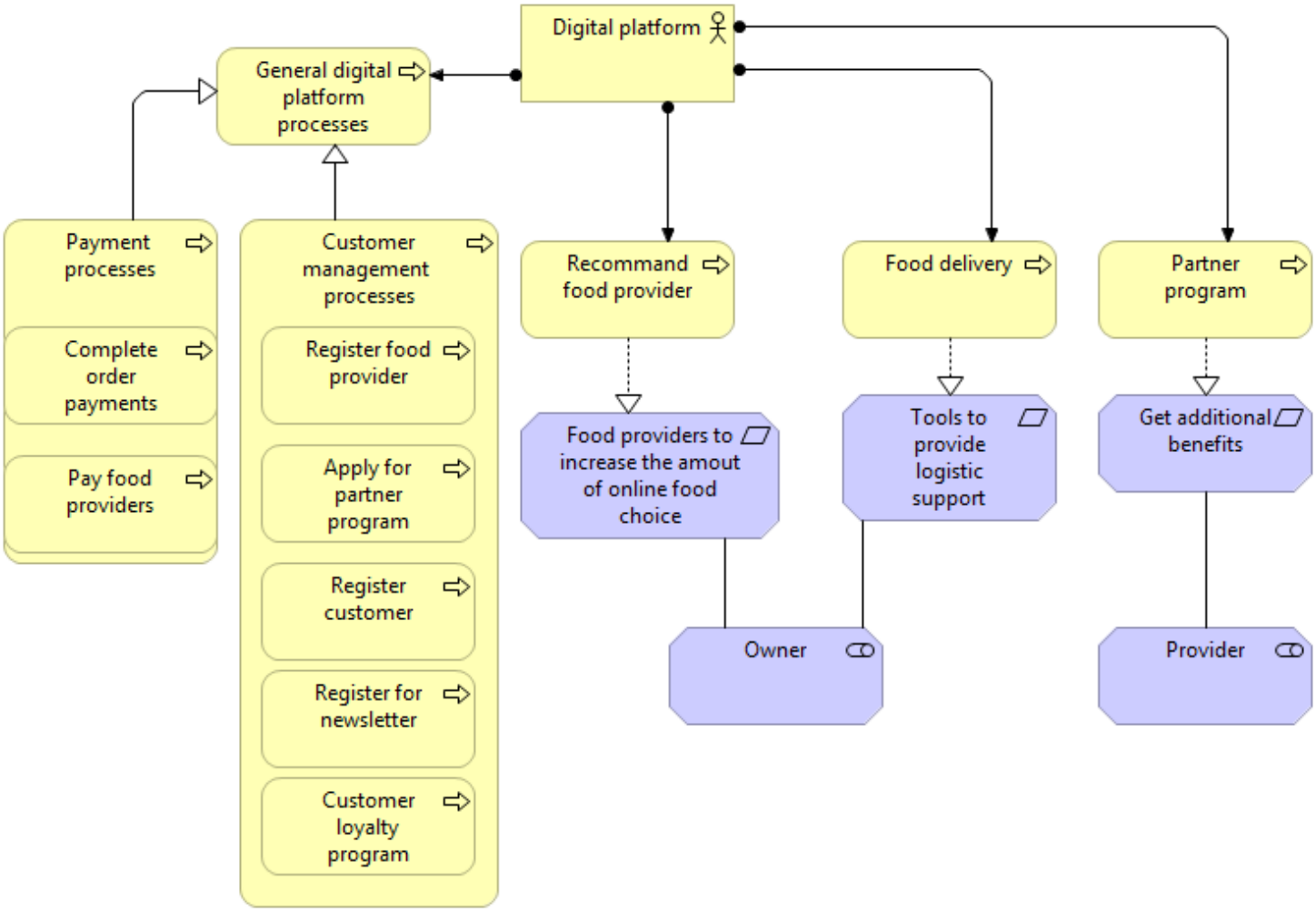
Actor Participate viewpoint Figure 32 (part 1)



