FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

ENTERPRISE MODELING OF THE IMPACT OF AUGMENTED REALITY ON THE BUYER-SELLER RELATIONSHIP

CASE STUDY RESEARCH

Word count: 19.721

Ruben Lovenweent

Student number : 01305126

Supervisor: Prof. dr. Geert Poels

Master's Dissertation submitted to obtain the degree of:

Master of Science in Business Economics: Marketing

Academic year: 2017 – 2018

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Ruben Lovenweent

Dutch summary

Het hoofddoel van deze masterproef was om de impact van toegevoegde realiteit, beter bekend onder de Engelse term *augmented reality (AR),* op de koper-verkoper relatie te analyseren. Drie cases werden onderzocht om het effect van deze impact te ontdekken. Deze cases kwamen uit de praktijk en werden uitgewerkt in samenwerking met de bedrijven Maersk, Duracell en Texet. De gebruikte waarden in deze cases zijn gebaseerd op getallen uit de praktijk, literatuur en in uitzonderlijke gevallen op veronderstellingen. De impact van *AR* op de koper-verkoper relatie werd onderzocht met behulp van bedrijfsmodeleringstechnieken, ook bekend onder de Engelse term *enterprise modeling (EM) techniques*. De gebruikte *EM* technieken waren het *Value Management Platform (VMP) en Business Process Model and Notation* (BPMN) voor de Maersk en Duracell cases en het *Value Management Platform* en *Service Blueprint (SB)* voor de Texet case. Het *VMP* werd gekozen als modeleringstechniek voor alle drie de cases omwille van zijn focus op waarde creatie, hetgeen een kernelement is wanneer innovatie wordt besproken. *BPMN* werd gekozen omwille van het feit dat *AR* vaak wordt geïmplementeerd om het bedrijfsproces te optimaliseren. *SB* tot slot kwam als alternatief voor *BPMN* naar boven bij het modeleren van de Texet case aangezien *BPMN* hiervoor niet geschikt bleek. *SB* was dan ook geen onderdeel van de onderzoekvragen. Een algemene- en twee sub onderzoeksvragen werden opgesteld:

"Kunnen *enterprise modeling* technieken de impact van *augmented reality* op de koper-verkoper relatie analyseren?"

- **"Kan het *Value Management Platform* de impact van *augmented reality* op de koper-verkoper relatie analyseren?"**
- **"Kan *Business Process Model and Notation* de impact van *augmented reality* op de koper-verkoper relatie analyseren?"**

Het antwoord op de algemene onderzoeksvraag kan als "ja" beschouwd worden voor elk van de drie cases. Het *VMP* was in staat om zowel proces- als klantgeoriënteerde cases te analyseren. *BPMN* bleek enkel geschikt voor procesgeoriënteerde cases en het gebruik van deze taal hangt in sterke mate af van de inhoud van de case om *AR* te analyseren. *SB* bewees zich een waardig alternatief voor *BPMN* wanneer *AR* een impact heeft op de klantenervaring. Wanneer een bepaalde *EM* techniek niet in staat was om *AR* in een bepaalde context te analyseren, kon een andere *EM* techniek gebruikt worden als substituut, vandaar dat "ja" op de vraag kan worden geantwoord. Elk van de drie modeleertechnieken werden bovendien als complementair beschouwd.

Preface

I am pleased to present this Master's Dissertation whereby I had the possibility to contribute to academic knowledge. I look back satisfied with the obtained result.

I would like to acknowledge all the people who assisted me in this process. Firstly, I thank my supervisor Prof. dr. Geert Poels for the many tips, valuable feedback and accessibility. Next, I thank the augmented reality providers Poppr and Soulmade for the information and provision of the cases. I would like to thank the actors of the cases themselves as well for their insights and practical information: Maersk Line Belgium, Duracell Batteries BVBA and Texet Benelux. I thank VDMBee founders Theodoor van Donghe and Henk de Man for their support regarding the Value Management Platform. I would like to end by thanking my friends, girlfriend and family for the moral support.

Content

List of used abbreviations

3D	Three dimensional
AR	Augmented reality
AV	Augmented virtuality
B2B	Business to business
BM	Business Model
BPMN	Business Process Model and Notation
CBMP	Continuous Business Model Planning
EM	Enterprise modeling
OMG	Object Management Group
SB	Service Blueprint
VMP	Value Management Platform
VR	Virtual reality
VSM	Value Stream Map

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1. Introduction

"The economy is disruptive" (Bower & Christensen, 1995). This almost 25 years old expression keeps staying in our economic and social image and is now more relevant than ever. It is expected that 75% of enterprises which are dominating the Standard & Poor's 500 will no longer exist in its current form by 2027 (Foster, 2012). The beauty of a disruptive economy is that it creates two opportunities. Firstly, it allows companies to redefine how and why they work. Secondly, companies can create a better way to serve both customers and employees who choose to collaborate with them because they believe in the company's purpose (Forbes, 2015). In order to enable those opportunities, organizations have to adjust their business model to the environment. A possible instrument for this business transformation is the implementation of augmented reality.

Augmented reality (AR) is a technology whereby the real world is extended by the addition of virtual elements. It distinguishes itself from virtual reality, which simulates an entirely virtual environment (Silva, de Oliveira, & Giraldi, 2003). AR is rising in popularity, which results in an increase in development of consumer AR-applications such as Pokémon Go, ARKit or Ikea Place. Next to those consumer applications, AR is making its entrance into the business world. It can be seen as an emerging technology that enables opportunities for businesses (Deloitte, 2018). That is the reason why businesses are looking at ways to use it in an optimal way and take advantage of this technology. Therefore, there is a need for methods to analyze the impact of augmented reality on the business and the buyer-seller relationship. Such a method could be enterprise modeling.

Enterprise Modeling (EM) is the collective name for different techniques that visualize and analyze the working and structure of an enterprise (Fox & Gruninger, 1998). It captures various aspects of an organization or a problem situation, such as business goals, processes and actors, in an integrated way. "EM contributes to the management of an organization by supporting change management, decision-making, and planning processes both within the different organizational functions and for its IT support" (Sandkuhl et al., 2014). This explanation of Sandkuhl et al. relates with the business transformation character that AR implies. Hence, the use of enterprise modeling techniques to measure the impact of AR on businesses provides a suitable reason for research.

This Master's Dissertation examines the impact of augmented reality on the buyer-seller relationship. To analyze this impact, it uses enterprise modeling techniques. A qualitative, multiple case-study research has been used. The main goal of the Dissertation is to evaluate the suitability to analyze the impact of AR of three different EM techniques: The Value Management Platform (VMP), Business Process Model and Notation (BPMN) and Service Blueprint (SB). The VMP is a toolkit that can be used to create a management dashboard for decision-making regarding business change. The VMP provides the interface for a background: The Value Delivery Modeling Language (VDML). VDML is a recent enterprise modeling standard adopted by the Object Management Group (OMG, 2015) to model value creation. BPMN, "will provide businesses with the capability of understanding their internal business procedures in a graphical notation and will give organizations the ability to communicate these procedures in a standard manner" (OMG, 2013). The used modeling version is BPMN 2.0. Service blueprint, "is a detailed description of a new service with its implications on working processes, time agreements, support, … in short everything which is practically necessary to ensure that the updated service runs smoothly" (Flanders Inshape, n.d.).

The instruments for evaluation are three case studies. The first case has been developed together with Maersk. Maersk is a shipping company that transports two types of containers. One is simple and entirely made out of metal in order to ship low cost materials. Another one is more advanced and equipped with a climate system (to adjust temperature, humidity, …). This second type of containers is used to ship high value goods such as art, luxury cars, … or low cost goods in need of climate support. Those goods often need a treatment during transport. During these treatments and to open the container, many mistakes are made. The augmented reality application that will be developed for this uses a body-cam in combination with AR-glasses (Microsoft Hololens). The body-cam reads the unique code of the container as well as the data on LCD screens. The AR glasses then tell the employee what has to happen and in which order.

A second case happened in collaboration with Duracell. This has been a quality control case. Duracell produces next to her small batteries also larger ones for B2B selling. Those exist out of relatively larger components. Some of those components need to be checked during quality control. It is difficult and time consuming however for their employees or a machine to check this. The success-rate is not 100%. Therefore, an augmented reality application has been developed that supports employees when checking for missing or disconnected parts. It also shows the name of smaller components and assists the employee with steps necessary to take.

The third case has been accomplished with Texet. Texet is market leader in Belgium for professional clothing (e.g. for hotel personnel, roadworkers but also Coca-Cola is one of their customers). An AR app will be developed that can be used by their customers or during their sales meetings. The AR app will visualize the clothing in 3D. It will be possible to add colors, a company logo or other finishing touches. What the customers do can be sent directly to Texet as well. Main goal of them is to improve and shorten the customer journey and to collect data regarding customer behavior. Two EM techniques have been used for each case. For the Maersk and Duracell cases, the VMP and BPMN have been used. For the Texet case, this has been the VMP and SB. Important to mention is that it was not intended to do any research on service blueprint but because the Texet case was not suited to model in BPMN, SB has been chosen as an alternative. Therefore, it has not been included as part of the research questions, but as part of an answer to the BPMN research question. Given these implications, the following research question with sub questions have been examined:

"Can enterprise modeling techniques analyze the impact of augmented reality on the buyer-seller relationship? "

Sub questions:

- **"Can the Value Management Platform be a an enterprise modeling technique to analyze the impact of augmented reality on the buyer-seller relationship?"**

- **"Can Business Process Model and Notation be an enterprise modeling technique to analyze the impact of augmented reality on the buyer-seller relationship?"**

A structured method has been applied with first a theoretical background in the context and literature section after which the research questions are discussed. Thirdly, the used research methodology is explained. Next, the AR case-studies are extensively illustrated. Subsequently, the VMP, BPMN and SB are subject to an evaluation. Ending with a discussion and conclusion, this Master's Dissertation hopes to contribute to the domains of enterprise modeling, augmented reality, value creation and business transformation.

2. Context

2.1. Augmented Reality

2.1.1. Definition

Azuma et al. (1997) state that "AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world". These authors describe the goal of AR as follows: "it enhances a user's perception of and interaction with the real world. The virtual objects display information that the user cannot directly detect with his own senses. The information conveyed by the virtual objects helps a user perform real-world tasks". In other words, the reason why AR is useful, is because it allows the user to obtain a better understanding of the existing reality. According to another research by Azuma et al. (2001), an AR system should have three characteristics. Firstly, it adds elements from the virtual world to the real world. Secondly, it is interactive in three dimensions (3D) in real-time and thirdly, it sets real and virtual objects on one line.

Milgram's Reality-Virtuality Continuum is defined by Paul Milgram and Fumio Kishino (1994) as "a continuum that spans between the real environment and the virtual environment comprising Augmented Reality (AR) and Augmented Virtuality (AV) in between". As can be seen in figure 1, AR is closer to the real world and AV is closer to a pure virtual environment. An entirely virtual environment is better known as VR or Virtual Reality. It is useful to know the definition of VR to avoid confusion with AR: "VR ensures that a user is being fully immersed in an entirely virtual world" (Milgram and Kishino, 1994).

Figure 1: Milgram and Kishino's reality-virtuality continuum

The hardware for AR and VR are similar because both have to create virtual elements for a user. However, AR has more graphic requirements since it has to be capable to follow reality. VR on the other hand, creates an entirely new world that hides the real one and thereby does not have to take reality into account which is why those graphic requirements are lower (Peddie, 2017).

2.1.2. Augmented reality in a business context

The interest in AR is increasing as innovators explore the business relevance and roles AR can play in organizations. This emerging technology holds an immense promise to change the way businesses operate. For example, it could be implemented for workforce enablement, customer experience and interaction. The first one, workforce enablement, has been confirmed by research: according to Milgram (1994), AR technology augments the sense of reality by superimposing virtual objects and cues upon the real world in real time. Azuma et al. (1997) state that "AR can also be used to augment or substitute users' missing senses by sensory substitution." It is therefore interesting to indicate that AR can be of use for businesses in need of employees with amplified senses. This will be demonstrated in this Dissertation in the Duracell case, which is a quality control case where the senses of their workforce were inadequate and in need of assistance by AR.

As for the Maersk case, AR will be implemented to avoid the employees to make mistakes. Use of AR in the field can improve safety, reduce mistakes or confusion and take the pressure off employees who cannot possibly be experts in all technologies and infrastructures. The quality control-Duracell case has already been slightly mentioned by telling that AR is used as an instrument for the amplification of the senses of the workforce. Furthermore, AR makes it possible for even inexperienced people to identify problems and perform repairs by following step-by-step instructions using AR overlays and to improve customer satisfaction by reducing associated costs or downtime. Finally, the Texet case focuses on the usage of AR to shorten the customer journey and increase customer satisfaction. Any smartphone or tablet can be an AR platform to create a shopping environment for customers, whether that's within the traditional brick-and-mortar or online store. AR technology is used to create a 3D shop that virtually replicates the experience of shopping in a traditional store. Giving customers the ability to try an item before buying it, can improve satisfaction and creates an appealing customer experience as well.

2.2. Enterprise modeling

Enterprise modeling techniques are the core of this Dissertation as they are the instruments to analyze the impact of AR on businesses. "An enterprise model represents the organization of all facets in a company and helps to solve particular organizational challenges" (Sandkuhl, 2014). From a design perspective, an enterprise model should provide the language used to explicitly define an enterprise (Fox & Gruniger, 1998). Applied to this thesis, each chosen EM technique should depend on the business model and content of each case. The goal of enterprise modeling is "to represent or formalize the structure and behavior of enterprise components and operations in order to understand, engineer or re-engineer, evaluate, optimize and even control the business organization and operations" (Vernadet, 2002).

Businesses face many challenges today. Such challenges could be for example the improvement of business processes, the understanding of all facets of the organization, placing the organizational strategy on one line or the development of the IT-strategy. EM helps businesses to tackle challenges by analyzing the enterprise from different angels. In this way, one can study or investigate all perspectives of the company that are each pointed at another facet of this company. Each angle is equally important because they assure together the complete mapping of the whole organization (Sandkuhl, 2014).

Each relevant EM technique for this Dissertation will be further discussed separately. The condition for inclusion of a technique is based on whether it has been used during the modeling of the cases.

2.2.1. The Value Management Platform

The VMP is a tool to model business change and is developed by VDMBee. It is based on a modeling language called The Value Delivery Modeling Language (VDML) which has been developed by the Object Management Group (OMG). Central to VDML is the concept of value. "Value is a measurable factor of benefit delivered to a recipient in association with a deliverable" (VDMBee, 2015). Also central to VDML, is the ability to model collaborative business relationships and role based business networks. Hence, "the purpose of VDML is to provide a standard modeling language for analysis and design of the operation of an enterprise with particular focus on the creation and exchange of value"(VDMBee, 2015). In other words, VDML allows organizations to model, design and analyze their process of value creation. In comparison with BPMN, VDML can provide a framework and generate requirements for the design of business processes, but "it provides a

more abstract view than BPMN and other process modeling tools by focusing on the consumption and production of deliverables and the statistical performance and contributions of value by activities including cost, quality and duration" (de Man & Cummins., 2013).

The Value Management Platform provides the interface for VDML. It has been developed to give VDML a touchable and practical character by incorporating its concepts and make them transparent and intuitive for managers. Using the VMP, business changes can be planned, different phases and scenarios can be modelled and the impact of changes on value creation can be estimated. Furthermore, once a business change trajectory has started, the platform helps monitoring the changes and keeping the company on track (VDMBee, 2015).

As mentioned in the introduction, it has become crucial for organizations to adapt to the changing environment. This fits within the Continuous Business Model Planning (CBMP) approach. This method states that "organizations have to continuously adapt their business model (BM) to the environment in order to keep up with the changing environment and survive." (VDMBee, 2015). The approach can manifest itself by both validating the existing BM or being on the lookout for a new one. VDMBee (2015) considers it as being "a continuum, ongoing effort". In CBMP, the business model is considered as the unit of strategic planning (Poels, Roelens, de Man and van Donghe, 2018).

Poels, Roelens, de Man and van Donghe (2018) did extensive research on the topic where the CBMP can be of use for the Value Management Platform. The VMP uses the CBMP structure. Hence, the cases in this Dissertation are structured in the same way. The CBMP process provides a high-level structuring in three stages: Discover, Prototype and Adopt. The purpose of the discover stage is the discovery of the AS-IS and TO-BE business models to be further elaborated in the prototype stage. The discovery of business models is done in a collaborative workshop involving the stakeholders in the CBMP initiative. The workshops are organized in 4 sessions:

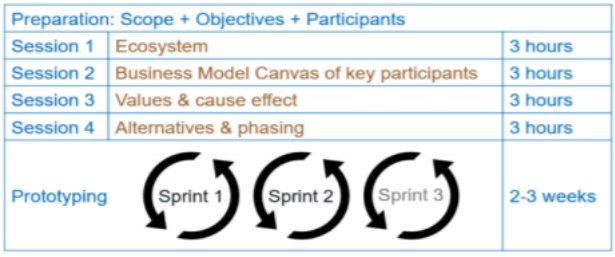

Figure 2: Different workshops in the discovery stage

The next step in the process is the prototype stage. “The purpose of this stage is to develop a multi-perspective business model ecosystem by further elaborating the interrelated business models from the discovery stage, for each of the phases and alternatives in the plan” (Poels et al., 2018). VDMBee (2015) refers to it as “designing and making the business model(s) explicit”. In this context, making it explicit means adding a value to all mapped components of the discovery stage and let these values aggregate with and have an impact on each other inside a business model cube (figure 3). The concept of business models that CBMP uses, is based on the Business Model Cube of Lindgren & Rasmussen (2013). By doing so, all business models in the ecosystem are balanced in terms of customer- and partner relationships and value is exchanged between participants in all directions. Presenting the business model as a cube means that there are six aspects: value propositions, customers, partners, activities, competencies and values. These components are interrelated with each other and combined into a business model cube. (Poels et al., 2018).

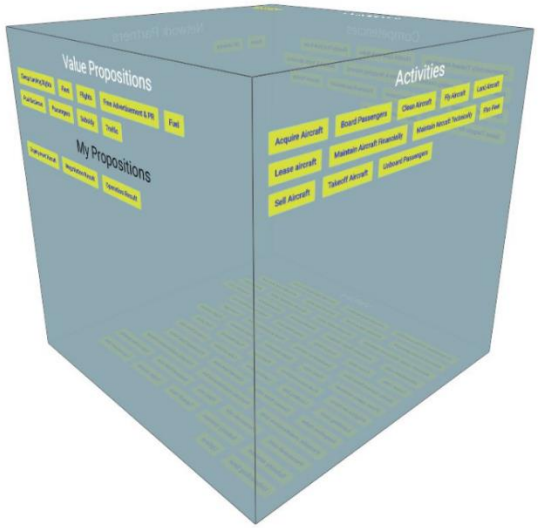

Figure 3: Example of a Business Model Cube

The final stadium is the Adopt stage. “The purpose of this stage is to present the prototyping results to strategic decision-makers, allowing them to decide on adoption and initiation of the required changes. Value management professionals support the decision-making process by using the built-in dashboard, reporting, and what-if scenario analysis techniques of the VMP.” (Poels et al., 2018). According to the same research, the VMP is qualified as well to support managers at taking decisions regarding the innovation of the business model.

2.2.2. Business Process Model and Notation

Business Process Model and Notation (BPMN) is a standard for modeling business processes. It has been designed by the Business Process Management Initiative (BPMI) and is being maintained by the Object Management Group (OMG). The actual version is BPMN 2.0, which is the used version in this Dissertation as well. According to the OMG (2011), it is intended "to be used directly by the stakeholders who design, manage and realize business processes, but at the same time be precise enough to allow BPMN diagrams to be translated into software process components." A business process diagram is made up of a set of graphical elements which are distinguishable from each other and familiar to most modelers (White, 2004). There are four basic categories of elements: flow objects, connecting objects, swimlanes and artifacts. Next to easily interpretable basic elements, some more difficult and advanced aspects are available as well which require a particular form of training (Wahl & Sindre, 2005).

Many research has been done to identify the quality of BPMN and its shortcomings. Recker et al. (2005) concluded that "BPMN possesses a high level of maturity because it has among other a high level of ontological completeness." What is missing however, is "the possibility to describe different types of statuses." Furthermore, "it is not possible to model particular structures". These weaknesses however, should not lead automatically to problems for the users. One can use another EM technique in addition to BPMN.

BPMN is used to model processes of which the activities are executed by actors. There are several situations where BPMN can be of use. Three sub-models are distinguished in an end-to-end BPMN model (Minoli, 2008): private business processes, abstract business processes and collaboration processes. Private business processes are processes that occur internally in a particular organization. Abstract business processes are used to represent the interaction between a private business process and another process or entity where only the activities used to communicate with other entities are shown. A collaboration process presents the interactions of different entities. This is a series of consecutive activities that display the information-exchange between the involved entities. Only the interactions between both parties are shown. The internal processes for the different entities can contain more activities than represented in the process.