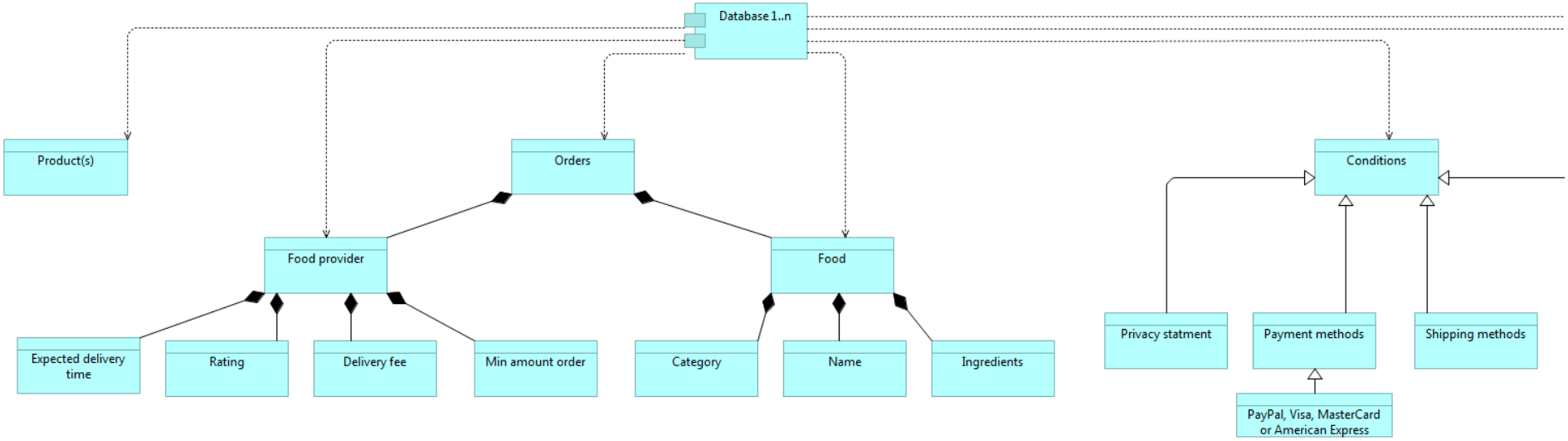
Actor Participate viewpoint Figure 32 (part 2)



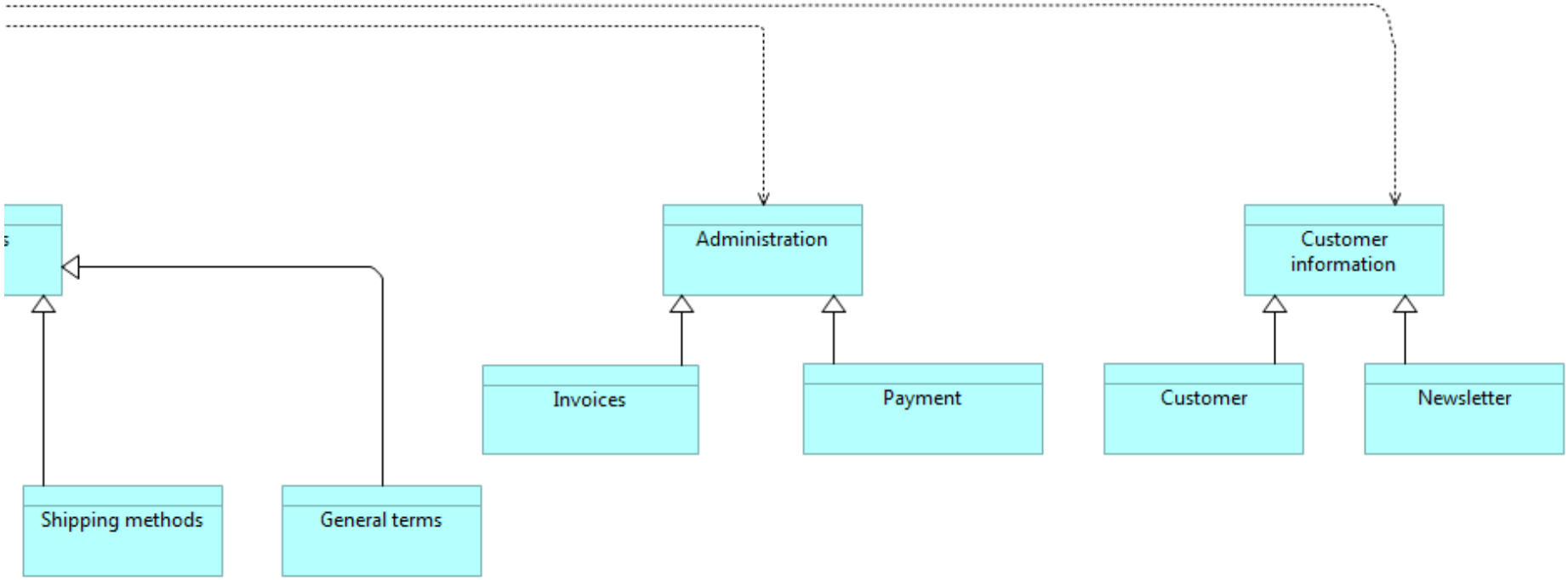
Business Process Viewpoint Figure 33 (part 1)



Business Process Viewpoint Figure 33 (part 2)



Data viewpoint (Part 1) Figure 34



Data viewpoint (Part 2) Figure 34

Appendix IV Visualization tool

This appendix contains each viewpoint form the Excel Document visualization tool.

Introduction Sheet

Introduction

This document can be used to aid in the creation process of a digital platform.
The document has seven viewpoints that allow one to think about the creation aspects of a digital platform.
Each viewpoint has a purpose and concepts with questions that one needs to consider.
These questions are only an indication. One can also come up with own questions.
The Business Process viewpoint comes with six identified processes that one has to consider
and place in the context of one's own digital platform. The Application and data viewpoints build upon
the choices made in the Business Process viewpoint.

How to read the model

The figure under "Total View" shows an overview of the different viewpoints and how they are related to each other.
The models are made in ArchiMate and follow the ArchiMate notation. But do not worry about the notation.
The questions allow one to understand the meaning of the concept and what to think about without understanding the notation.
The models can hold text with '1..n'. This means that one has to at least enter 1, but can enter more information in this concept.

The flow of the viewpoints

The viewpoints start with the Goal viewpoint to capture the reasons and achievements of the digital platform.
The Goal viewpoint is used in the Actor Participate viewpoint. This viewpoint captures different stakeholders
that participate in the digital platform network. Reasons to participate can hold requirements.
These need a business process to be realized. The business processes are captured in the business process viewpoint.
The Application Structure viewpoint captures the IT systems needed to realize the business processes.
Each IT system has functions and/or services that are also captured.
An IT system holds data, which is captured in the Data viewpoint, and has ways of being accessed, which is
captured in the Application Usage viewpoint
The Application Communication viewpoint can be used to capture the communication between services/functions.

Therefore, the recommended order to complete the viewpoints is:
Goal viewpoint -> Actor Participate Viewpoint -> Business Process viewpoint -> Application Structure viewpoint -> Application Usage viewpoint
-> Data viewpoint -> Application Communication viewpoint

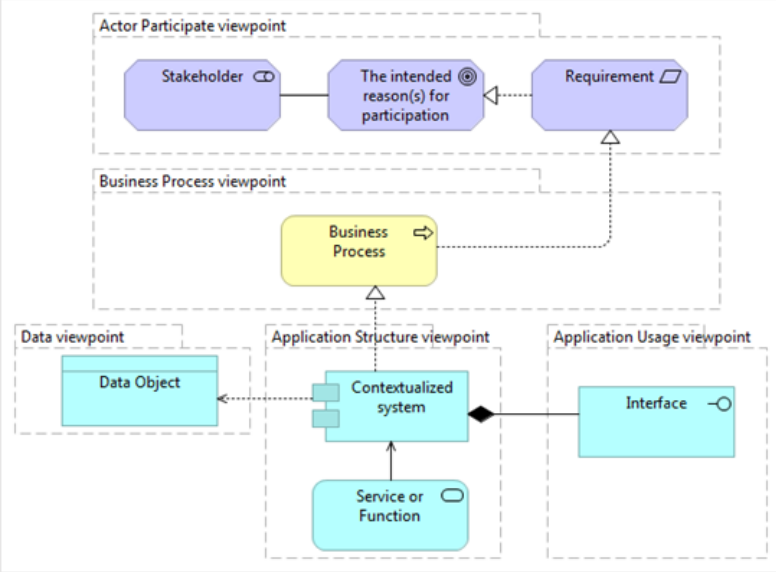
Use of this document

When clicking on a viewpoint, One will see a model, a description of the purpose, and concepts and related questions.
One needs to think about these questions and apply them to one's own digital platform.
The answers can be written under the corresponding concept column.