2.2.3. Service Blueprint

A service blueprint captures the core components and aspects of the service process. Information about the front- and backstage, customers, workforce, environment, supportive processes, resources, etc. is included. In addition, it describes the meaning of interaction between different components and how those components relate to each other. A service blueprint creates insight in the elements that make a service tangible. Customers get in touch with the service by these tangible elements. A service blueprint starts with the representation of the renewed customer journey. The different steps in the journey are filled in by using both front- and backstage elements. Subsequently, all parties necessary for an optimal flow of the service are added. The result is a flow of the process about how the customer experiences the service (Flanders Inshape, n.d.).

This EM technique is very interesting for the Texet case which aims at using AR to optimize and shorten their customer journey. Texet would like to bring a whole new customer experience in their service process. A service blueprint helps to manage the customer experience by mapping all contacts or touchpoints with the customer. Furthermore, "it can help to decide on the competitive position in the market more clearly" (Bitner, Ostrom & Morgan, 2008). By comparing the desired with the current service, it can determine the gaps between both. "Service blueprints can also be used to design the ideal service process" (Bitner, Ostrom & Morgan, 2008).

3. Research questions

"Can enterprise modeling techniques analyze the impact of augmented reality on the buyer-seller relationship? "

To identify the meaning of the general research question, a small dissection will be made. The goal is to make an analysis of augmented reality on businesses. AR as a technology has been chosen because of its many business possibilities and emerging character, as discussed in the introduction and context section. The instruments to analyze the impact of AR on businesses are enterprise modeling techniques. The reason for this is that EM techniques help businesses to tackle challenges by analyzing the enterprise from different angles. By doing so, it is possible to investigate all perspectives of the company that are each pointed at another facet of this company (Sandkuhl, 2014). Because of its emerging character, it is clear there a need for suitable EM techniques to analyze the impact of AR on businesses. The final part of the research question deals with the focus on the buyer-seller relationship as part of the business because AR often has a direct influence on the customer. A simultaneous focus on the internal business process will be an inevitable byproduct of course and therefore will also be included.

To answer this research question, several enterprise modeling techniques will have to be investigated practically. The Value Management Platform as a first EM technique has been chosen because of its focus on value creation, which is a core element for innovation. VMDL, the language behind the VMP, is an aggregation of seven value models and therefore one of the most accurate value modeling techniques (OMG, 2015). BPMN is the second EM technique. The reason why is that AR, apart from being used often in a direct customer context, is frequently implemented to improve the business process too. BPMN is suited to identify and understand processes due to its visualization of it. Also the possibility to graphically construct AS-IS and TO-BE phases, is an extra argument. As can be seen, the service blueprint EM technique is not included as part of the research questions, since it rather came up as an alternative for BPMN in the Texet case. Both techniques led to the division of two sub research questions:

- **"Can the Value Management Platform be a an enterprise modeling technique to analyze the impact of augmented reality on the buyer-seller relationship?"**
- **"Can Business Process Model and Notation be an enterprise modeling technique to analyze the impact of augmented reality on the buyer-seller relationship?"**

4. Research methodology

In order to make a proper evaluation on the impact of augmented reality on the buyer-seller relationship, multiple case studies were made. Those case studies imply that a qualitative research method is in its place since there is a focus on text, not on numbers. Qualitative methods are designed to assist researchers in understanding phenomena in context (Recker, 2013). Making case studies is in line with this. In addition, "qualitative methods are helpful when you want to study a specific phenomenon in depth. They are well suited for explanatory research where a phenomenon is not yet fully understood, not yet well researched or still emerging" (Recker, 2013). Augmented reality meets two of these three conditions. The first one is "not yet being well researched" since there is only few knowledge of the impact of AR on the buyer-seller relationship and which EM techniques are suitable for this. The second one is the "still emerging" character of AR as described in the context section.

One of the key techniques of qualitative research is observation. "Direct observation involves the researcher as a passive bystander whilst participant observation includes the researcher as an active participant who is influencing the phenomenon" (Recker, 2013). The use of VMP fits definitely in the second one, participant observation. Therefore, observation and more specifically participant observation is the data collection technique of this Dissertation.

The execution of case studies is a commonly used research method in information systems research and is the appropriate manner to study real-life phenomena that are out of the control of the researcher (Yin, 2014). This corresponds well with this thesis where real cases within a business environment have been analyzed. Therefore, a real-life context has been investigated which is not directly controllable by the researcher.

The main strengths of the case-study method is that researchers (Recker, 2013):

"• Can study information systems-related phenomena in their natural setting,
• Can learn about the state of the art and generate theory from practice,
• Are enabled to understand the nature and complexity of processes, events, actions and behaviors taking place, and
•Can gain valuable insights into new, emerging topics."

Of course, these strengths should relate to the AR case studies. Firstly, the cases happen in their natural setting. They are performed in the field and thereby study a phenomenon in the context in which it occurs. This actually holds for both the making AR cases as for the use of the VMP, where the discovery stage operates in a real-life context. Secondly, theory can be generated from practice since the analysis of AR by EM techniques will lead to concrete observations. This links with the third strength as well by being able to understand the nature of events taking place which is crucial in an analytical environment. Finally, the new and undiscovered practice of AR can lead to new insights since there is an emerging character noticeable.

Descending into more detail, the type of case-study design and corresponding unit of analysis has to be identified. Robert Yin (2009) illustrates four types in figure 4:

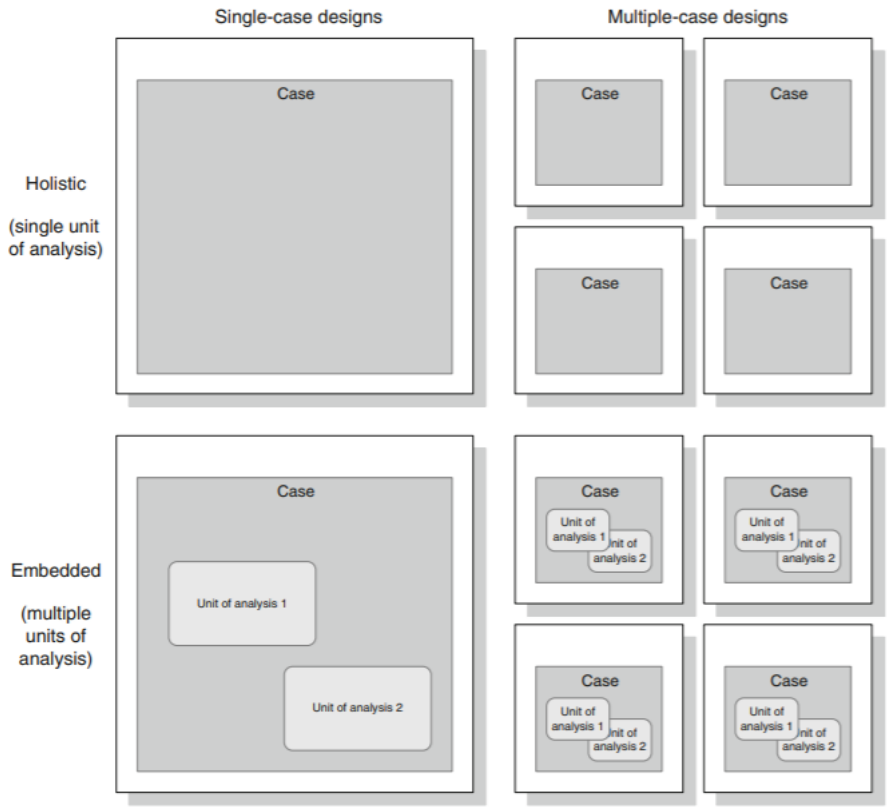

Figure 4: Case-study design types by Yin

This design type of this Dissertation is holistic with multiple-cases. Yin (2009) also states that "multiple cases strengthen the results by replicating the pattern-matching ability and increasing confidence in the robustness of the results". In other words, a multiple case study is deemed best to enable an appropriate level of generalization of the findings and to eliminate single-case bias.

Furthermore, according to Recker (2013), multiple case studies can be used "when it is the researcher's intention to build or test a theory". The analysis of these cases can be used as a first step towards building a theory. Important to notice here are the words 'as a first step' because case study methods have some limitations as well. Most significant ones including problems of controlled deduction, expressed by Recker (2013) as "a lack of adequate evidence to support evidences beyond any doubt, problems of replicability due to the highly contextualized nature of inquire, and problems of control mechanisms to account for rival explanations or potentially confounding actors". Applying this on the research of this paper, it will be possible to make findings plausible but not represent them as hard evidence.

5. Cases

5.1. Maersk

5.1.1. Explanation of the case

Background of the case: The Maersk Group is the world's largest container shipping company. They operate as a middle man between the shipments' sender and receiver. Maersk transports two types of containers; a standard one and one equipped with a climate system (to adjust temperature, humidity, …), the so called reefer container.

Figure 5: A Maersk reefer container

Goods in a reefer container are often in need of a treatment while being shipped. Such treatment could be the adjustment of the climatological conditions because weather conditions outside of the container change. In addition, goods could also be in need of real physical care. For example, art does not only need the right temperature and humidity conditions at the right time but also needs to be sprayed often with some kind of varnish. Other examples are pharmaceutical storage, particular foods, storage of dangerous goods,… It is clear that those treatments have to occur without any mistakes made by employees. At the current moment however, employees often open the wrong container at the wrong time or give an incorrect treatment. All required treatment information and steps are available on paper in the AS-IS situation.

Figure 6: Reefer container temperature and humidity adjuster

<u>How AR is used:</u> The augmented reality application that will be developed for this uses a body-cam in combination with AR-glasses (Microsoft Hololens). The body-cam reads the unique code of the container as well as the data on LCD screens. Next, employees receive all required information on their Hololens. For example, it is indicated whether the particular container or goods are in need of a treatment at a given time. This is synchronized with current weather conditions and conditions required for the goods. If a climatological adjustment is necessary, all required steps are presented on the Hololens. Subsequently, if the goods are in need of a physical care, those steps will be shown as well.

<u>Goals:</u> As already mentioned, employees often make mistakes when the information is given on paper. The goals of AR's implementation are to reduce the error percentage and increase efficiency. This will lead to an increase in customer satisfaction which automatically will lead to an increase in container volume and profit and a decrease in costs.

5.1.2. The VMP model of Maersk

The modeling of Maersk into the VMP has been reduced to its shipping services and partners. Only the components of the business model that were relevant for the implementation of AR and the understanding of the case have been included. This led to an abstract view of the business model. The same applies to the included values of the case. Those values are either based on real, practical numbers, on research or in rare cases on assumptions. This first VMP model of Maersk can be seen

as the AS-IS situation or the business model without AR. The second section of the VMP illustrates the TO-BE situation or the business model with implementation of AR.

5.1.2.1. Discovery Stage

The discovery stage of the VMP provides a good format to get a deeper understanding of the case and will be illustrated first. The business ecosystem map (figure 7) will be discussed as the first part of this stage. This map identifies the way Maersk exchanges value with its partners for their shipping services which happens through value propositions. It is also possible to make a representation of the ecosystem of those partners but this was not applicable to this case, since none of the partners had to make modifications to their own ecosystem to accommodate the transformation of Maersk.

Maersk shipping services finds itself in the middle of the map with all its partners around them. Each partner is connected in a network. Despite Maersk being an intermediate for the shipment senders and receivers and having two customers in a way, the shipment receivers are indicated as the customers in the VMP. This has two reasons: firstly, the "receivers" is the party that experiences most downsides when errors in the treatments are made and secondly, they are the ones who usually pay for the shipment, whether they have to pay it directly when ordering or whether it has been included in the purchase price of the good.

A shipping service is the exchanged value proposition between both the shipment receivers and senders. Furthermore, all partners necessary to make the shipping service possible have been included: the harbors with its "container handling service" value proposition, the Maersk Container Industry (part of the Maersk Group that is responsible for the building of containers) including its "goods storage" value proposition, the Maersk Line (part of the Maersk Group that is responsible for ship construction) along with its "means of transport" value proposition and the APM Terminals (subsidiary of the Maersk Group that is responsible for the transfer of containers from ship to harbor or other means of transport) with the "container transfer" value proposition. The mentioned value propositions all have a returning trajectory as well, which is referred to as the same value proposition but with the word "business" behind. "Business" refers to an amount of work. For example, harbors offer "a container handling service" and Maersk offers "business" or an amount of work in "the container handling service" back. All networks, partners and value propositions have been mapped immediately and thereby located in the rightful place in the Cube. Values were assigned later, during the prototype stage.

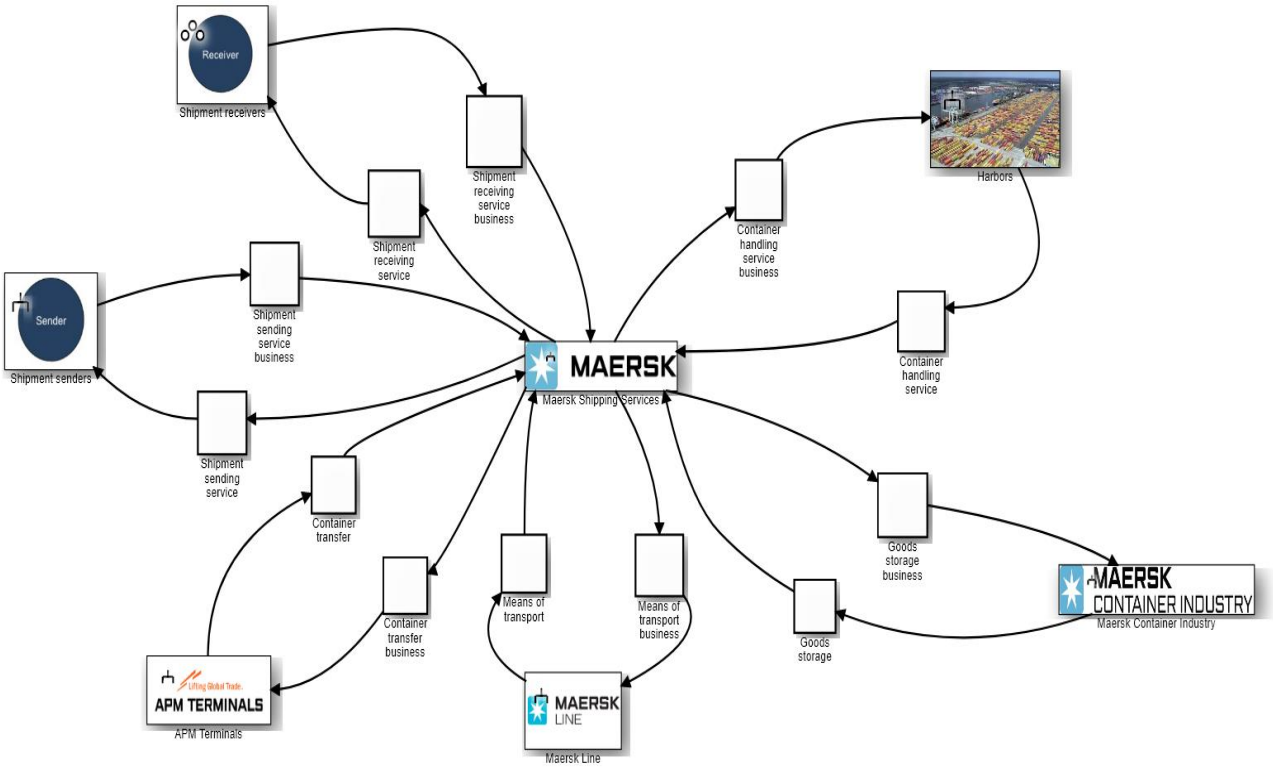

Figure 7: The AS-IS Business Ecosystem Map of Maersk

The strategy map (figure 8) is the next visual representation of the discovery stage. The map illustrates the strategy of the organization to create value. It is built up from bottom to top and by showing arrow flows, it is a useful reference when prototyping the impacts of values. The map is based on the Strategy Map by Kaplan and Norton (2004) but slightly changed to fit in the business change context. The map will be explained here from top to bottom, for understanding purposes.

Maersk's all time business goal is to increase the profit margin, which is being influenced by the shipped container volume and the costs. The right side of the map shows how the container volume gets impacted by the customer satisfaction, which depends on her behalf on the shipping price and -speed and the treatment quality. When descending the map, it can be seen that the shipping price is impacted by the efficiency percentage and the treatment quality by the treatment error percentage. Those two values will be crucial in this case because they get impacted the most by the implementation of AR, as will be illustrated in the TO-BE section. Furthermore, all separate costs are shown and are all aggregated towards the general cost. For a good understanding, the conveyance cost has to be explained: those are the costs arising from transport only, including ship or truck costs. The term 'transport cost' has not been used however to avoid misunderstandings, since the core service of Maersk is to transport goods. In the bottom lane, all required capabilities and resources and how they impact the separate costs, are shown.

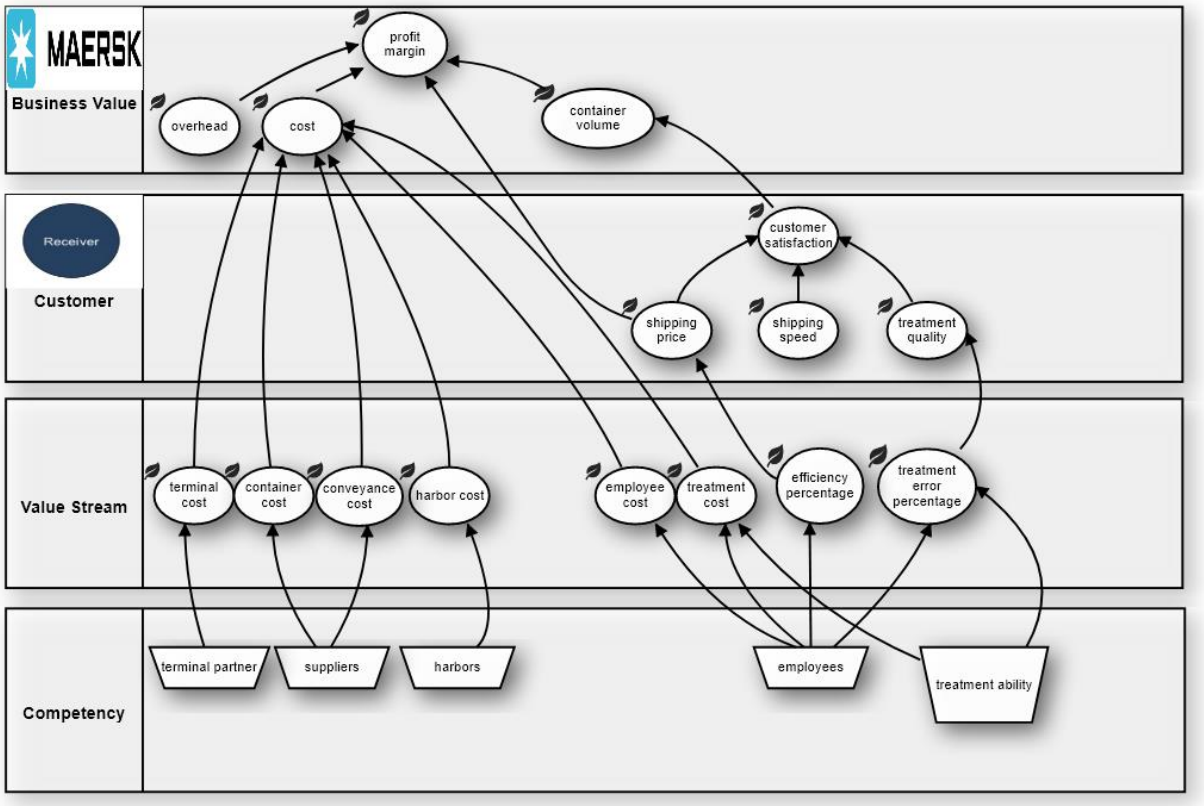

Figure 8: The AS-IS Strategy Map of Maersk

The final visualization of the discovery stage is the value stream map. This map takes a closer look at the required value streams with their corresponding activities and competences. Only those relevant to put in the Cube were mapped. A value stream is relevant when an activity is required to put a corresponding value on. Some values can only be part of the business model if they are internally created because not all values come from exchanged value propositions. As shown in figure 9, the required streams all have the same two activities: ship and treat. All four value streams have those activities in common, so all four value streams should be included. The revenue, employee cost and treatment cost proposition also have the same competences as the shipment receiving service stream because they have the same activities, but are not illustrated for space reasons.

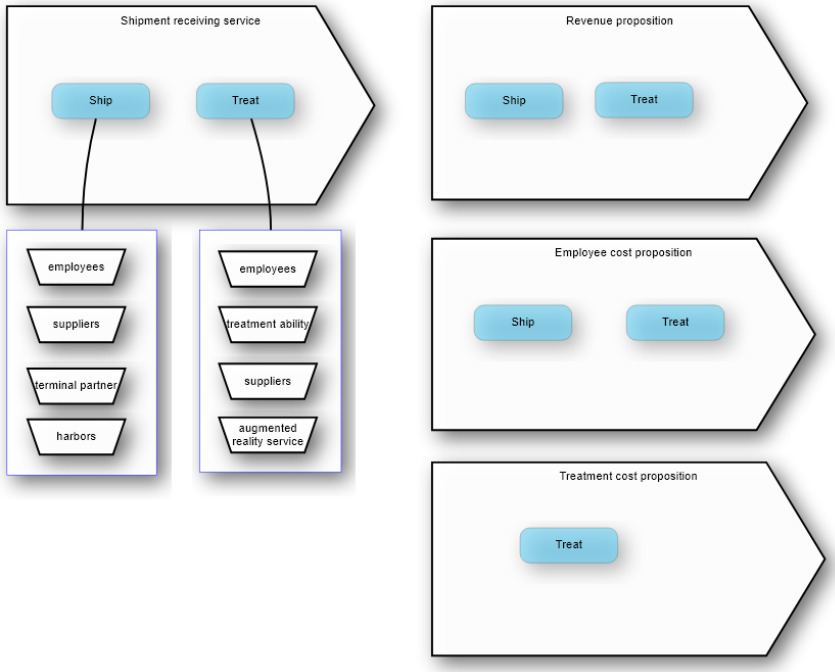

Figure 9: The AS-IS Value Stream Map of Maersk

5.1.2.2. Prototype Stage

The second building block of the VMP is the prototype stage. During this stage, values were added to all mapped components of the discovery stage and those values were then aggregated if required. Plan values are success factors for the business and are measure criteria to compare values over consecutive phases. The name of a plan value remains unchanged throughout the plan, but its value changes of course, which is why they are an excellent measure for comparison. The plan values for Maersk can be found in figure 10. Their inclusion has been based on whether the values are part of Maersk's goal and are thereby a success factor for the business.

AS IS	
Base Alternative (Primary)	
container volume	4185.00 containers
efficiency	14.00 work hours/container
error rate percentage	20.00 %
profit	1780825.00 €
profit margin	11.44 %

Figure 10: The AS-IS Plan values of Maersk

An aggregated view of the profit, revenue and cost structure is given in figure 11 to get a clearer understanding of the structure of the case. Profit is of course the result of revenue and the total cost. It is important to involve the profit margin too since it is the ratio between profit and revenue or in other words, the percentage of revenue that remains from profit. It gives a good indication on how the increase in revenue compares itself with the increase in costs and therefore it can be a good basis to judge whether an investment, here the investment in AR, is worth it or not. The cost structure is shown as well. Revenue itself is the result of the container price multiplied with the container volume.

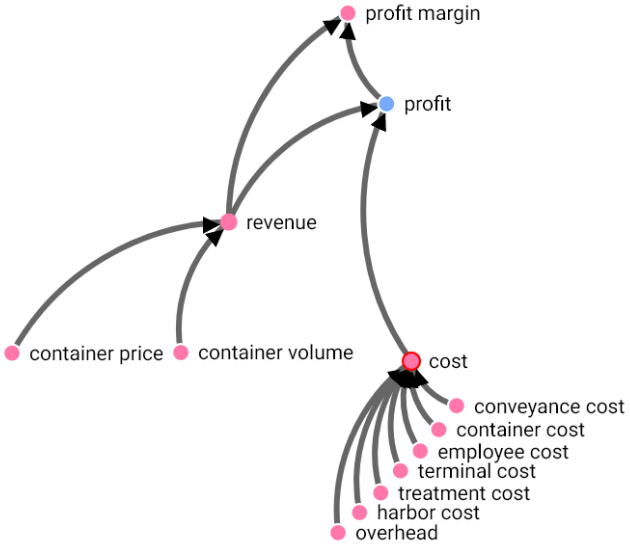

Figure 11: The aggregated view of the AS-IS profit, revenue and cost structure of Maersk

A second important component of the plan values to illustrate the structure and far-reaching aggregations of the case, is the container volume (figure 12). The container volume is impacted by the customer satisfaction (77,5% in AS-IS) which gets influenced by the shipping speed, container price and treatment quality. A satisfaction impact conversion rate is required to convert the satisfaction percentage into containers and is set on 54 containers/%, which is based on an assumption. In other words, an increase of the customer satisfaction by 1% will result in an increase in shipped container volume by 54 containers. This is one way to let the customer satisfaction impact the sold volume of a business. In the Duracell and Texet cases, other ways of satisfaction impact on the volume will be illustrated. The container volume aggregates towards all costs of course, since those are variable costs and depend on the amount of shipped containers.

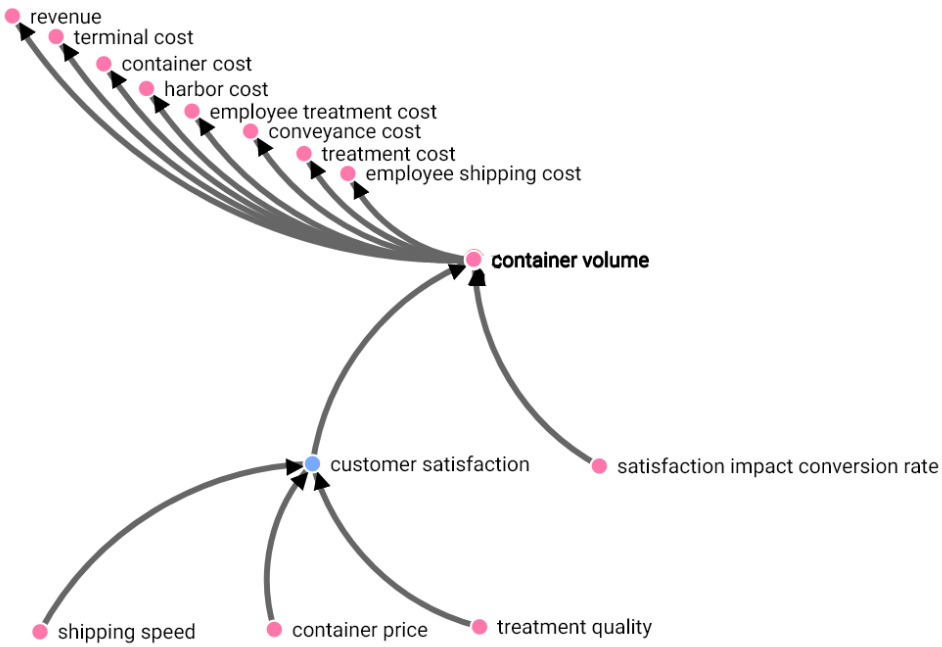

Figure 12: The AS-IS aggregated view of the container volume of Maersk

Since the container volume is impacted entirely by the customer satisfaction in this case and thereby very important, a deeper explanation of this satisfaction is required. In the VMP, the customer satisfaction is the weighted average of multiple values. Here those values are the container price, the shipping speed and the treatment quality (figure 13).

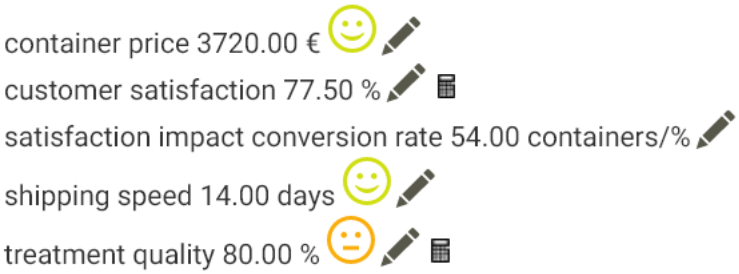

Figure 13: The AS-IS customer satisfaction and its impacting values of Maersk

All three variables are expresses in different unities so in order to create one general satisfaction, satisfaction intervals have to be created. As an example, the satisfaction intervals of the shipping speed are given (figure 14). The intervals should be interpreted as follows: a shipping speed between 0 and 5 days results into a shipping satisfaction of 100%. Or in the Maersk example, a shipping speed of 14 days results into a satisfaction of 70% since the lower limit is included. A weight of 25% is assigned to the shipping speed, which means that the 70% shipping speed will have a 17.5% contribution to the satisfaction. When the satisfaction percentage of the container

price and treatment quality with their assigned weights are included as well, the customer satisfaction amounts to 77,5% in the AS-IS situation of Maersk. Another important impact factor for customer satisfaction is the treatment quality. Right now, treatment quality is at 80% which is the result of a perfect quality (100%) and the error rate percentage (20%, based on information coming from Maersk). This means that in 20% of the cases, some kind of mistake happens (e.g. opening the container when not allowed, entering a wrong temperature or humidity level, giving a wrong type of treatment, …).

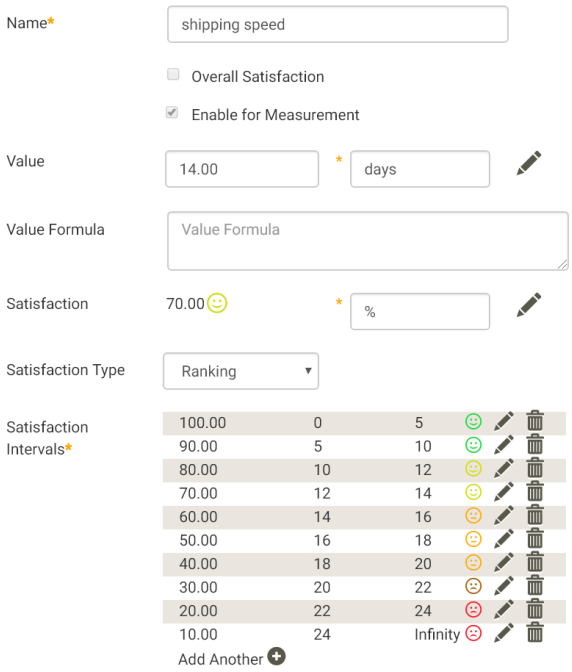

Figure 14: The AS-IS shipping speed of Maersk

The last value of the plan values is the efficiency rate. Right now, employees of Maersk need 14 work hours to treat a shipment during the whole shipping time, which is the result of the cost per hour for an employee (€30, info coming from Maersk) and the total cost to treat an entire container for the whole shipping time (€420, info coming from Maersk).

To finalize the illustration of the AS-IS situation of the Maersk case, all "my propositions" are explained. "My propositions" are those which are captured by the organization itself. In this case it is a representation of all cost and revenue streams. The costs are in line with all its corresponding activities or value propositions and are each time the result of a cost per container and the container volume, except for the overhead costs which are fixed. The same is applicable to revenue, which is the result of a container selling price and the container volume.

My Proposition	From (Role)	Values
Container cost proposition	Container buyer	container cost 502200.00 €
Conveyance cost proposition	Transport means buyer	conveyance cost 6821550.00 €
Employee cost proposition	Receiver intermediate	employee cost 3201525.00 € employee shipping cost 1443825.00 € employee treatment cost 1757700.00 €
Harbor cost proposition	Container handling buyer	harbor cost 313875.00 €
Overhead cost proposition	Receiver intermediate	overhead 500000.00 €
Revenue proposition	Receiver intermediate	revenue 15568200.00 €
Terminal cost proposition	Transfer service buyer	terminal cost 481275.00 €
Total cost proposition	Receiver intermediate	cost 13787375.00 €
Treatment cost proposition	Receiver intermediate	treatment cost 1966950.00 €

Figure 15: The AS-IS my propositions of Maersk

5.1.3. Impact of AR on the VMP model of Maersk

In this section, the TO-BE situation of Maersk and thereby the implementation of AR will be illustrated. Only the parts which were subject to change will be discussed.

5.1.3.1. Discovery stage

Again, the business ecosystem map will be presented first. Not many changes can be identified apart from the addition of one extra partner, Poppr (figure 16). Poppr is the AR-provider. Apart from a small visual difference, the addition of a value on the exchanged value proposition is more important of course. The value proposition 'Augmented reality service' carries an AR error impact of 15% and efficiency impact of 25%. Those impact percentages are based on research by Capgemini (2018).

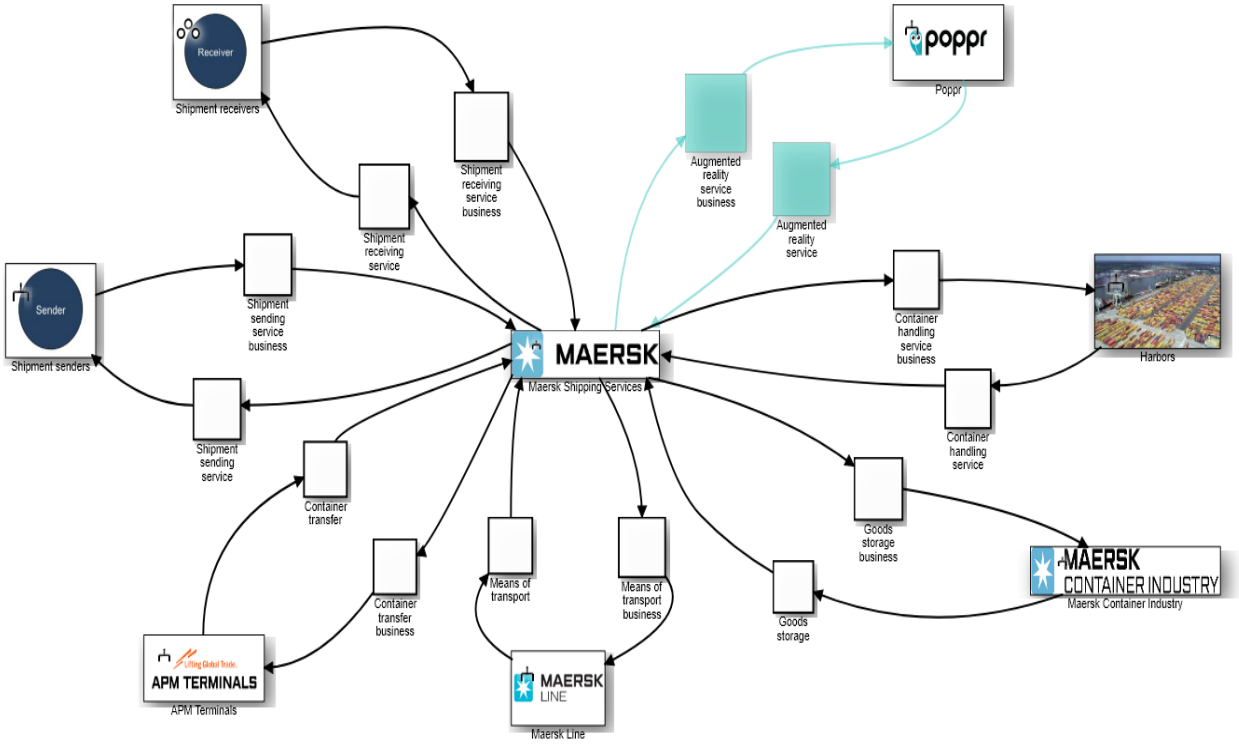

Figure 16: The TO-BE Ecosystem Map of Maersk

The TO-BE strategy map (figure 17) does not show many differences at a first sight either but shows the impact of AR in a better way than the ecomap. Despite the addition of only two elements, the way AR influences particular parts of the organization is shown by arrows. It can be identified how AR impacts both the efficiency percentage as well as the treatment error percentage. This gives a very good abstract understanding of AR's influence.

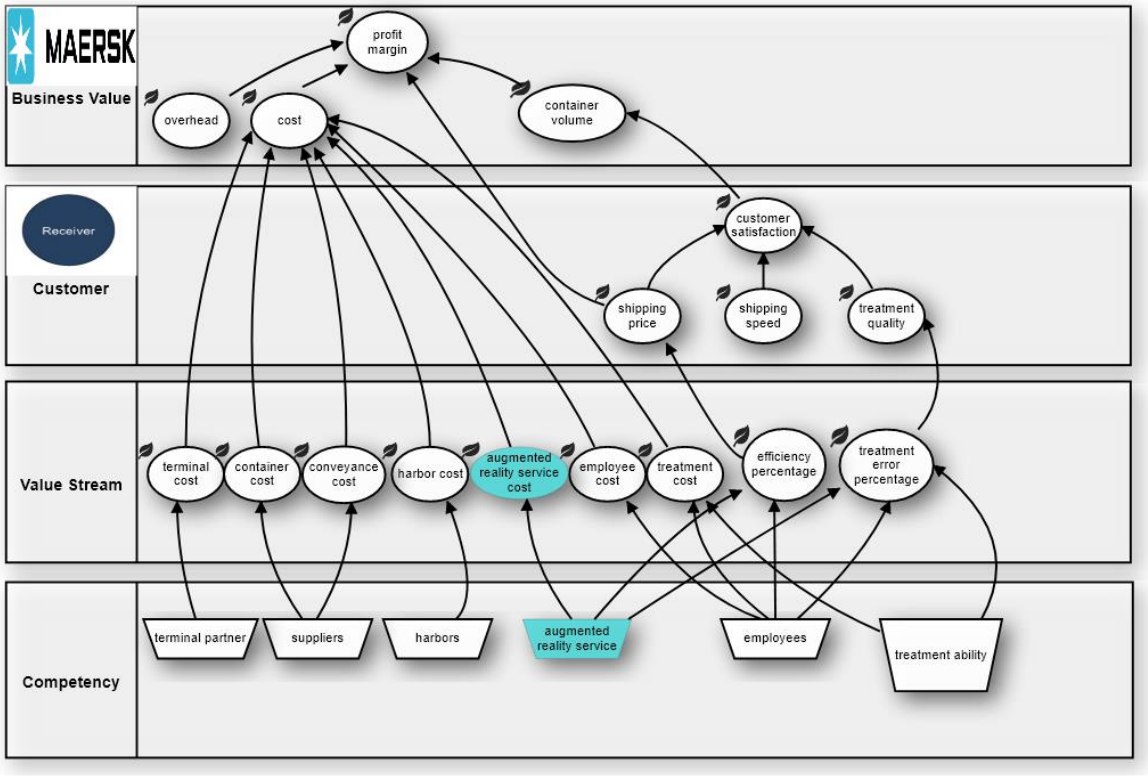

Figure 17: The TO-BE Strategy Map of Maersk

No differences are identified in the value stream map which is therefore not shown. Reason for this is that the addition of AR does not require any changes in the very abstract or basic activities. Of course, the way those activities are performed by the employees change because AR is used, but the same two activities, 'Ship' and 'Treat', remain the same. There is also no 'Augmented reality cost proposition' value stream required because the cost coming from AR is put on a value proposition, not on an activity.

5.1.3.2. Prototype stage

The two values on which AR had a direct impact are the treatment error percentage and the efficiency percentage. The goal of the case was to reduce the treatment error percentage but AR also has an impact on the efficiency during a treatment. Employees do not have to lose any time searching for information or checking whether this information is correct. In the AS-IS situation, the error percentage for treatments had been set on 20%. AR can have an impact of 15% on the error rate percentage according to Capgemini (2018). The aggregated view (figure 18) illustrates very visually how, thanks to an impact factor, AR is able to influence the error rate percentage. The calculation behind it is simply the subtraction of the as-is error rate (20%) and the AR service error impact. This leads to an error rate percentage of 5% and a treatment quality of 95%.

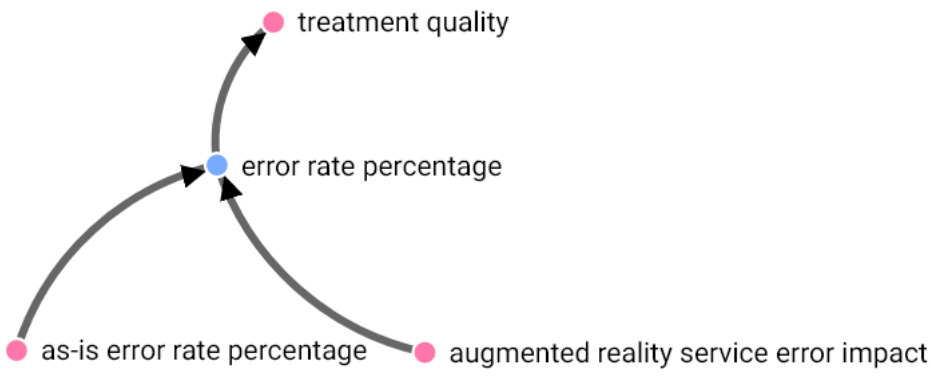

Figure 18: The aggregated view of the TO-BE error rate percentage of Maersk

The second value on which AR had a direct impact, is the efficiency. In the AS-IS situation, the efficiency of employees had been set on 14 hours/container. This means that an employee spends a total amount of 14 hours to treat each container during its shipping time. AR can impact efficiency up to 25% (Capgemini, 2018). In figure 19, the aggregated view indicates how AR impacts that efficiency. To calculate it well, the 25% impact percentage first impacts the average employee treatment cost per hour. The AS-IS treatment cost is reduced by 25% which results into the creation of an extra value, the average augmented reality treatment impact per container. Next, this value needs to be subtracted from the AS-IS value to create a new average employee treatment cost per container, which is €315. Now, this cost only needs to be transformed in an efficiency unity by dividing it through the €30 employee cost per hour. This leads to an efficiency of 10.5 work hours/container.