For example, In the goal viewpoint, the question: "What change does the digital platform bring?" is asked.
This question belongs to the concept of reasons for creating a digital platform.
If one moves to A1, the same concept is shown. Therefore, the A column is the place to write the answers down.
One can write down the first answer to this question in A2 of the goal viewpoint.
Each question can have multiple answers and does not have to fit into one row.
One can use A2, A3, or A4 to write an answer or multiple answers to the question.
Besides, one can also come up with his/her own questions to capture the concept of reasons for creating a digital platform.

Good luck with the creation process of a digital platform!

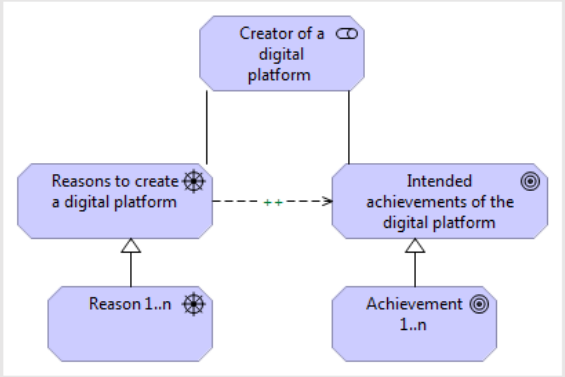
Total view



Goal viewpoint

Reasons to create a digital platform	Intended achievements of the digital platform

Model:



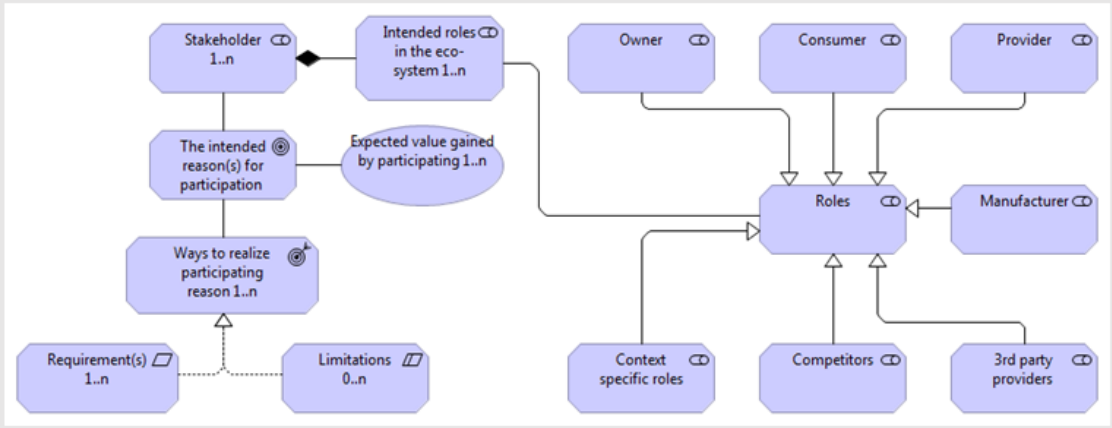
Purpose:
The goal viewpoint captures the reason one has to start a digital platform and the future plans/achievements for the digital platform.

Concepts & related questions
Reasons to create a digital platform
-What change does the digital platform bring?
-What value does the digital platform bring?
-What is the price of participation for each stakeholder?
-How does the digital platform create revenu?
-What is the (core) interaction that takes place in the digital platform?

Intended achievements of the digital platform
-Where does the digital platform stand in two years?
-What problem does the digital platform try to solve?
-What is the unique competitive advantage of the digital platform in the future?
-How big and scalable is the digital platform intended to be in the future?

Stak	Intende	The ir	Expec	Ways to r	Requirer	Limitations

Model:



Purpose

The Actor Participate viewpoint captures the different stakeholders and their roles in the digital platform eco-system.
For each stakeholder, the incentive to participate is captured.

Concepts & related questions

The owner of the digital platform has the intended reason and expected value captured in the Goal viewpoint.

Stakeholder

-Who are the main stakeholders that participate in the digital platform?

Intended roles in the eco-system

-What are the roles of the stakeholders and how will they change?

- Roles can be: Owner, Consumer, Provider, Manufacturer, Competitor, 3rd party provider, or a context specific role

Intended reason(s) for participation

-Why would the stakeholder participate in the digital platform network?

Expected value gained by participating

-What is the value this stakeholder gains by participating in the digital platform network?

-Who benefits from the digital platform, and in which manner?