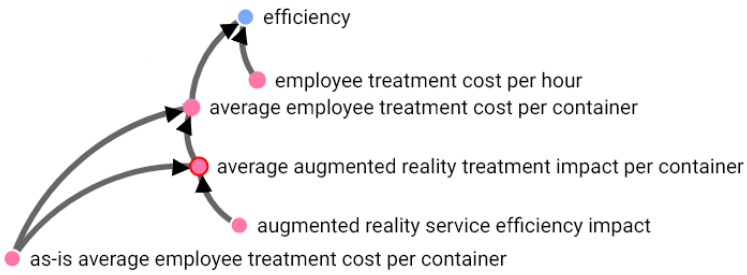

Figure 19: The aggregated view of the TO-BE treatment efficiency of Maersk

AR had a direct impact on two values but an indirect impact on the whole business model of Maersk. Most prominent indirect impact can be found in the customer satisfaction which rises from 77.5% to 85% thanks to the increase of the treatment quality, which stood for a weight of 50% on the customer satisfaction. The shipping speed and price did not change due to AR because it did not have an impact on how fast the goods are shipped or the price. A reduce in price would have been possible but is often considered as a bad decision because it can change the price perception of the customer. It is rather recommended to keep the price at the same level to

increase profit. As already mentioned in the AS-IS situation, the customer satisfaction entirely impacts the container volume. Each satisfaction raise of 1% leads to an increase of 54 shipped containers. This means the total container volume augments to 4590 containers. The increase in shipped containers then leads to an increase in revenue (and variable costs) and thereby to an increase in profit and its margin as well. The change in plan values is shown in figure 20.

Values	AS IS	TO BE
	Base Alternative / Base Scenario	Base Alternative / Base Scenario
Uncategorized		
container volume [Maersk] (containers)	4185.00	4590.00
efficiency (work hours/container)	14.00	10.50
error rate percentage (%)	20.00	5.00
profit (€)	1780825.00	2373340.00
profit margin (%)	11.44	13.90

Figure 20: Overview of the AS-IS and TO-BE plan values of Maersk

A second presentation to decide on the adoption of the TO-BE situation can be found in figure 21, which represents a radar view of the plan values. As shown, profit margin, profit and container volume all cover a bigger area in the Alt-1 or TO-BE situation. The efficiency- and error rate percentage cover smaller areas but this is a good thing: the error rate percentage has to be as low as possible and the efficiency is expressed in an amount of work hours/container, which should be as low as possible too. Based on all implications, it would be recommended to start with the implementation of augmented reality for Maersk.

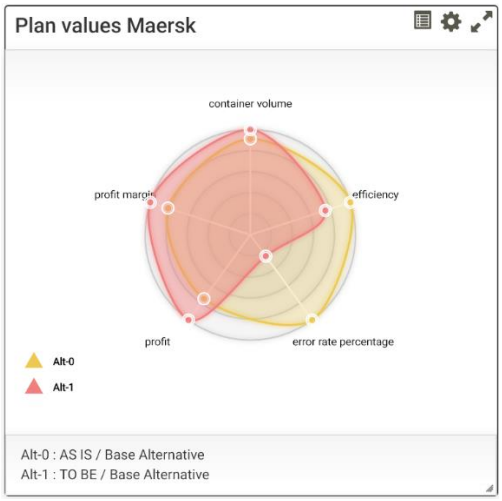

Figure 21: Radar view of the plan values of Maersk

5.1.4. BPMN model of Maersk

The goal of BPMN is to provide a graphical notation that is understandable by and for all business users. It is possible of course to create both an AS-IS and TO-BE situation and compare those, which is why BPMN is put forward as an EM technique for business transformation. The AS-IS BPMN model of Maersk can be found in figure 22. In a way, this model is a graphical translation of the whole business flow as outlined in the 'explanation of the case'-section. A general shipment flow is given on the upper side of the diagram. This general flow is kept rather abstract to focus on the treatment process. This can be identified by the subprocess sign and gets unfolded in the lower part of the diagram. Focus lies on the treatment process since this is where the innovation of AR will take place in the TO-BE section. The subprocess is not illustrated in a separate diagram because of the 'container and treatment data', which are transferred from the general- to the subprocess.

As can be detected from the steps, the treatment subprocess is a rather manual one because of the use of paper documentation as information source. During the first gateway of the subprocess, it has to be identified whether a treatment is required or not. Not all containers on the ship are in need of a treatment so this has to be checked. Therefore, the first steps of the treatment subprocess are inevitable for each container. If a treatment is required, there are two possibilities: either the goods need climatological adjustment and/or they require care. The climatological adjustment, and thereby whether a treatment is required, can vary from day to day, depending on the weather conditions. If no climatological adjustment is required, the next step is automatically to give care. Otherwise, the decision would have been made at the first gateway that no treatment is required. If climatological conditions were in need of adjustment, it should still be decided on whether the goods are in need of care or not. This is where the subprocess ends but as can be identified from the treatment activity in the general process, the treatment activity is a loop. The activity should be repeated each day and in some occasions multiple times a day, as long as the shipment is transported.

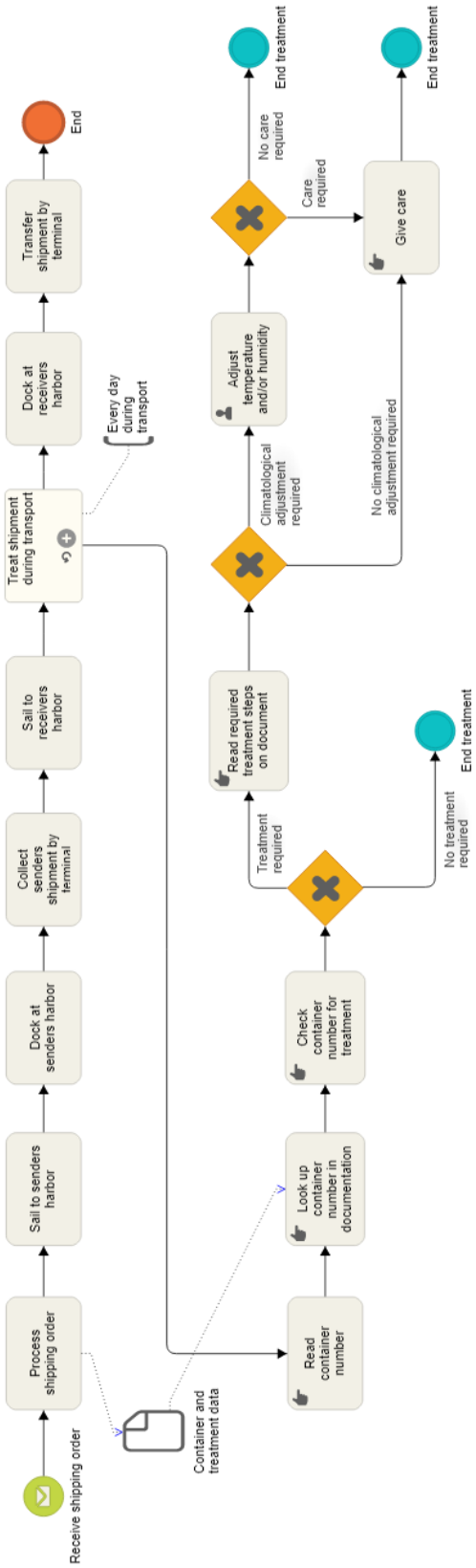

Figure 22: The AS-IS BPMN model of Maersk

5.1.5. Impact of AR on the BPMN model of Maersk

In this section, the TO-BE BPMN model of Maersk will be illustrated and can be found in figure 23. The upper general process remains identical to the AS-IS situation because AR is only applicable to the treatment subprocess. Firstly, the outside of the container is scanned by a bodycam, so not directly by the AR-Hololens. The device that scans the bodycam gives a signal to the Hololens in order to synchronize and transfer the required information for that specific container and its goods. Whereas all information in the AS-IS was documented on paper, this is now entirely digitalized which makes it possible to present the data on the Hololens.

The activities of the treatment process are now very similar to the AS-IS situation, apart from the step that the data have to be read from the Hololens instead of paper. BPMN clearly indicates the change in the beginning of the subprocess but afterwards it can be no longer identified. All activities that have to be undertaken from there remain the same. No real impacts on the intrinsic steps coming from the new technology can be identified. The employee executes all activities in the TO-BE while carrying the Hololens and this implies that fewer mistakes are made by them but this is impossible to prove or indicate by only a graphical representation. This is a backlog of BPMN compared to the VMP and will be part of the evaluation in section 6. Of course, it should be kept in mind that the goal of BPMN is to graphically present a business process, not to show it by numeric values.

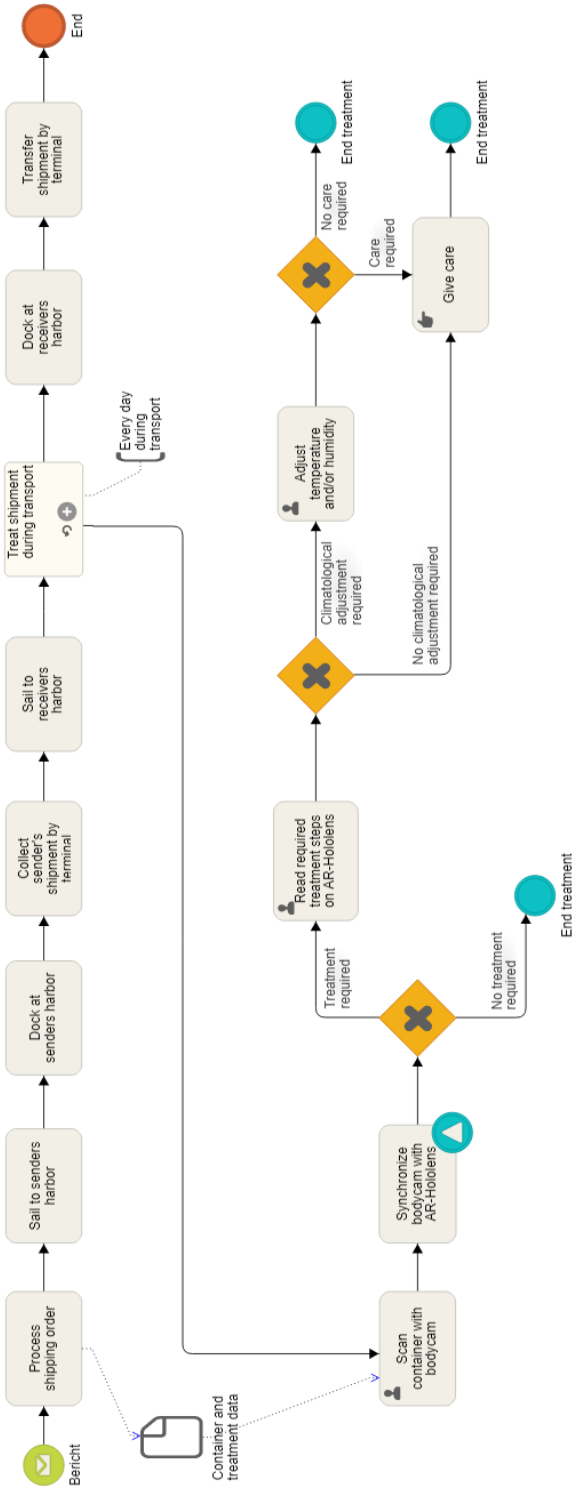

Figure 23: The TO-BE BPNM model of Maersk

5.2. Duracell

5.2.1. Explanation of the case

Background of the case: Duracell is a provider of alkaline batteries and produces next to her small batteries also larger ones for B2B selling in their factory in Aarschot, Belgium. These batteries are composed out of relatively larger components. Some of those components need to be checked during quality control on the so called paperrail. It is difficult and time consuming however for their employees to check this. The current success-rate to detect a mistake is at 94%. Mistakes are made because quality control occurs by the usage of samples and those samples are tested manually by employees. In addition, Duracell offers a 12 month guarantee to her B2B customers. If a battery is defect or damaged, Duracell repairs it and sends it back. This is only the case for their B2B batteries because those are too expensive to simply replace. Employees will have to search for the defect and repair it, which is a very time consuming action.

How AR is used: An augmented reality application has been developed that supports employees when checking for missing or disconnected parts. Firstly, an AR camera will be able to detect the failure after which a system identifies the problem and synchronizes with the Hololens to present the necessary steps to take. Figure 24 gives an example on how the employee is able to control the battery component by the AR camera.

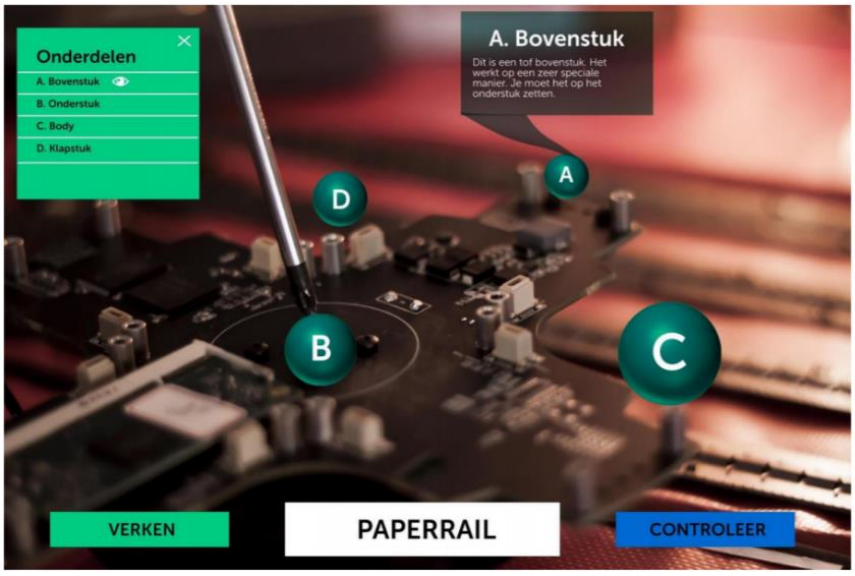

Figure 24: An image of how the AR camera controls a battery component

Figure 25 shows an example of the AR Hololens vision when a defect is detected. The system synchronizes with the Hololens to provide the employee with the necessary steps to solve the problem.

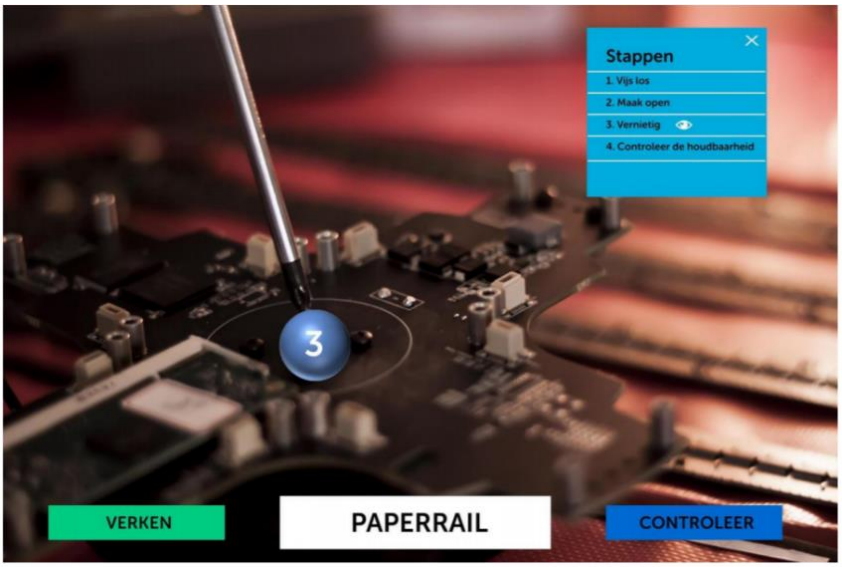

Figure 25: An image of how the employee receives the required steps on the Hololens glasses

Goals: The main goal is to increase the success-rate for quality control. In addition, AR can assist the employee to reduce the repair time if a battery is still under guarantee while being damaged. Meeting both goals would lead to a decrease in costs and therefore to an increase in profit and an improvement of customer satisfaction, both being the business goals behind it.

5.2.2. The VMP model of Duracell

The modeling of Duracell into the VMP has been reduced to its B2B battery production. Only the components of the business model that were relevant for the implementation of AR and the understanding of the case have been included. This led to an abstract view of the business model. The same applies to the included values of the case. Those values are either based on real and practical numbers, research or in rare occasions on assumptions. The first VMP model of Duracell can be seen as the AS-IS situation or the business model without AR. The second section of the VMP illustrates the TO-BE situation or the business model with implementation of AR.

5.2.2.1. Discovery stage

Starting with the business ecosystem map (figure 26), it can be identified how Duracell exchanges value propositions with its most prominent partners. This is a very abstract image of Duracell's operations but only those partners required to model the later impact of AR have been included. Duracell interacts with its suppliers for raw materials and components and offers back a business, i.e. an amount of work for raw materials and components. Duracell does not ship the goods directly to its professional customers nor does it receive any direct orders from them since a network of distributors is doing this for them. The batteries are offered to the distributors and in doing so, a business is sent to Duracell. Important to mention is that batteries are rather the product itself instead of a pure value proposition but because it inquires a distributor, the value proposition here is the actual battery. If the batteries would have been sold directly to the customer, another value proposition such as 'energy storage' could have been in its place. Furthermore, Duracell offers other value propositions than batteries to their customers. Repair- , customer service and quality are the most important ones because they will be impacted by AR in the TO-BE section.

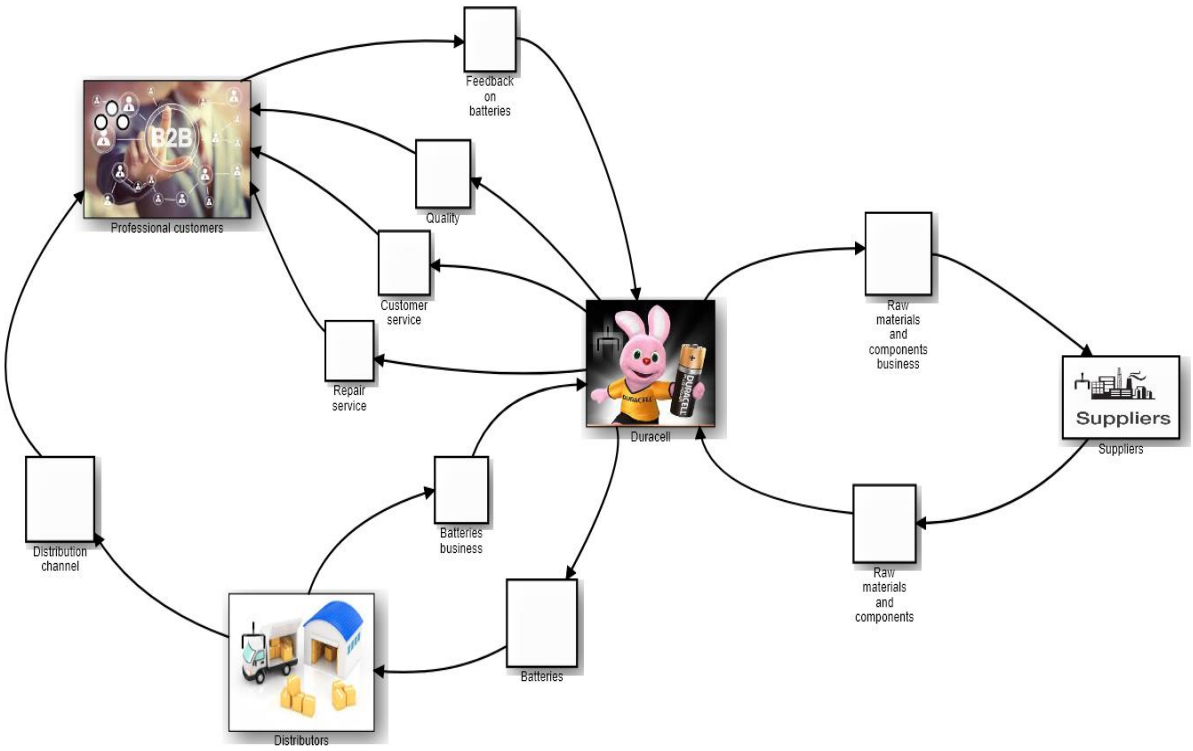

Figure 26: The AS-IS Business Ecosystem Map of Duracell

The strategy map (figure 27) is the next visual representation of the discovery stage. The map illustrates the strategy of the organization to create value. A big part of the value creation process can be explained by the business value 'sales volume'. Sales volume gets impacted by the customer satisfaction just like in the Maersk case but here, the distributors influence the sold volume as well. In the prototype stage, this will be explained as the presence of a market volume. Customer satisfaction is the result of the battery quality, the battery repair time (which are both the main goals for improvement in this case) and the battery price, which will remain unchanged in the case. Yet, the price remains important for both the customer satisfaction and the profit margin. On the right side of the map, the cost structure is illustrated together with the capabilities or resources that cause those costs.