-What are the different value propositions for each stakeholders?

Ways to realize participating reason

-Which functionalities does the digital platform need to have in order to realize the intended reason to participate?

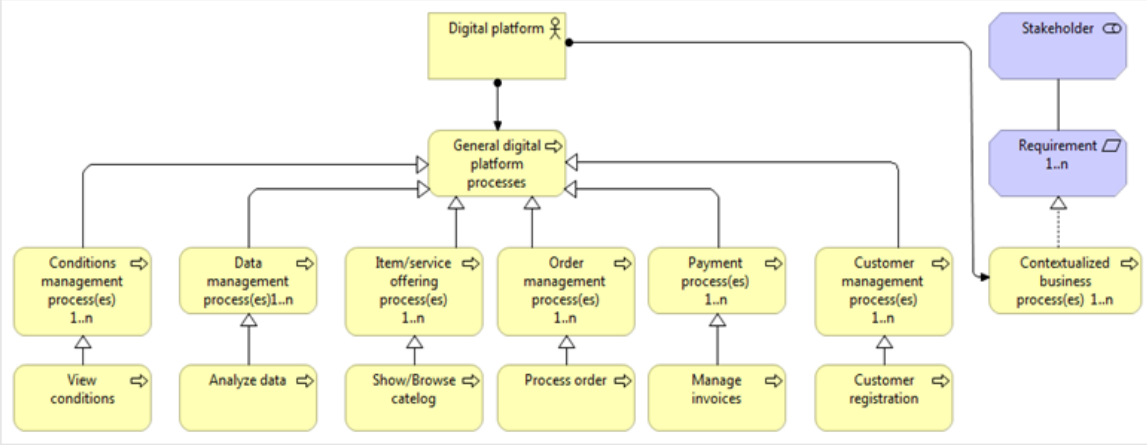
-How does the digital platform ensure the intended reason is realized?

-How does the digital platform achieve commitment of stakeholders?

Actor Participate Viewpoint

Business Process Viewpoint

Condi Data Item/ Order Paym Custo Stak Requi Contex Model:



Purpose:
The Business Process viewpoint captures the various business processes that realize various business aspects, such as customer management, order management, or context-specific processes.

Concepts & related questions

Condition management

-How openly is the data and information shared within the digital platform?
-How are the services/content regulated?
-How do users access the legal documents? When do they accept/read them?
-What are the contents of the privacy statement/ How is the GDPR implemented?
-What privileges do different roles have? /
-What are the general rules of the digital platform?

Data management

- How does the digital platform manage data?
- How does the digital platform use data to improve/ learn?
- Which processes produce useful data?
-How should data be presented, and to which stakeholders?

Item/service offering

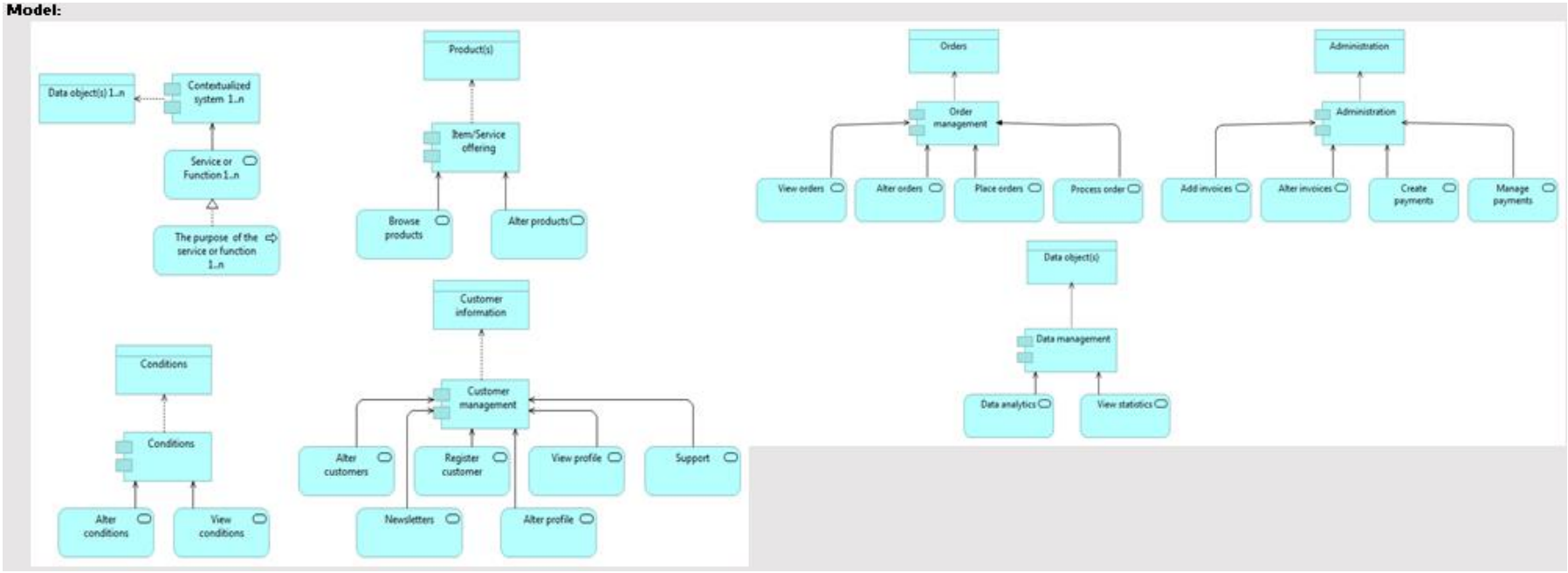
-What are the items/services offered to consumers?
-Which stakeholder is responsible for which item/service?
-Which options do stakeholders have to find the items/services and navigate them?
-What is the revenue model for these items/services?
-Which processes are there to manage these services?