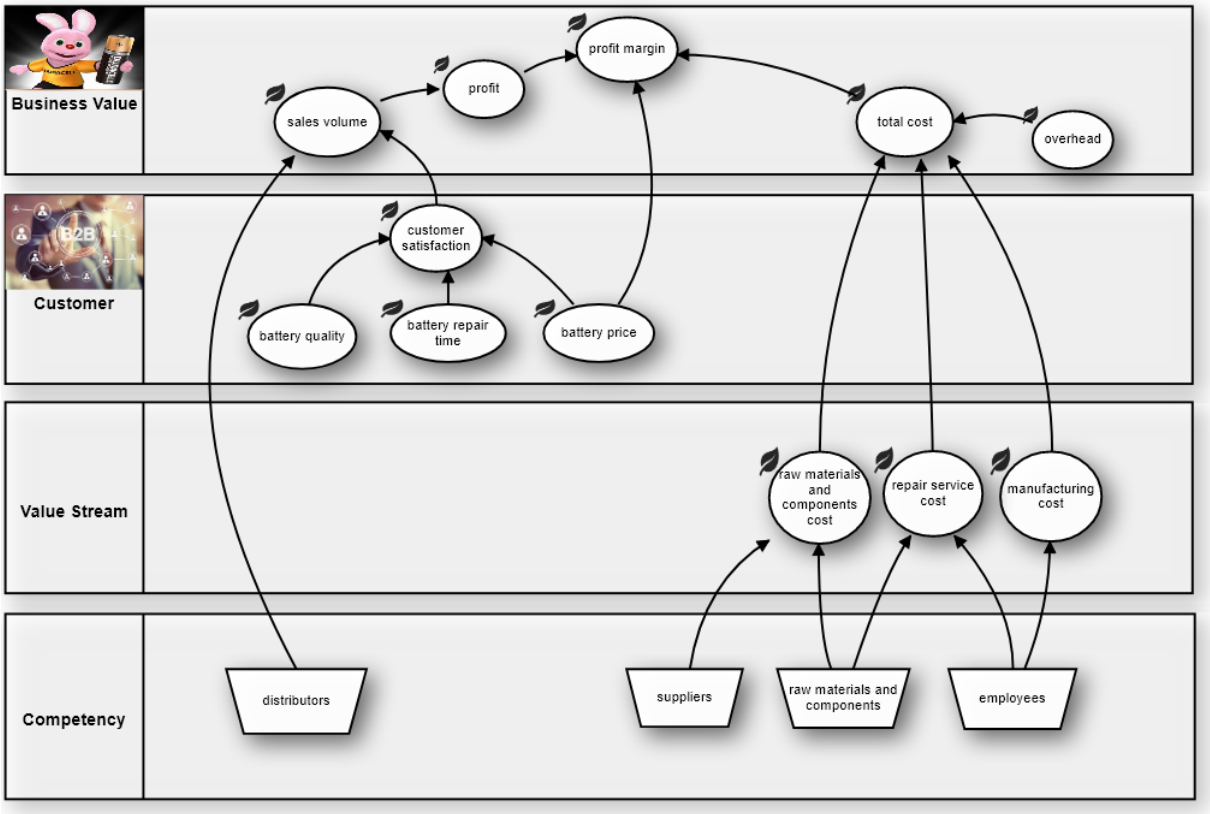

Figure 27: The AS-IS Strategy Map of Duracell

The value stream map (figure 28) is more extensive than the one from Maersk because the whole case is much more internally oriented. It is based on quality control and repair service, two processes that occur entirely inside the business and are therefore put on activities. This is also the reason that the ecomap is not very extensive. The quality control is indicated as part of the general 'Manufacture' activity. All activities are connected with its required competency containers. The same condition as in the first case has been used to include an activity in the map

or not, depending on the fact whether particular internal values are required instead of the ones coming from value propositions.

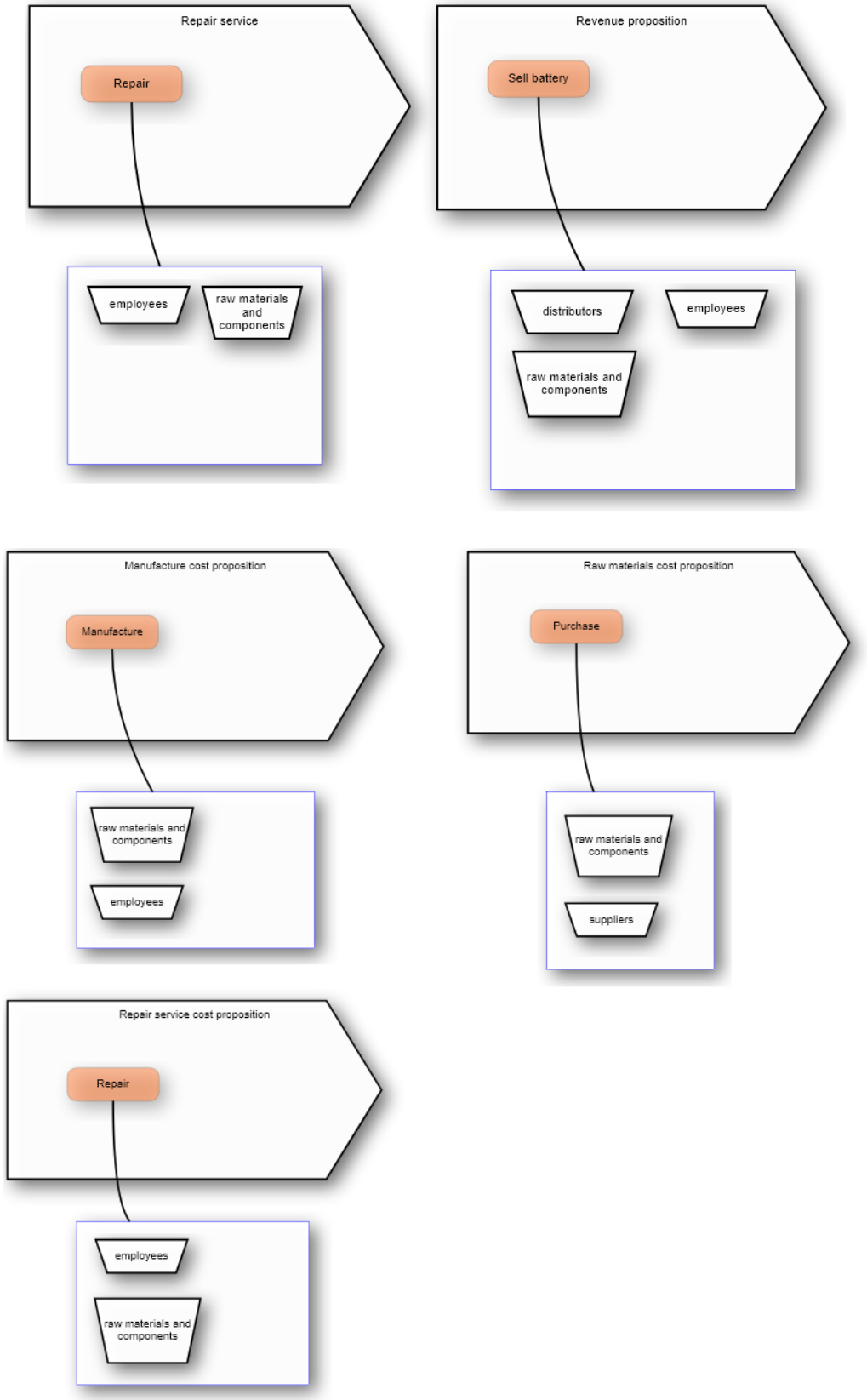

Figure 28: The AS-IS Value Stream Map of Duracell

5.2.2.2. Prototype stage

The prototype stage will be started by discussing the plan values (figure 29), which are the success factors for the business and a measure criterium to compare values over consecutive phases. Profit, profit margin and sales volume could have been identified from the strategy map already because they were illustrated as the most important business values. Battery quality and repair time are the two values that are subject to optimization and are therefore considered as success factors as well.

AS IS	
Base Alternative (Primary)	
battery quality	94.00 %
battery repair time	4.00 days
profit	5698574.00 €
profit margin	15.15 %
sales volume	20890 batteries

Figure 29: The AS-IS plan values of Duracell

The aggregated view of figure 30 provides a very good visual representation of the structure of the whole case. Profit is the result of the revenue and the total cost. Revenue on its behalf is the outcome of the price multiplied by the sales volume. Like in the strategy map, it is clear that the sales volume is the key impact factor in this case. In the Maersk case, the sales volume (there called container volume) was influenced entirely by the customer satisfaction while in the Duracell case, the sales volume is only influenced partly by the customer satisfaction. The other part is coming from a fixed market volume. This is no coincidence, the position of Duracell in the market is so strong that their sales volume is only partly impacted by the satisfaction. Even if the satisfaction would be at a theoretical 0%, they would still sell a fixed amount because of their competitive advantages. Maersk has a strong market position too, but the logistics market is too saturated with other strong brands there.

The customer satisfaction impacts the sales volume due to a customer satisfaction volume impact, which is the result of the actual satisfaction (71%) times the customer satisfaction conversion rate (60 batteries/%). This conversion rate is based on an assumption. A rise or fall of the satisfaction of 1% results in the increase or decrease of the volume by 60 batteries. This means that a customer satisfaction of 71% leads to a sales volume impact of 4260 batteries ((71%*60 batteries/%) + the

market volume). Furthermore, the sales volume contributes to all costs, except to the overhead cost. For example: an increase in sales volume implies an increase in raw materials and components costs. But also: a rise in sales volume leads to a rise in repaired batteries, which can be seen on the right side of figure 30. The more sales, the more batteries have to be produced so the more failures will happen at a same production error percentage. The rise in repaired batteries then leads to an increase of the repair cost.

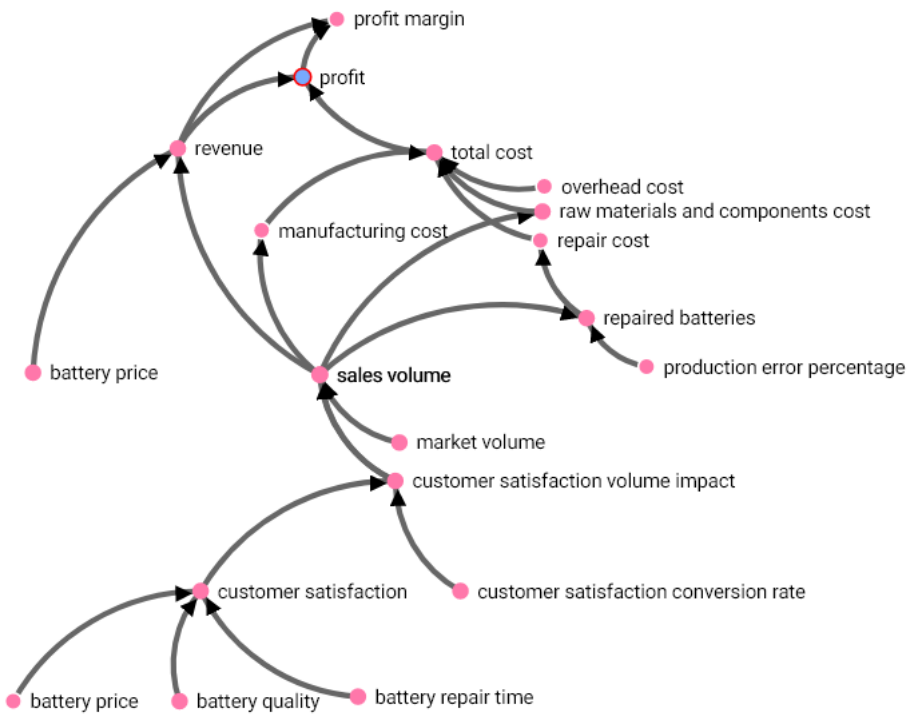

Figure 30: The revenue and total cost aggregated view of Duracell

The customer satisfaction is the product of three values (figure 31): the battery price, -quality and -repair time. The battery price will remain unchanged in this case as well. The quality and repair time are the two most important values for the later impact of AR. The current battery quality is as high as 94%, which is based on information coming from Duracell. The current battery repair time takes 4 days, which looks very long at first sight but it includes transport of the battery to Duracell and back to the customer. This is also based on information coming from Duracell. Just like in the Maersk case, intervals were added to the three values to indicate how satisfied a consumer would be with their actual value. Next, a weight is added to the value in order to calculate the weighted average in the total customer satisfaction.

battery price 1800.00 €

battery quality 94 %

battery repair time 4 days

customer satisfaction 71 %

customer satisfaction conversion rate 60 batteries/%

customer satisfaction volume impact 4260 batteries

Figure 31: The customer satisfaction and its impacting AS-IS values of Duracell

A final important value for this case is the repair service cost proposition (figure 32), which is the result of the 'Repair' activity. Three values are coming from this cost proposition: the repair cost per day (€160.00), the repair cost per battery (€640.00, which is the result of the repair cost per day multiplied with the number of days for repair time) and the total number of repaired batteries (1253 batteries), which is necessary to calculate the total repair cost. Those values will be influenced by AR in the TO-BE situation.

Repair service cost proposition	My Business (Supporter ***(Business)***)	Repair	repair cost per battery 640.00 € (Repair) repair cost per day 160.00 €/day (Repair) repaired batteries 1253 batteries (Repair)

Figure 32: The AS-IS Repair service cost proposition of Duracell

5.2.3. Impact of AR on the VMP model of Duracell

In this section, the TO-BE situation of Duracell and added to this, the implementation of AR will be illustrated. Only the parts which were subject to change will be discussed.

5.2.3.1. Discovery stage

Just like in the Maersk case, not many changes are noticeable in the TO-BE ecomap of Duracell (figure 33). The inclusion of Duracell's AR developing partner, Soulmade, is the only modification. Of course, the necessity of the addition of extra value propositions should not be underestimated since the AR impact values are put on these value propositions.

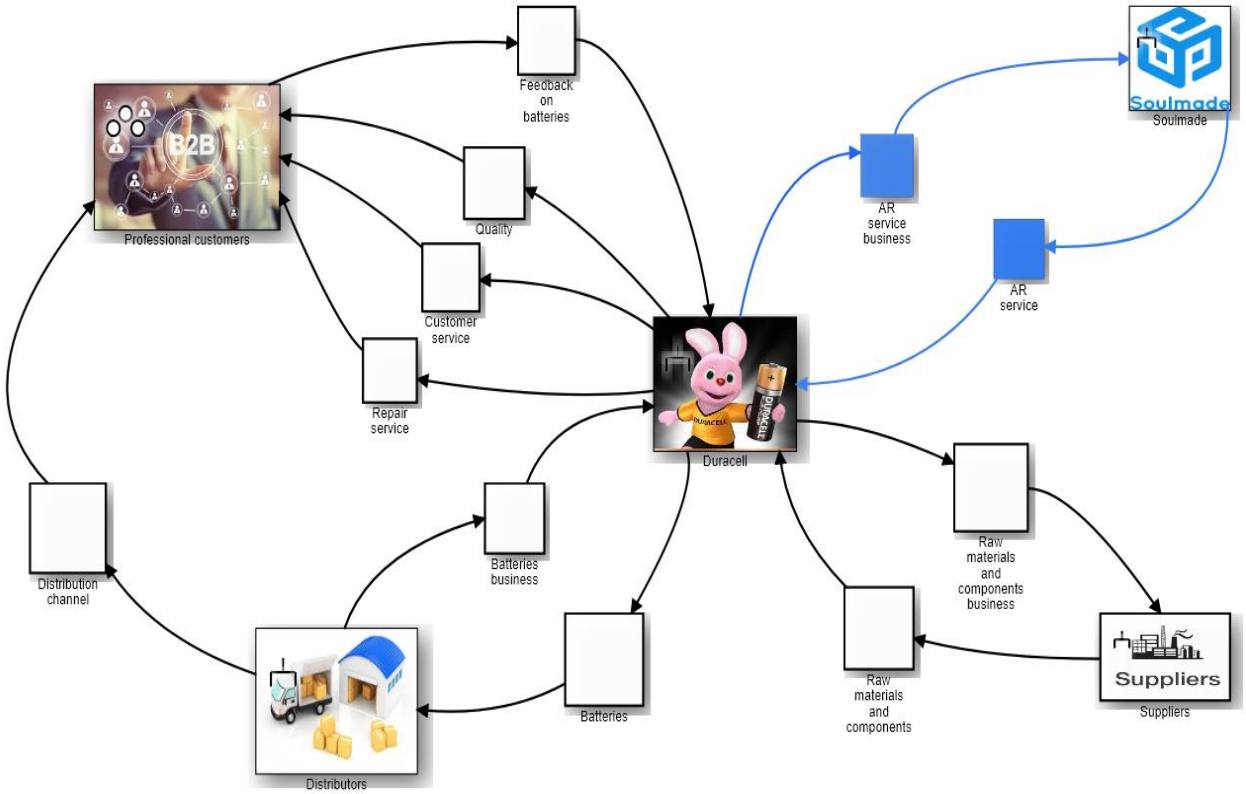

Figure 33: The TO-BE Business Ecosystem Map of Duracell

A link can be identified with the Maersk case for the impact of AR on the strategy map. The TO-BE strategy map (figure 34) illustrates the implementation of the new technology, and especially how it impacts the business process, much better than the ecomap. It is presented very clearly how the 'augmented reality service' competency influences the battery quality and -repair time.

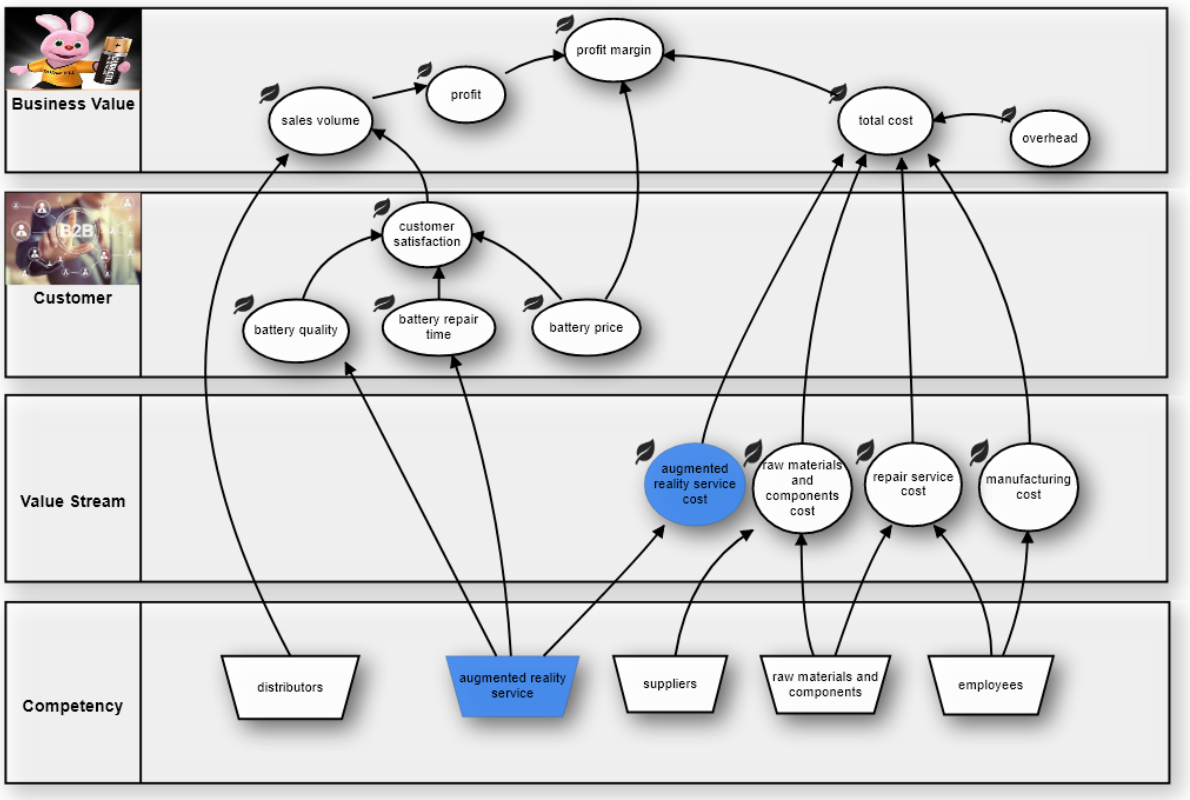

Figure 34: The TO-BE Strategy Map of Duracell

As for the TO-BE value stream map, one change can be identified: the addition of an 'Augmented reality service cost proposition' (figure 35). This value stream should be added to the entire AS-IS value stream map. The activity 'Apply AR' is added because AR will have an impact on the internal process.

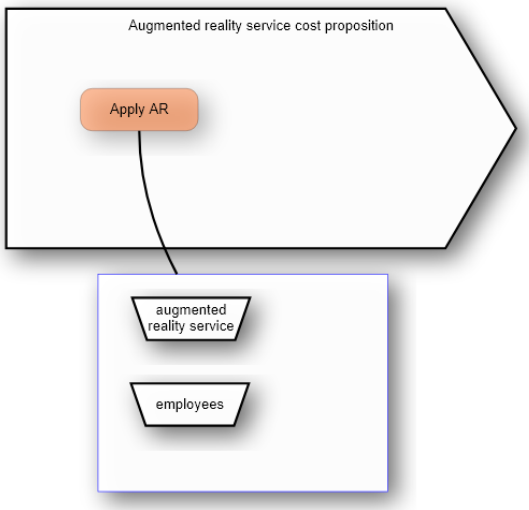

Figure 35: The added TO-BE value stream of Duracell

5.2.3.2. Prototype stage

The two values on which AR had an direct impact are the battery quality and battery repair time. The goal of the case was to increase the battery quality but AR had an impact on the repair time as well when a battery was still under guarantee. Employees do not have to lose as much time as before when searching for the cause of the defect. In the AS-IS situation, the battery quality, i.e. success-rate of the quality control, had been set on 94%. AR can have an impact of 15% on error rate percentages so in this case it can increase the success-rate with 15%, according to Capgemini (2018). This would lead to a success-rate of 100% but since a failure of the system is always possible, a new battery quality of 99% is reached. Therefore, the impact of AR on the quality will only be 5%. The aggregated view (figure 36) illustrates how, thanks to an impact factor, AR can influence the battery quality. The calculation behind it is simply the addition of the AR impact factor (5%) to the AS-IS battery quality (94%).

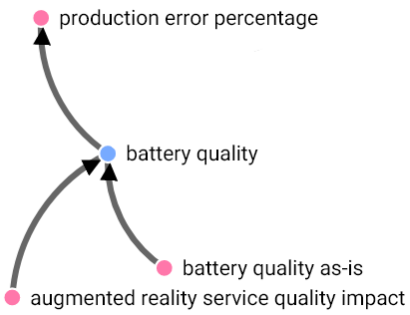

Figure 36: The T0-BE aggregated view of the battery quality of Duracell

The second value on which AR had a direct impact, is the battery repair time. In the AS-IS situation, the repair time had been set on 4 days, which is based on information coming from Duracell. Those 4 days include both the duration of the actual fixing (2 days) as well as the transport (2 days). The impact of AR on efficiency, i.e. the time to repair the battery, can go up to 25% (Capgemini, 2018). Of course, AR can only impact the actual fixing time which is 2 days. AR can reduce this with half a day (25% of 2 days) but can have no impact on the transport time. Therefore, the impact of AR is 12.5% on the complete repair time. In figure 37, the aggregated view shows how AR impacts the repair time. The augmented reality service repair time impact percentage equals 12.5%. This is multiplied to the AS-IS battery repair time to calculate the repair time impact which is 0.5 days. Next, this impact gets aggregated to a new battery repair time by subtracting it from the AS-IS repair time. 3.5 days is the new battery repair time. A shorter time will eventually result into a lower repair cost per battery.

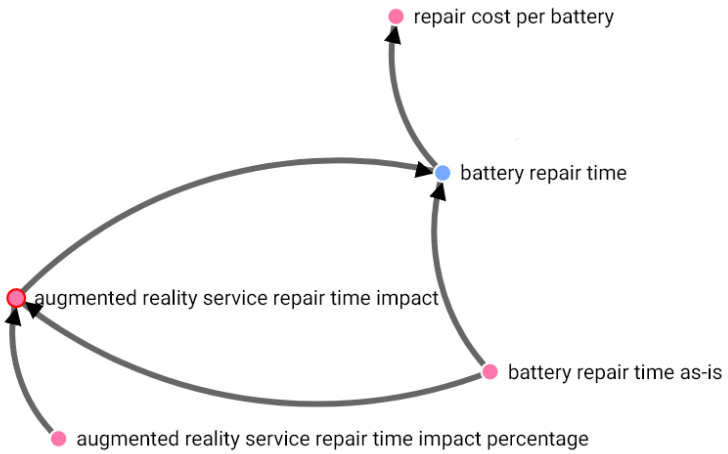

Figure 37: The TO-BE aggregated view of the battery repair time of Duracell

This repair cost leads to a decrease of the values of the 'Repair' activity (figure 38). The repair cost per day (€160.00) remains unchanged but the amount of days decreased from 4 to 3.5. This leads to a decrease in repair cost per battery from €640.00 to €560.00. The amount of repaired batteries decreases very strongly from 1253 to 214 batteries but this is the result of the increase of the success-rate of the quality control which changed from 94 to 99%. A 99% success-rate means a production error rate of only 1%, which has been multiplied by the new sales volume of 21430 batteries.

Repair service cost proposition	My Business (Supporter ***(Business)***)	Repair	repair cost per battery 560.00 € (Repair) repair cost per day 160.00 €/day (Repair) repaired batteries 214 batteries (Repair)

Figure 38: The TO-BE Repair service cost proposition of Duracell

That new sales volume of 21430 is the result of the increase in customer satisfaction. Satisfaction rose from 71 to 80% because battery quality and -repair time improved. The market volume (16630 batteries) remained unchanged but the part of the sales volume that is influenced by the customer satisfaction, increased. The new plan values can be seen in figure 39. All plan values improved very well due to the implementation of AR.

Values	AS IS	TO BE
	Base Alternative / Base Scenario	Base Alternative / Base Scenario
Uncategorized		
battery quality [Duracell] (%)	94.00	99.00
battery repair time [Duracell] (days)	4.00	3.50
profit (€)	5798574.00	6745242.00
profit margin (%)	15.42	17.49
sales volume [Duracell] (batteries)	20890	21430

Figure 39: Overview of the AS-IS and TO-BE plan values of Duracell

Figure 40 illustrates how the battery quality increased, as can be detected from the % values on the left vertical axis. The battery repair time decreased, as can be read from the right vertical axis. The implementation of AR ensured Duracell to meet both of its business goals: the increase of the success-rate by quality control and the decrease of repair time when a battery is damaged.

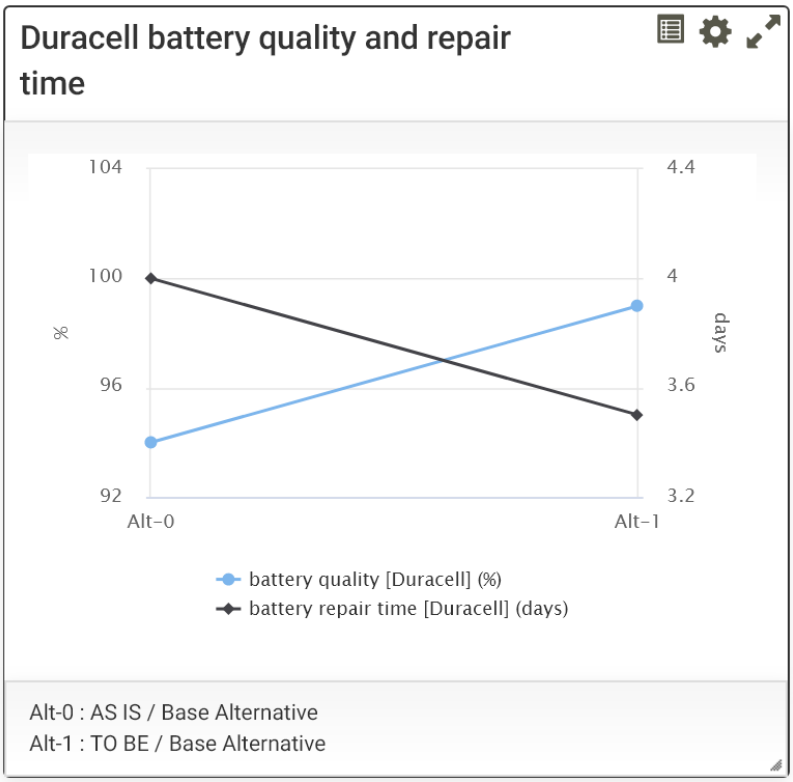

Figure 40: The changes in the battery quality and -repair time of Duracell

5.2.4. BPMN model of Duracell

The AS-IS BPMN model of Duracell can be found in figure 41. In a way, this model is a graphical translation of the whole business flow as outlined in the 'explanation of the case' section. A general battery manufacturing flow is given on the upper side of the diagram. This general flow is kept rather abstract to focus on the quality control process. In this BPMN diagram, different lanes have been illustrated because the quality control happens in another department of the factory, which has not been the case for the Maersk flow. Another difference is that the control battery activity has to be gone through entirely before being able to go to the next step.

Quality control in the AS-IS situation happens manually. The employee takes out samples of the components to check them. An event-based gateway is used because the detection and occurrence of a defect is something that has to happen. It is not possible to simply choose for one activity or another based on information, an event truly has to occur to base the continuation on. If a defect is detected, another employee has to repair it manually. Next, the component is checked again by the employee who repaired it, which is why another 'Control manually' activity is added and the flow did not return to the first 'Control manually' activity. If the repair did not succeed, a defect will be detected again and the repair flow will repeat itself. If no defect is detected, the battery will be shipped immediately to the distributor.

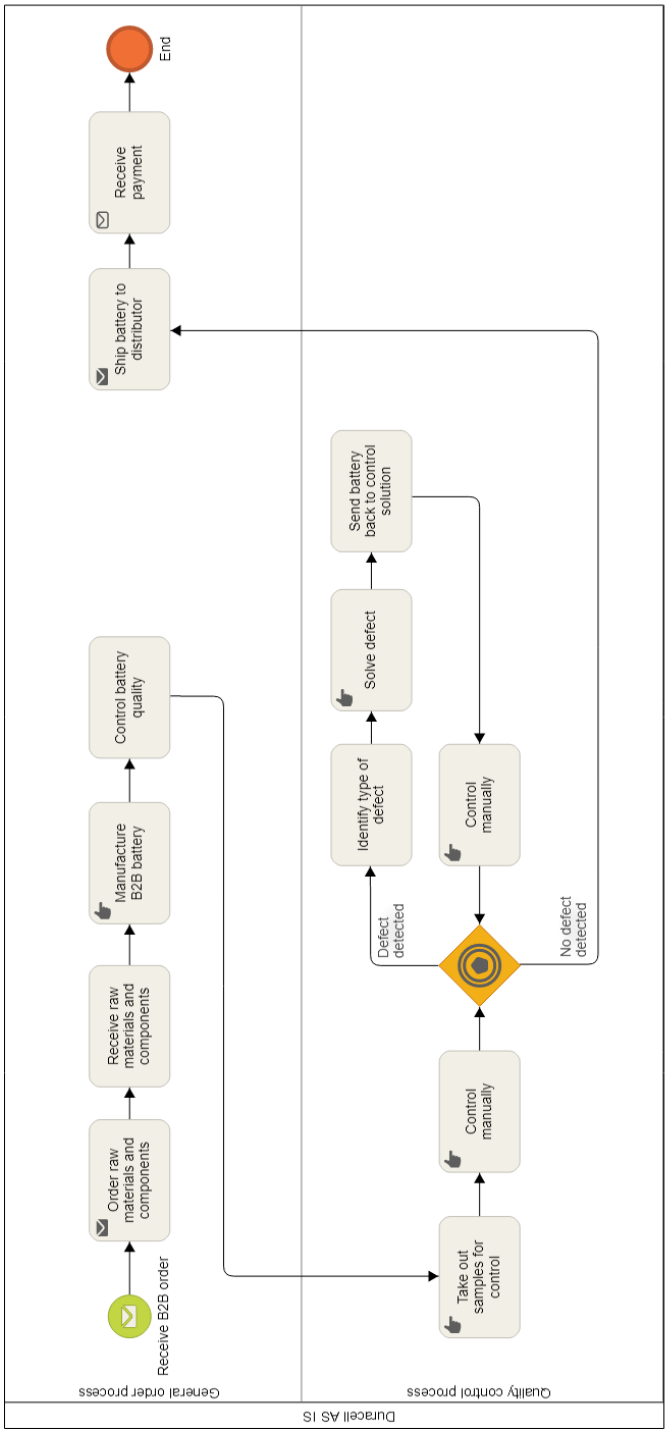

Figure 41: The AS-IS BPMN model of Duracell

5.2.5. Impact of AR on the BPMN model of Duracell

The TO-BE BPMN model of Duracell can be found in figure 42. The upper general process remains identical to the AS-IS situation because AR is only applicable on the quality control part. Firstly, the battery components are checked by the AR camera. This is a script task, which means that this activity is an automatic task executed by an information system. Just like in the AS-IS diagram, an event-based gateway is in its place. If a defect is detected, the AR-camera will give a signal to the Hololens to synchronize the nature of the defect and to recommend which repair steps are required. The employee will then read and execute those steps after which he or she will send a signal to the system from a tablet to indicate that the component is repaired. The information system with AR camera will then check the component again for defects. If the solution was incorrect, the repair flow will be followed again. If the solution was correct, the battery will be shipped immediately to the distributor. In the AS-IS, the reparation of the battery was entirely based on the skills of the employees whereas in the TO-BE, the skills of the employees are combined with the help of AR. It is important to mention that employees are still necessary but that they are able to work more efficiently than before.

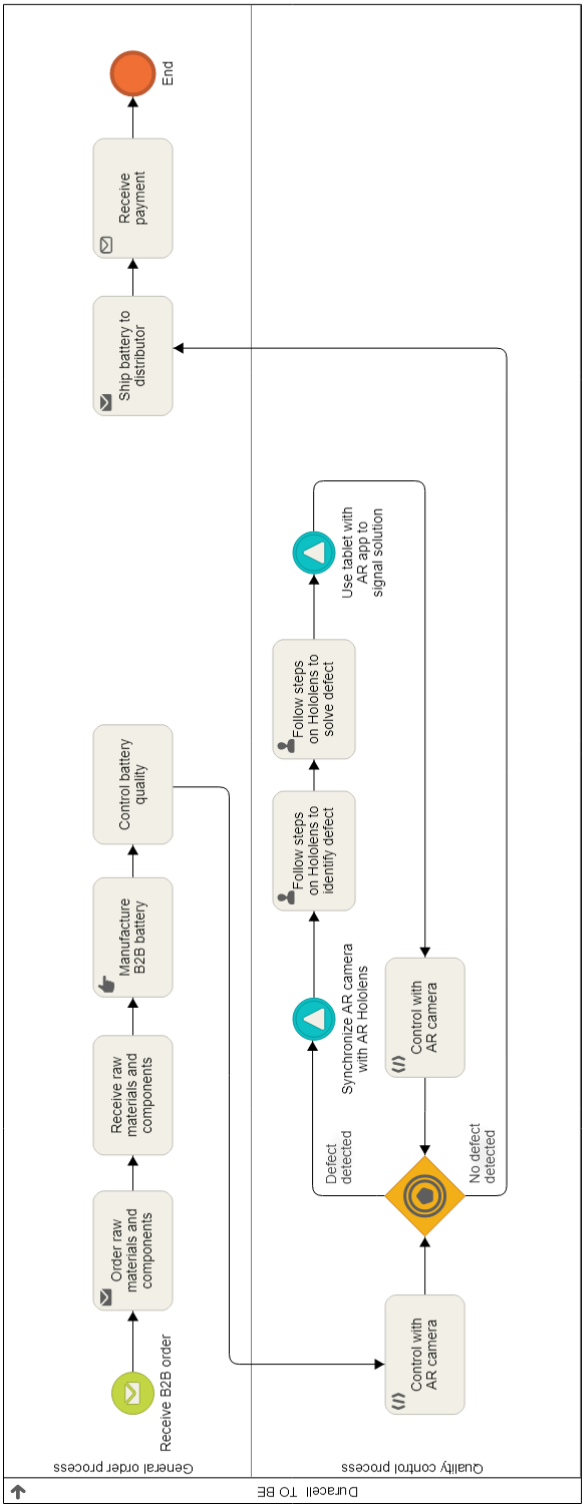

Figure 42: The TO-BE BPMN model of Duracell

5.3. Texet

5.3.1. Explanation of the case

Background of the case: Texet is a provider of professional clothing (e.g. for hotel personnel or roadworkers). Texet believes that the current duration to design the clothing according to the wishes of the customer takes too long. Several presales meetings are required, after which samples or try-outs have to be demonstrated and often modified. The whole customer journey, i.e. the number of touchpoints between Texet and its customer, is too long, too time consuming and too expensive. The customer journey is of course more than the sales meetings alone and all other touchpoints will be illustrated as well.

How AR is used: An AR app that can be used by their salespeople to demonstrate the clothing or by their own customers during the sales meetings will be developed. The AR app will visualize the clothing in 3D. It will be possible to add colors, a company logo or other finishing touches. AR will allow the customer to participate much easier in the design process. In this way, the amount of presales meetings and number of samples can be reduced.

Goals: Texet would like to reduce the required time to close a deal and shorten the customer journey. On top of that, Texet would like to collect customer data when the AR app is being used (e.g. what are the products customers are looking or for how long).

5.3.2. The VMP model of Texet

The Texet case is very different compared to the Maersk and Duracell cases. Their goal is not an optimization of their core production process but an improvement of the buying process. This type of content asks for a different angle when analyzing the impact of AR in the VMP. No classical VMP model with the enterprise at its center has been made, but this time the customer will be at the center. The whole VMP model of Texet will be customer oriented instead of enterprise oriented. Different plan values such as a customer experience impact will be used instead of classical ones such as profit or sales volume. In doing so, it can be tested for this case whether the VMP can be suitable to analyze the impact of AR in a customer oriented context. The first VMP model of Texet can be seen as the AS-IS customer situation or the customer model without AR. The second section of the VMP illustrates the TO-BE situation or the customer model with implementation of AR.

5.3.2.1. Discovery stage

The AS-IS business ecosystem map (figure 43) is approached differently compared to the previous cases. The customer is at the center this time while Texet is considered as a partner of the customer. For the occasion, the business ecosystem map has been transformed into a customer ecosystem map. All exchanged value propositions are touchpoints of the customer journey. A touchpoint between a customer and a business can be considered as a value proposition as well because it provides some kind of benefit for one of the partners. Between the customer and Texet, the presales meetings and sampling value propositions are most important because AR will have a direct impact on the values they are carrying. The two other parties in the AS-IS situation are two marketing partners, a traditional and a digital one. They both offer marketing touchpoints as value propositions to the customer.

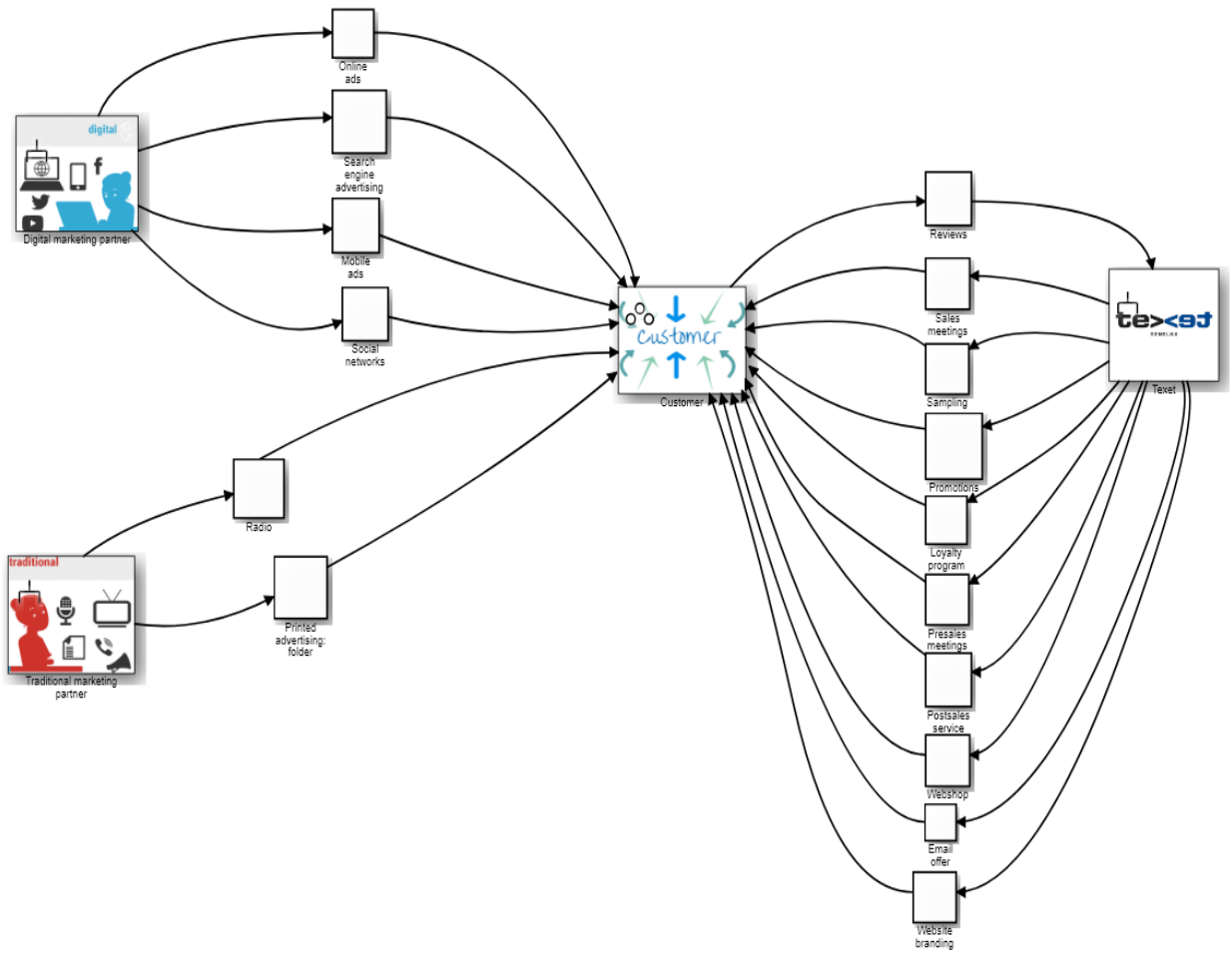

Figure 43: The AS-IS Customer Ecosystem Map of Texet

The strategy map has been modified as well and changed into a customer strategy map (figure 44). The business value lane has been deleted to enable a complete focus of the customer. Starting at the middle of the customer lane, the customer touchpoints in general are illustrated. This is an aggregated value of all combined value streams i.e. the values coming from touchpoints. Those are not all presented because there are too many, but simply summarized in the value stream lane based on its partners. They are all influenced by their respective competency as well. Going back to the customer lane, the customer touchpoints influence both the customer satisfaction and the customer experience impact. The customer touchpoints impact the customer satisfaction directly because customers do not like too many of them. The average deal closing speed and the number of design attempts are the other influencers of the satisfaction. The customer experience (CE) impact on the right is the result of the customer touchpoint influence and -exposure. The CE is not a value that can increase or decrease but will remain always at 100% because it expresses the relative CE impact of each touchpoint. No value stream map has been developed since the customer oriented approach of the VMP does not require any activities. Some touchpoints are the result of internal activities of course, but it is not relevant to put these on activities since those activities would not carry any values, all values are put on the value propositions, i.e. touchpoints.