Application Structure viewpoint

Contextualized system	Item/Service c	Condition	Customer manage	Order mar	Data mana	Administration
Service or Function						
The purpose of the service or function						
Data object(s)						

Part 1

Model:



Purpose:
The Application Structure viewpoint captures the different systems and their services and functions that are required to realize the business processes of the digital platform.

Concepts& related questions
The answer to the related questions builds upon answers given by the Business Process viewpoint and provides an indication of what to look for.
For example: if a digital platform uses a payment provider, the administration questions are irrelevant.

Meta model
Contextualized system: an encapsulation of application functionality aligned to support or realizes a specific set of business processes within the digital platform. It encapsulates its behavior and data, exposes functions or s
Service or Function: behavior that the contextualized system can perform to realize business processes. Services are external behavior and functions are internal behavior.
The purpose of the service or function: a short textual implementational description on a high level of the service or function, which describes the purpose or behavior performed when the service or function is implemented.
Data object: a high-level object that contains information about a topic structured for automated processing within the digital platform.

Based on the Business Process viewpoint the six identified processes are seen as IT systems:
Item/Service offering
-How does the system present the item/services?
-What are the functions/options the digital platform has concerning the items/services? (example: browse products)

Conditions
-How are the conditions stored in the system?
-Is there an editor or does the system read a word document with conditions in it?
-What kind of functionalty does there need to be in order to show the conditions to users?

Customer management
-How are support requests managed? An e-ticket system can be an outcome.
-How does the registration process look?
-Does a stakeholder have a profile? If so, what information is stored on the profile?
-How does a stakeholder edit and access the profile?

Order management
-How does a consumer view an order?
-Can a consumer change an order once placed? If so, for which duration?
-How does the digital platform process the order?
-Which steps does this processing contain and what needs to be registered in the system?