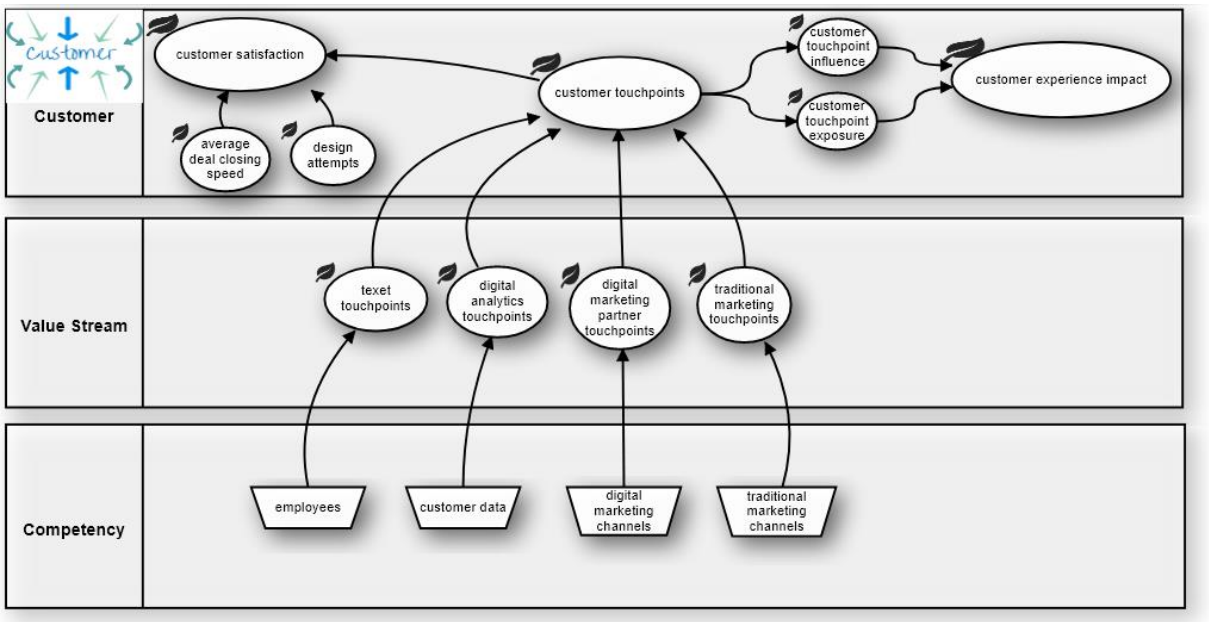

Figure 44: The AS-IS Customer Strategy Map of Texet

5.3.2.2. Prototype stage

The prototype stage will be started by discussing the plan values again, which in the customer oriented context will be called customer plan values. This time, the values can be seen as the success factors for the customer and a measure criteria to compare values over consecutive phases for them. All customer plan values (figure 45) could have already been identified in the customer strategy map but are given a numeric value here.

AS IS	
Base Alternative (Primary)	
average deal closing speed	7 meetings
customer experience impact	100.00 %
customer satisfaction	72.00 %
customer touchpoints	16 touchpoints
design attempts	3 attempts

Figure 45: The AS-IS Customer plan values of Texet

The average deal closing speed is expressed in a number of meetings (figure 45). It is the sum (figure 46) of the number of presales meetings (3), sampling meetings (2) and sales meetings (2). A difference between those meetings is made because AR will have an impact on the presales and sampling meetings but not on the sales meetings itself. During presales meetings, information is exchanged between Texet and its customer about the characteristics of the clothing and the price. The sampling meetings are the moments when the design is presented to the customer. This design often has to be modified because the customer is not always satisfied with the initial one, hence the choice for two meetings. During sales meetings at last, the final price- and quantity provisions are negotiated.

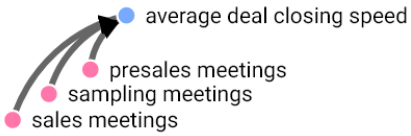

Figure 46: The AS-IS aggregated view of the average deal closing speed of Texet

The next customer value is the customer experience impact (figure 47). As already slightly mentioned, this value is not able to increase or decrease but will always remain at 100%. The purpose of this value is to identify the relative impact of each touchpoint on the customer experience. Despite remaining on 100% over consecutive phases, it is definitely possible for the values that impact the customer experience to change. New touchpoints can be added or deleted by which the relative proportions will change or those proportions can be changed directly. It can be seen for example that the printed advertising impact is at 10.00%.

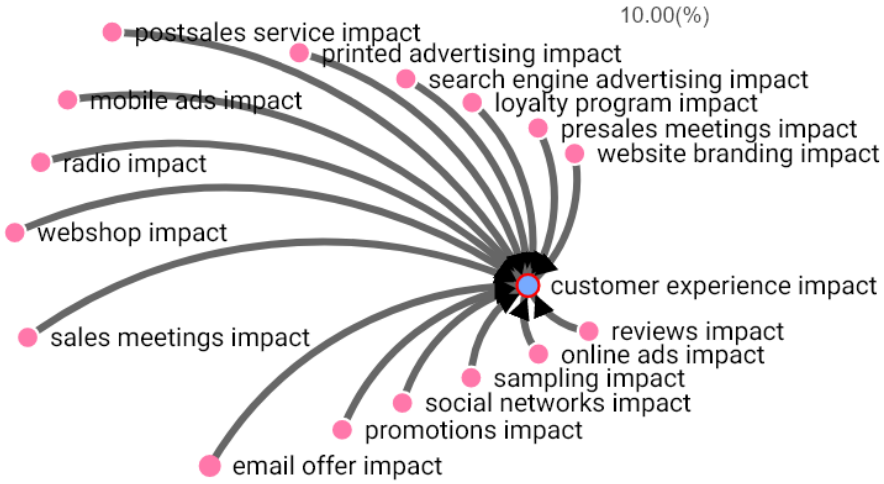

Figure 47: The AS-IS aggregated view of the customer experience impact of Texet

The impact of a touchpoint is the result of two values: the number of exposures of a touchpoint and the influence of each touchpoint during that exposure. Figure 47 shows that the printed advertising impact is at 10.00% which is the result (figure 48) of the printed advertising exposure multiplied with the printed advertising influence.

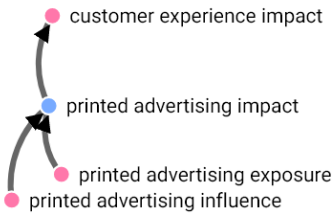

Figure 48: The AS-IS aggregated view of the printed advertising impact of Texet

The printed advertising exposure (2 exposures) and the printed advertising influence (5%/exposure) are shown in figure 49 and multiplied with each other. The two exposures actually mean that a customer is exposed two times on average to the printed advertising touchpoint during the customer journey. The 5%/exposure value means that one exposure of this touchpoint,

has an influence in terms of experience of 5% on the customer. Together, the values contribute to the general customer experience impact (100%) and its relative part (10.00%) on this impact can be identified.

Printed advertising: folder	Traditional marketing partner (Traditional marketing provider *(Partner)*)	Customer *[Texet Customer Business Model Package]*	printed advertising exposure 2.00 exposures printed advertising impact 10.00 % printed advertising influence 5.00 %/exposure printed advertising touchpoint 1 touchpoint	✔

Figure 49: The printed advertising: folder value proposition and its CE impact values of Texet

The following customer value is the customer satisfaction. The concept is the same as explained in the two previous cases and its aggregating values can be seen in figure 50. The number of touchpoints influence the satisfaction as follows: the fewer touchpoints, the higher the satisfaction. It should be mentioned however that this is not the case for all customers. Some customers actually like to be exposed to a small number of touchpoints because they like to be in contact with the business. Most customers though are touchpoint averse and would like to see this reduced to a minimum. Therefore, the choice has been made that fewer touchpoints lead to a higher customer satisfaction. It will be mentioned in section 6 to possibly add a parabolic character to the customer satisfaction in the VMP.

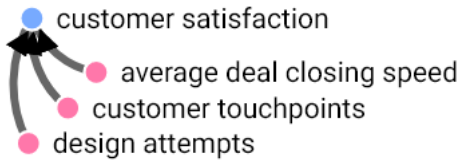

Figure 50: The AS-IS aggregated view of the customer satisfaction of Texet

Next value of the customer plan values is the 'number of touchpoints' which has been added because it is one of Texet's goals to reduce this number. It is the sum of all touchpoints and stands at 16 (figure 45) in the AS-IS situation. The value of '1 touchpoint' (which can be seen in figure 49 as the last value below) was simply added to each touchpoint value proposition and added up together. This value aggregates towards the customer satisfaction. The final customer plan value is the number of design attempts, which is currently at 3 (figure 45) and based on information coming from Texet. The value also impacts the customer satisfaction.

5.3.3. Impact of AR on the VMP model of Texet

In this section, the TO-BE customer situation of Texet and thereby the implementation of AR will be illustrated. Only the parts which were subject to change will be discussed. AR will be considered as a new touchpoint.

5.3.3.1. Discovery stage

Contrary to the two previous cases, the TO-BE customer ecosystem map (figure 51) shows the change due to AR clearly. It implies the addition of a new AR partner with its AR-experience touchpoint and the data-analytics partner with its customer data touchpoint. Those are indicated on the map by the color of its respective partner logo. Some value proposition touchpoints have been deleted because of the implementation of AR: the sampling, email offer and printed advertising folder touchpoints. Those touchpoints are still presented in figure 51 but have a red cross over them to indicate that they are no longer part of the model. Those red crosses are no part of the VMP but were illustrated for clarity purposes and to give an example of how the ecomap can become clearer as a business transformation map, which will be further discussed in section 6. It is of course not allowed to map those touchpoints with a red cross on to the cube.

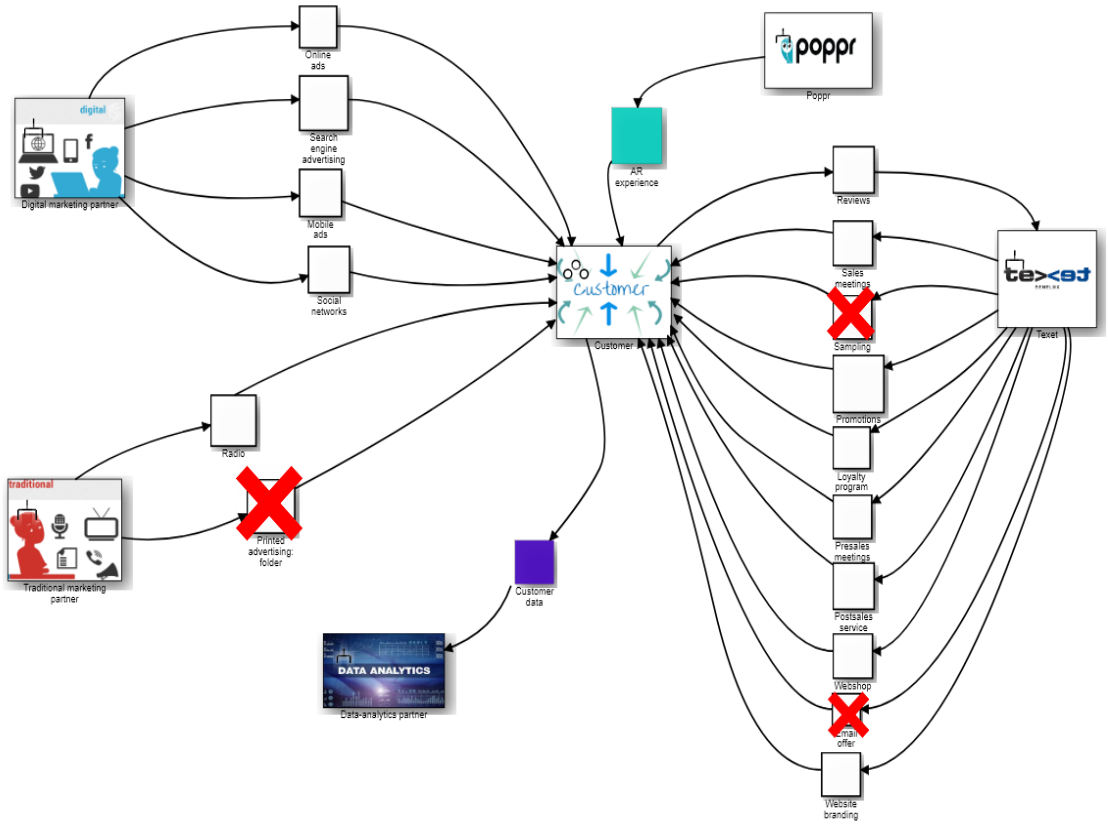

Figure 51: The TO-BE Customer Ecosystem Map of Texet

The TO-BE customer strategy map is illustrated in figure 52. Despite not showing that much change, the customer strategy map is still helpful because it shows the reader that AR has an impact on all customer plan values. It directly influences the customer touchpoints, Texet touchpoints, average deal closing speeds, design attempts and customer experience impact.

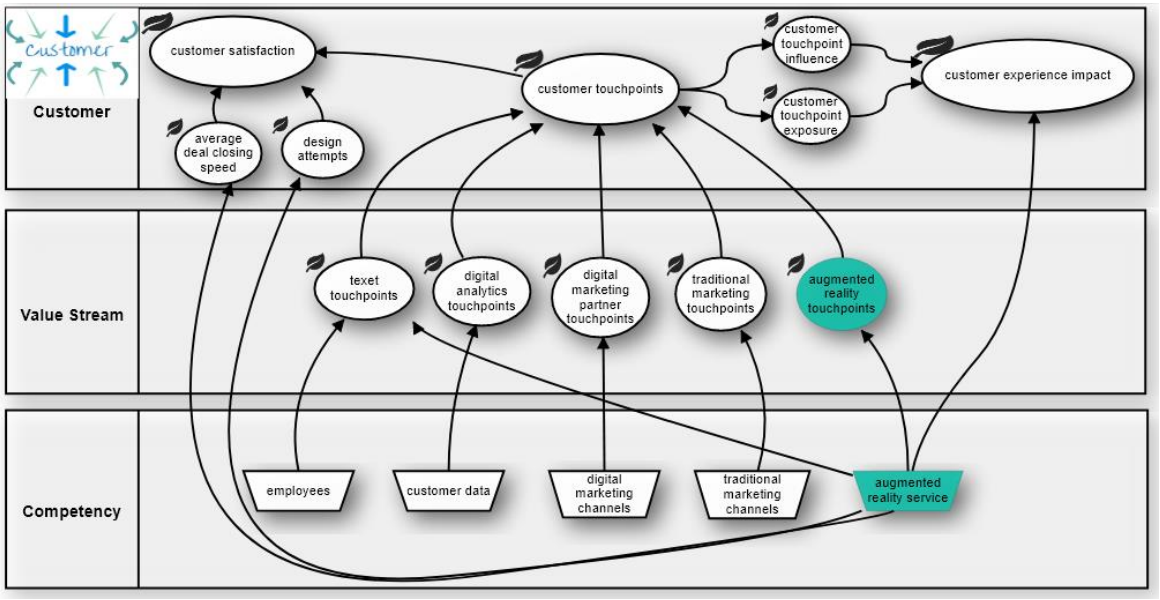

Figure 52: The TO-BE Customer Strategy Map of Texet

5.3.3.2. Prototype stage

The first value on which AR will have an impact, is the average deal closing speed (figure 53). Due to AR, only one presales meeting will be required. In the AS-IS situation, employees of Texet needed three meetings to provide all the necessary clothing information and characteristics which are now entirely available in the AR app. In addition, the sampling meetings will no longer have to exist. Customers can choose the desired design entirely by themselves so Texet no longer has to come up with try-outs or samples of the design. In some exceptions, it might still be possible that the customer is not satisfied with its own design, which is why the number of sales meetings is kept at two. This brings the average deal closing speed in the TO-BE situation to three meetings where this was seven in the AS-IS. The number of meetings will appear on the value in the VMP when touched with the mouse.

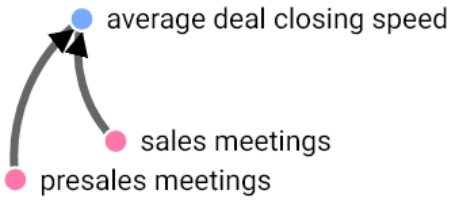

Figure 53: The TO-BE aggregated view of the average deal closing speed of Texet

The second customer value which has been influenced by AR, is the customer experience impact. As mentioned before, this value will remain at 100%. The way this 100% is reached and thereby the way the customer experiences its journey, is different however. Three AS-IS touchpoints have been deleted so its factors were deleted from the experience impact as well: the email offer, the printed advertising and the sampling touchpoints. Email offers and printed advertising will be replaced by offers and advertisements online and in the application. The removal of the sampling touchpoint has already been discussed in the 'average deal closing speed' impact. The addition of a new experience impact factor arises: the AR experience impact (figure 54). It immediately becomes the largest impact factor of the CE with 15%, having 3 exposures and a 5%/exposure influence. Other changes in the impact factors happened as well because of AR. The presales meetings for example went from 3 meetings to 1 which means the number of exposures went from 3 to 1 as well, causing its entire impact to decrease from 15% to 5%. Another example is the webshop, which influence factor increased from 2%/exposure to 4%/exposure because customers now have a direct access from the AR app to the webshop.

Value Proposition	From (Role)	To (Role)	Values	Attached
AR experience	Poppr (Augmented reality provider *(Partner)*)	Customer *[Texet Customer Business Model Package]*	ar experience exposure 3.00 exposures ar experience impact 15.00 % ar experience influence 5.00 %/exposure ar experience touchpoint 1 touchpoint	✔

Figure 54: The AR experience value proposition of Texet

The third impacted customer value is the number of touchpoints which is simply calculated by the sum of all touchpoints. This amount went from 16 to 14 touchpoints. AR also had an impact on the fourth customer value: the number of design attempts which decreased from 3 to 2 attempts because customers can now choose their own design in the AR app. The improvement of those two customer values combined with acceleration of the average deal closing speed led to an increase of the customer satisfaction from 72 to 86%. The TO-BE customer values are shown in figure 55.

TO BE	
Base Alternative (Primary)	
average deal closing speed	3 meetings
customer experience impact	100.00 %
customer satisfaction	86.00 %
customer touchpoints	14 touchpoints
design attempts	2 attempts

Figure 55: The TO-BE Customer values of Texet

5.3.4. Service blueprint of Texet

The service blueprint canvas of Texet is illustrated in figure 56. It was not intended to do any research on service blueprint but because the Texet case was not suited to model in BPMN, SB was chosen as an alternative. Reason for this is that BPMN focuses on visualizing the flow of business processes, while AR had no impact on any change of the internal production process. For Texet, AR had an impact on the service and experience provided to the customer, hence the choice for service blueprint. The goal was to improve and shorten the customer journey, which is also a part of the service blueprint canvas.

Starting in the top lane, physical evidence, the customer journey touchpoints are presented. Not each touchpoint is shown here because there are simply too many but summarizing touchpoints have been used instead. The arrows in the first lane show that some touchpoints have an impact on others. For example, digital marketing touchpoints can lead eventually to a presales meeting because a customer might have seen an online advertisement. Each touchpoint influences a component of the second lane, i.e. a customer action. The corresponding customer action is shown each time and consists out of multiple actions that are executed by a customer. Those actions derive from being subject to the touchpoint. As from the third lane, actions only influence an upper component of the map. Reason for this is that those lanes are created to illustrate which actions are required to make the customer perform its customer actions and eventually buy the service.