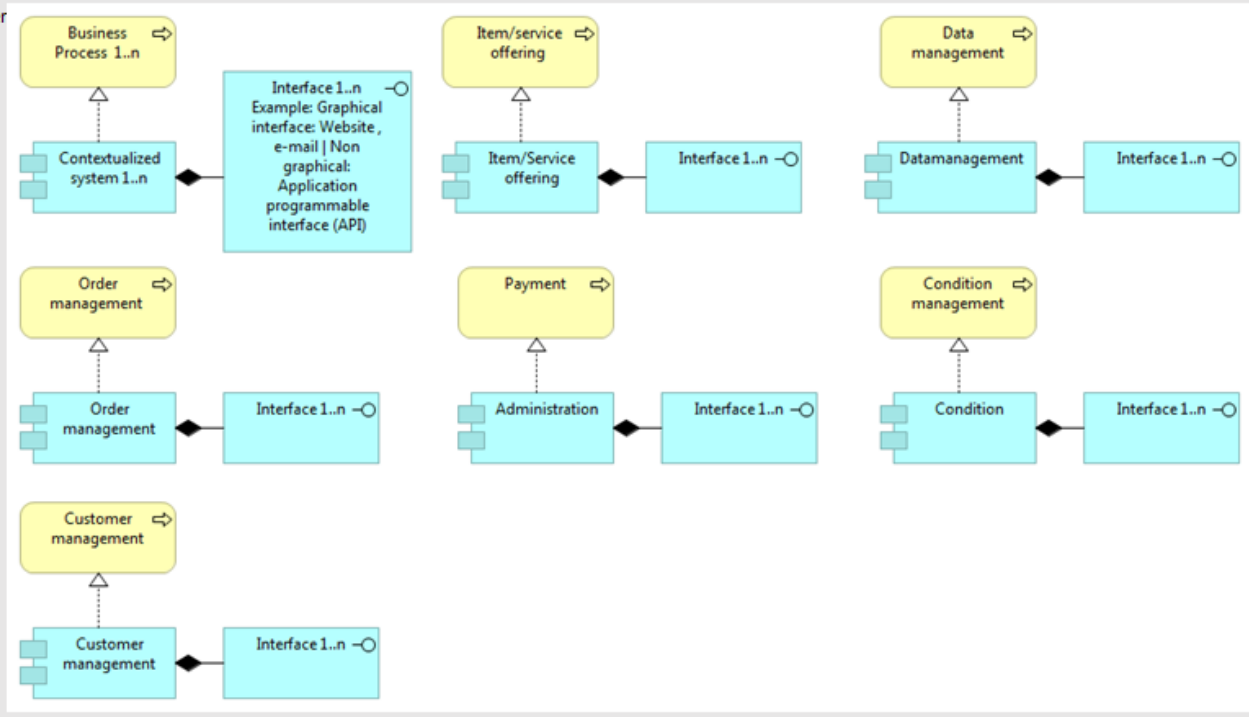
Data management
-Which analysis techniques does the system need to perform?
-Which visualization techniques does the system support?
-How can a stakeholder start an analysis?
-Which stakeholder can start an analysis?
-How are the statistics accessible?

Administration
-Which steps can a stakeholder take when managing invoices?
-Which steps does the system go through when executing a payment?
-Where can stakeholders manage invoices?
-How does the system deal with different tax rates?

Context specific
When there are business processes created by stakeholders, these can be placed here. What does the system do to support a business process? Which functions/services does it have?
-How do the function or services work? Which data is created by these functions or services?

Application Usage Viewpoint

Business process	Iter	Data m	Ord	Payı	Cond	Customer ma	Model:
Contextualized system	Iter	Data m	Ord	Adm	Cond	Customer manager	
Interface							



Part 1

Purpose:
The Application Usage captures the realization of business processes by the identified IT systems and the accessibility of these IT systems.

Concepts& related questions
The identified systems in Business Process and Application Structure viewpoint are combined in this viewpoint to see if each business process is realized, and each IT system has a task.

Meta model
Business Process: A business process identified in the Business Process viewpoint
Contextualized system: A IT system identified in the Application Structure viewpoint that contains the functionality to realize the business process.
Interface: Possible ways to access the functionalities provided by the system. These can be graphical, website, or non-graphical APIs.

The related question for each system is the same:
-How to ensure access to the platform?
-How does the system provide its functionalities?
Graphical: How does the webpage look? Does it have a login form? Describe the general layout of the webpage and how it realizes the business function.
Non-Graphical: What are the functions that the API has. Describe how another system can interact with the API.

What is an API?
An application programming interface (API) is a connection between computers or between computer programs.
It is a type of software interface, offering a service to other pieces of software.
This is used for direct communication, so there is no website on which a user goes.
More information see: https://en.wikipedia.org/wiki/API

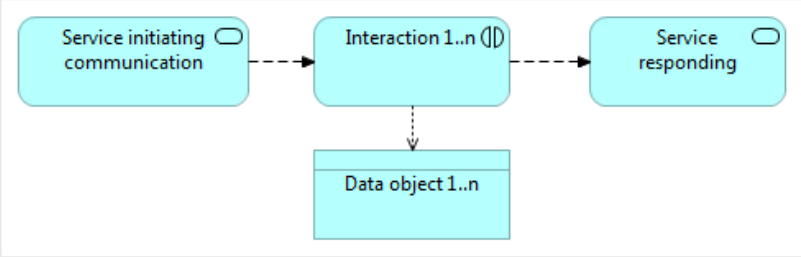
What do I need?
As a rule of thumb, if there is data (like text) that comes from a machine and needs to be read by a human, or text from a human to the machine, you want a graphical interface (also known as human-to-machine communication). If there is data that comes from one machine to another machine, you want an API (also known as machine-to-machine).