The onstage contact actions, i.e. the actions visible for the customer, are shown in the third lane. Two important activities are the 'Employee provides clothing information' and 'Employee guides client through sampling process'. Reason for this is that those activities are the core activities of the buying process in the AS-IS situation. They lead eventually to the presales and sampling touchpoints and will be impacted mostly by AR. The sales meetings are also important but have only to do with the 'Employee negotiates' action which is not considered as a core activity. The backstage contact action in the fourth lane are the actions invisible to the customer such as the webshop- and inventory system or production. Despite being invisible, those actions still influence the onstage contact actions as can be identified from the arrows. The final lane at last, contains the support processes. Those are mainly the operations coming from partners or outsourced activities. Some influence the customer actions, others the actions within the business.

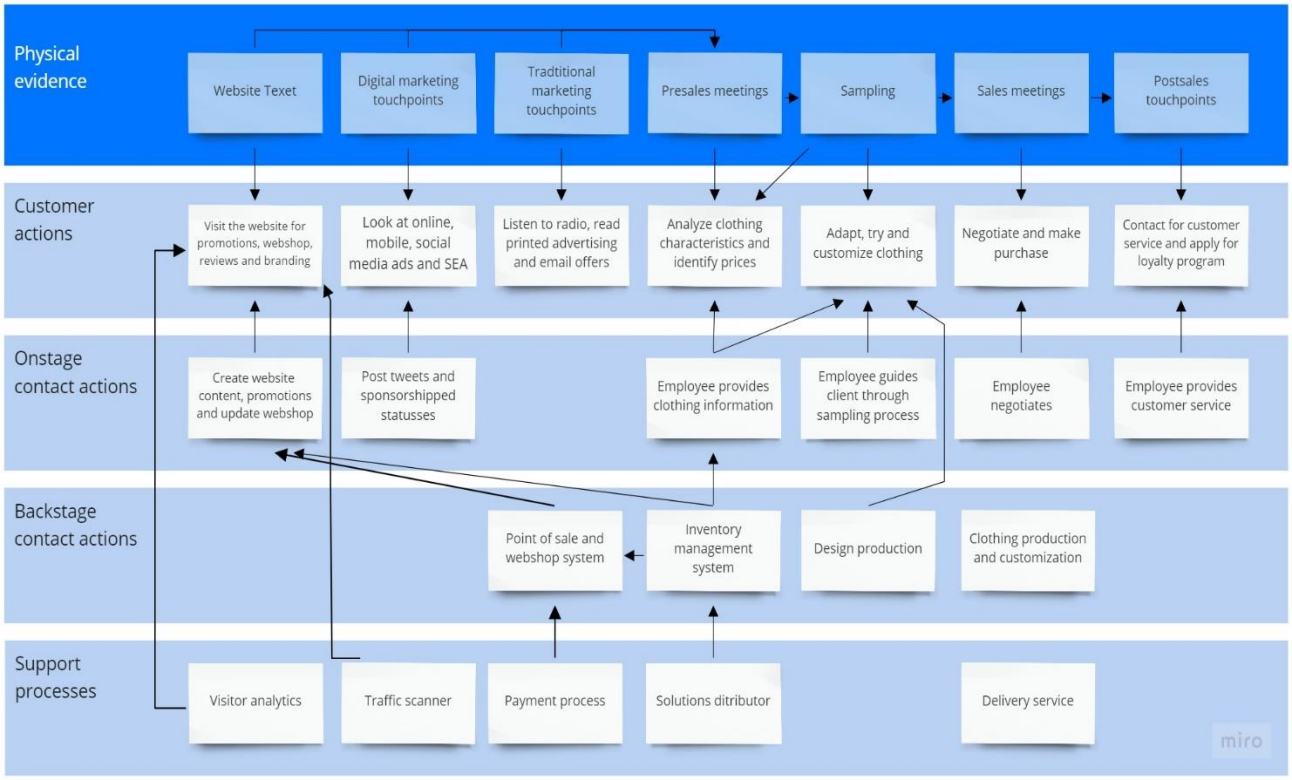

Figure 56: The AS-IS Service Blueprint of Texet

5.3.5. Impact of AR on the service blueprint of Texet

A change in the TO-BE service blueprint (figure 57) can already be identified in the physical evidence lane: the switch of the sampling touchpoint with the AR experience touchpoint. There is also a change in the way the sales meetings touchpoint is influenced: presales meetings are now able to influence the sales meetings directly because AR can be used during the presales meeting already whereas in the AS-IS situation, a sample had to be designed first. Customers can make their desired clothing design already during that presales meeting. Some changes can be identified in the customer actions lane as well: the 'read printed advertising and email offers' are deleted because they are now integrated in the online touchpoint and the AR app. Therefore, they are no longer part of the actions that derive from the traditional marketing touchpoints. The biggest change can be found in the customer actions deriving from the AR experience touchpoint, which are 'visualize clothing' and 'experience customization'.

One new and one changed onstage action can be identified in the third lane. 'Employee guides client through sampling process' has been changed into 'Employee guides client through AR-experience' while the 'Augmented reality application' is an entirely new one. In the TO-BE situation, employees no longer have to demonstrate designs physically but can do this virtually

thanks to AR. Of course, customers want to see the clothing in real life but this can be combined with the sales meeting. The backstage contact actions imply one addition and one removal: a customer data analytics program is added, which is part of the contact actions and not of the support processes because they are used directly by Texet to base their digital marketing touchpoints and interact with the customer on. The removed action is the production of the design, which was seen as a separate action in the AS-IS situation because customers were often unsatisfied with the first design so it had to be redesigned often. Now, the design process is seen as part of the general clothing production since customers designed the clothing themselves. The final lane underwent only one addition: the augmented reality provider. This is a supporting process because it is outsourced to a partner and the provider on its own is not in direct contact with the customer, only the application is.

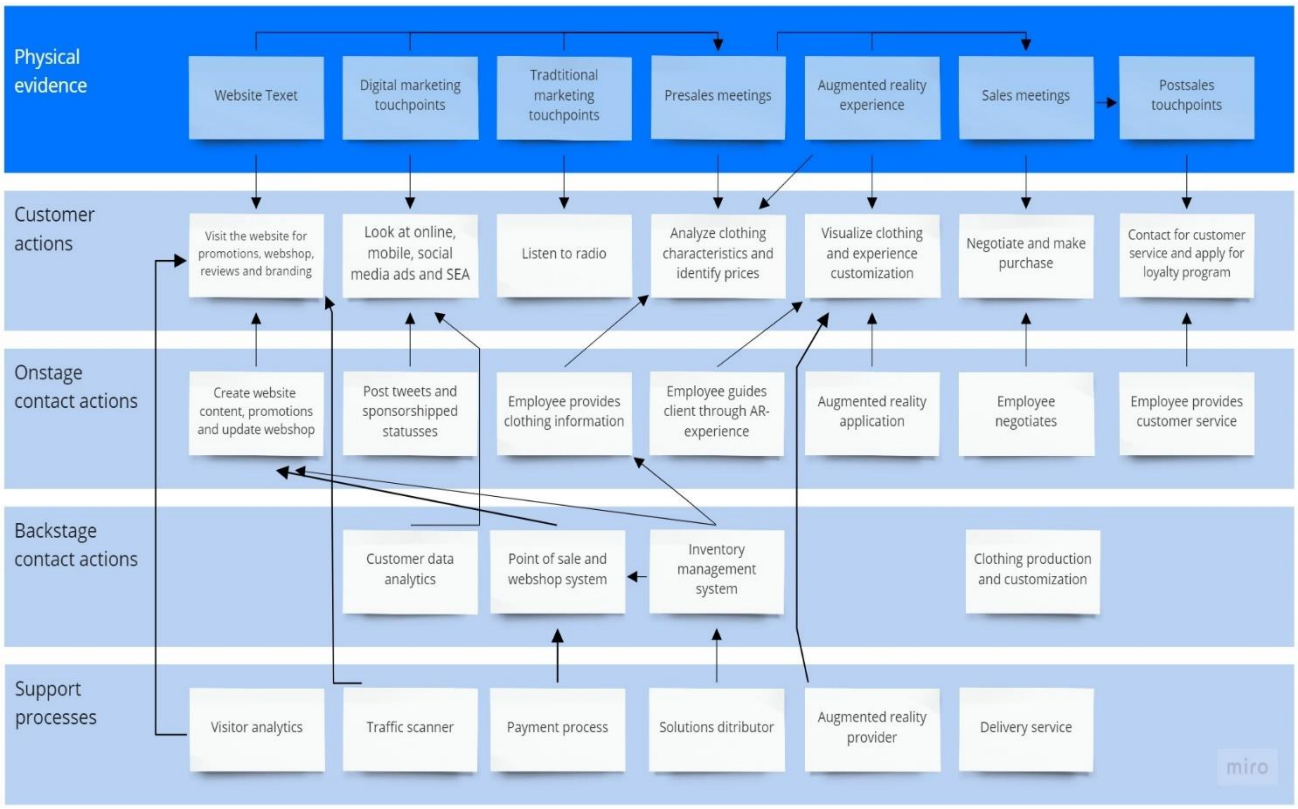

Figure 57: The TO-BE Service Blueprint of Texet

6. Evaluation of the used enterprise modeling techniques

The goal of this section is to discuss the acquired insights of the EM modeling techniques that are coming from the cases, i.e. coming from the implementation of a new technology: augmented reality. An extensive illustration of the cases was among others necessary for understanding purposes of this section because real examples coming from those cases will be used to clarify the insights. A direct answer to the research questions is not given yet, this is kept for the discussion section.

6.1. Insights coming from the Value Management Platform

First, insights coming from the discovery phase will be discussed. The business ecosystem map does not always show very clearly how the new technology impacts the business model. Its goal is to show the way value propositions are exchanged between partners but for the Maersk and Duracell case, the addition of augmented reality just led to an addition of a partner and a partner that offers an AR service proposition. This is very abstract and does not contribute much. In the Texet case however, where value propositions were considered as touchpoints of the customer journey, the ecomap was very clear and revealing regarding the impact of AR. Despite being more clearly in the Texet case, an illustration of red crosses on the deleted value propositions were shown. This is purely an example to demonstrate how the ecomap can maybe increase clarity and make a bigger contribution to visualize the impact of AR in the ecosystem map. It should be mentioned however that if those red crosses are used, which are not an official part of the VMP but added by another tool after a printscreen was taken, it may not be forgotten not to map those value propositions. They are not allowed to be a part of the cube. Another idea can be for the ecomap to add the possibility of mapping another kind of value propositions, for example which are impossible to map.

As for the strategy map, the impact of AR could have been detected very visually due to the use of arrows and lanes. For all three cases, the strategy map was considered as the most useful discovery stage map to illustrate the impact of AR on the organization. The map showed the impact on the buyer-seller relationship very clearly as well because of the presence of a customer lane. As for the Texet case, no business value lane has been used because it was a customer-only oriented case. This did not lead to any complications however. When desired, any values coming from the business can be put on its corresponding value propositions because the business is considered as a partner. In the Texet case, these were only the touchpoint- and customer

experience values. The value stream map was useful in two out of three cases. In the Duracell and Texet case, it showed the impact of AR on the internal activities well. In the Maersk case however, the activities on itself did not change and therefore the value stream map did not change as well.

The prototype stage is very useful to compare the impact of AR on the business because numeric values are added. The VMP is the only used EM techniques which is capable of doing so. Especially the plan values were helpful to compare the values over consecutive phases. The aggregated views show the impact of AR in a very visual way. They can be accessed when clicked on the hyperlink of the value. In a way, it is a more profound zoom-in of the strategy map. Within the tool itself, it is possible to go over the values with the computer mouse to see the corresponding numeric value. This makes the combination of visualization and a numeric impact very helpful.

The actual part of the business which these cases desired to analyze, was the impact of AR on the buyer-seller relationship. In all three cases the value 'customer satisfaction' has been illustrated, which is an excellent numeric representation of this buyer-seller relationship. It has been identified how the general satisfaction evolved but also how its different elements were impacted by AR. Despite being considered as very valuable for all three cases, one recommendation can be given: to add the possibility of a parabolic character to the customer satisfaction. This came out as a result of the Texet case. The number of touchpoints of the customer journey was one of the elements that contributed to the customer satisfaction: the fewer touchpoints, the higher the customer satisfaction becomes. But this is not always the case for customers, some actually like to experience a particular amount of touchpoints until a certain level. This would mean that customer satisfaction has to increase when the number of touchpoints increases until a certain level after which the customer satisfaction would decrease if the number of touchpoints keeps increasing. This is not possible to do in the current interval or weighted average structure of the VMP.

The prototype stage is very helpful in a customer oriented context as well to analyze the impact of AR, despite not being the true purpose of the VMP, which is to operate in an enterprise oriented context. Values such as the customer experience impact or the number of touchpoints of a customer journey were successfully implemented in the VMP. Here, this resulted in the customer plan values and those were suited to compare over consecutive phases as well. In the adopt stage at last, it was possible to show the impact of AR in a graphical way. By doing so, business people could easily understand this impact and do not need an analytical mindset.

In general, did the VMP meet its purpose? As mentioned in the context section, the VDMBee profiles the VMP as follows: "in the VMP, business changes can be planned, different phases and scenarios can be modelled and the impact of changes on value creation can be estimated". The answer on each part of this purpose for all three cases, i.e. to analyze the impact of AR, is yes. A final general supporting notion can be given however. The VMP designers at VDMBee are considering the addition of a process design map as part of the value stream map. In other words, it might be possible in the future to create an abstract process flow as part of the VSM. An overlap with BPMN can be detected which purpose it is to create an abstract process flow as well. It could be very useful to combine both EM techniques since the VMP does not provide a process flow map right now. The strategy map provides an abstract view of how values can impact each other but this does not represent the actual process.

6.2. Insights coming from Business Process Model and Notation

The strongest point of BPMN is illustrating how AR impacts the internal production or value creation process. Despite being abstract, it shows well how the flow of activities modifies. BPMN can be a useful EM technique to give insight in the new operational steps of a business and be able to identify the required elements to fulfil these steps, as has been the case for Maersk and Duracell. Important to underline however is that it only gives clearance on the impact of AR on the internal process. It is difficult to identify partners or the customer. This has been one of the reasons why BPMN was not suitable to analyze a customer oriented case like Texet. Furthermore, it is not possible to add numeric values to BPMN. It has to be mentioned that this is not the purpose of BPMN but it creates a backlog when being compared to the VMP.

In general, did BPMN reach its purpose? As mentioned in the introduction, the Object Management Group profiles BPMN as follows: "BPMN will provide businesses with the capability of understanding their internal business procedures in a graphical notation and will give organizations the ability to communicate these procedures in a standard manner". Compared to this quote, BPMN did indeed meet its purpose. It has proven itself as being capable to understand the internal business procedures in a graphical notation. But, AR is a new technology that is not always used to improve the internal process of the business but is often implemented to create an enjoyable customer experience or to improve the customer journey as well. This is where BPMN is difficult to use, i.e. the use of BPMN to analyze the impact of AR on the buyer-seller relationship depends highly on the content of the case. This is an extra argument to support the use of BPMN as part of the potentially upcoming process design map in the VMP because a customer oriented case has been successfully implemented there. In that process design map, it might even be

possible to add numeric values to the BPMN components, after which a numeric AR impact can be easily added.

6.3. Insights coming from Service Blueprint

Service blueprint has proven itself to be a good substitute for BPMN when AR is implemented in a customer oriented context. The impact of AR on the customer journey, which represents one of the lanes in service blueprint, and the customer experience, has been illustrated clearly. In addition, it is useful to identify the changed customer actions due to AR. In this way, Texet can recognize how the customer will possibly behave and can adapt itself to it to become even more customer focused. Furthermore, service blueprint could be a complementary EM technique to the VMP as well. For the Texet case, the maps of the discovery stage have been adapted to a customer oriented approach but there is no pure customer-only map available in that discovery stage. It could go even further and add values to the service blueprint map to identify how a new technology can impact for example the customer actions expressed in numbers.

In general, did service blueprint meet its purpose? As mentioned in the introduction, the Flanders Inshape profiles the SB as follows: "a detailed description of a new service with its implications on working processes, time agreements, support, … in short everything which is practically necessary to ensure that the updated service runs smoothly". Service blueprint has proven itself as suitable to do so for the Texet case. One observation has to be made however: this has only been tested on a customer oriented case. In entirely process oriented cases such as Maersk and Duracell, service blueprint would not have been a suitable EM technique because the customer has not been directly impacted by AR.

7. Discussion

7.1. Limitations

The values used when modeling the case in the VMP are mostly based on real-life numbers and research. In some occasions however, the values had to be based on assumptions. Especially for the impact of customer satisfaction on sales, assumptions had to be used because this is difficult to measure in practice. Furthermore, the comparison of the AS-IS and TO-BE phases are very direct. AS-IS is modeled as being entirely without AR while in the TO-BE, the AR is completely up and running. In a practical environment however, a business and its employees often need time to adjust to a new technology. This adjustment period is not taken into account and could lead to an inefficient work environment or an increase in costs.

7.2. Results

In this section, the research questions will be answered. Firstly, the sub questions will be discussed after which those will contribute to the general research question.

Sub question 1: **"Can the Value Management Platform be an enterprise modeling technique to analyze the impact of augmented reality on the buyer-seller relationship?"**

The impact of AR on the buyer-seller relationship has been positively modeled into the Value Management Platform for all three cases. The visualizing maps of the discovery stage, the comparing plan values over consecutive phases and the adopt stage graphs were considered as most important parameters to indicate and analyze this impact. Even when AR has been implemented in a customer oriented way, the VMP has proven itself as a suitable enterprise modeling technique.

Sub question 2: **"Can Business Process Model and Notation be an enterprise modeling technique to analyze the impact of augmented reality on the buyer-seller relationship?"**

In the Maersk and Duracell cases or in other words the two process oriented cases, BPMN has proven itself as a suitable enterprise modeling technique to analyze the impact of augmented reality on the buyer-seller relationship. For the Texet case however, BPMN did not prove itself as suitable for it. AR is a new technology that is not always used to improve the internal process of

the business but is often implemented to create an enjoyable customer experience or to improve the customer journey as well. This is where BPMN is difficult to use, i.e. the use of BPMN to analyze the impact of AR on the buyer-seller relationship depends highly on the content of the case. The analysis of AR's impact in the substitutional enterprise modeling technique, service blueprint, is considered as successful.

Research question: **"Can enterprise modeling techniques analyze the impact of augmented reality on the buyer-seller relationship? "**

Enterprise modeling techniques can analyze the impact of augmented reality on the buyer-seller relationship. The Value Management Platform was able to analyze this in both process- and customer oriented cases. BPMN was only suitable to analyze it within process oriented cases and its usage depends highly on the content of the case. Service blueprint has proven itself to be a valuable enterprise modeling technique when augmented reality has an impact on the customer experience. When a particular enterprise modeling technique is not able to analyze the impact of augmented reality in a certain context, like BPMN in a customer oriented context, another enterprise modeling technique, like service blueprint, can be used as a substitute. This is why the research question is answered positively. In addition, all three used enterprise modeling techniques are considered as complementary as well.

8. Conclusion

The main goal of this Master's Dissertation has been to analyze the impact of augmented reality on the buyer-seller relationship. Three cases have been researched to discover the effect of this impact. These cases were real-life, practical cases and were executed together with Maersk, Duracell and Texet. The impact of AR on the buyer-seller relationship has been researched by enterprise modeling techniques. The used values have been based on real-life numbers, literature and in some occasions assumptions. The used enterprise modeling techniques were the Value Management Platform and Business Process Model and Notation for the Maersk and Duracell cases and the Value Management Platform and Service Blueprint for the Texet case.

The general research question has been whether "enterprise modeling techniques can analyze the impact of augmented reality on the buyer-seller relationship?". The answer is yes for all three cases. The Value Management Platform was able to analyze this in both process- and customer oriented cases. BPMN was only suitable to analyze it within process oriented cases and its usage depends highly on the content of the case. Service blueprint has proven itself to be a valuable enterprise modeling technique when augmented reality has an impact on the customer experience. When a particular enterprise modeling technique is not able to analyze the impact of augmented reality in a certain context, like BPMN in a customer oriented context, another enterprise modeling technique, like service blueprint, can be used as a substitute. This is the reason why the research question is answered positively. In addition, all three used enterprise modeling techniques are considered as complementary as well.

As for future research, multiple areas can still be explored. Firstly, the cases illustrated in this Dissertation could be applied to new, yet similar cases in order to determine whether the above statements are correct. Secondly, the impact of AR could be modeled in a transitional way to avoid one of the limitations of this research, which is that AR is directly implemented in the TO-BE situation without taking any transitional phases into account. Thirdly, a practical field research of the cases could be executed. For example, researchers could wait in time or evaluate the implementation of AR after a few years. By doing so, it could be verified whether the models of the enterprise modeling techniques were accurate and have a practical similarity.

Given these provisions, this Master's Dissertation hopes to contribute to the domains of enterprise modeling, augmented reality, value creation and business transformation.

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