Part 2

Application Communication

Service initatir	Service r	Inter	Data object

Model:



Purpose:
The Application Communication viewpoint captures the services and functions that communicate together; one goal can be to achieve better functionalities.

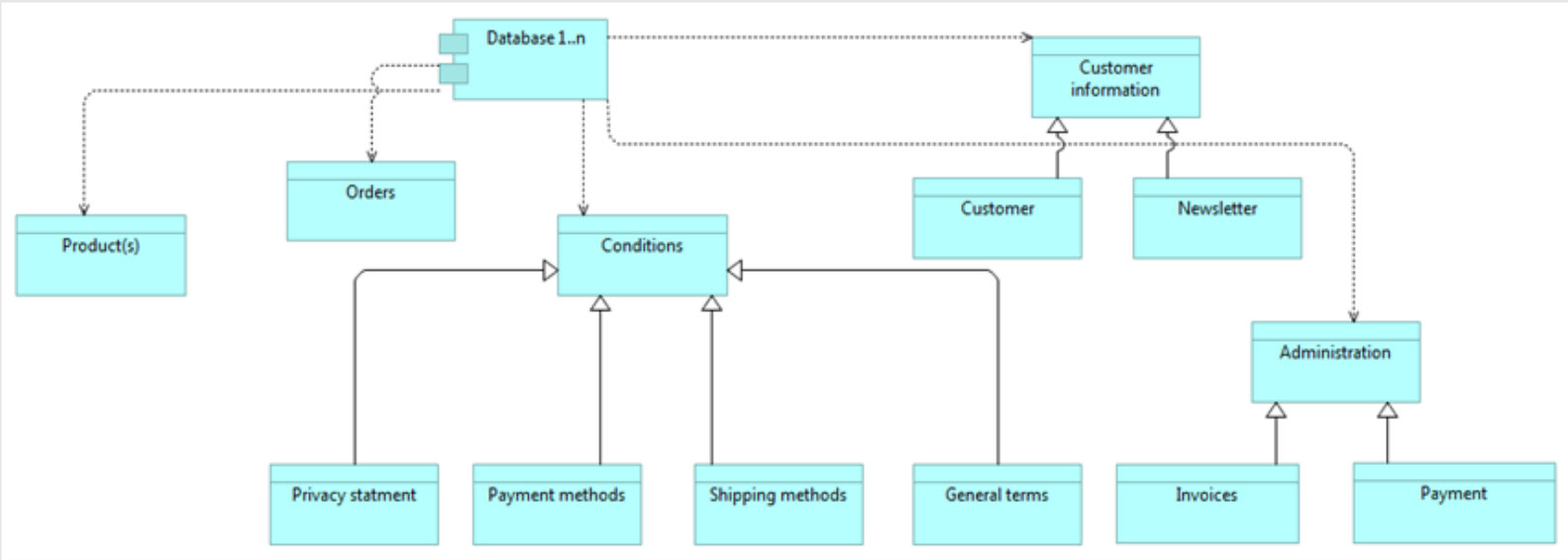
Concepts & related questions
This viewpoint uses the functions or services from the Application Structure viewpoint
This viewpoint is an additional viewpoint that can help to create a more efficient digital platform.
But also show the communication flow between different systems.
The general question is: Which service or function uses data that another service or function can use to perform a certain task.
For example: An price estimation gathers information about a product. This information can be communicated to the product intake service.

Meta model
Service init communication
-Which service or function starts the communication?
Service responding
-Which service or function responses?
Interaction
-What is the goal of the communication?
-Does a service have data another service needs? Or do two services process the same data?
Data object
-Which data is communicated?

Data viewpoint

Data object

Model:



Purpose:

The Data viewpoint captures all data objects within the digital platform. These are used in other viewpoints to clarify how the data is used.

Concept & related questions

Data object

-What are the different data objects created in the Application Structure viewpoint?

-What do these data objects contain, and how are they related to other data objects?

-How is the data within this viewpoint used to improve the digital platform?

-Does every data object belong to the same database? Or are there multiple databases?