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# Augmented Reality Try-On Adoption in the Online Clothing Industry: Understanding Key Challenges and Critical Success Factors

Master Thesis

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## ABSTRACT

Augmented Reality in fashion retail is expected to be utilised more widely over the next years; however, research on effective adoption procedures from an organisational standpoint is still rare. The purpose of this paper is to identify key challenges and critical success factors that determine the effectiveness of AR try-on implementations by firms in the online garment industry. Three perspectives are considered, namely brands, online retailer and consulting industry experts. Building on Grounded Theory methodology, qualitative interviews were conducted with the experts in the field. The analysed insights were additionally wrapped in a survey and related by each participant in a second data collection round. Based on the data, a respective adoption framework was designed, describing the factors' underlying connections and their contribution to effective adoption. Overall, six key challenges have been obtained from the interviews, originating from market-related, technology-based and firm-specific issues. To cope with such, six critical success factors are outlined, namely vision & strategy, holistic underlying processes, user interface & communication, customised tech solutions, supply chain involvement, as well as change management. The study contributes knowledge on the comparatively new but quickly emerging field of Augmented Reality try-ons and extends adoption literature on industry 4.0 technologies by examining the understudied organisational view. It further highlights the importance to handle potential challenges with operational measures from within the company. For practitioners, first guidance is provided to develop suitable strategies and sustain an effective Augmented Reality adoption by better understanding potential challenges and respective critical success. Furthermore, fields for future research are outlined and precise contributions discussed.


**Keywords** Augmented reality, Virtual try-on; Critical success factors (Firm); Challenges; Technology adoption; Fashion; Clothing trade; Electronic commerce

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| | |
|---|---|
| AR | Augmented Reality |
| GT | Grounded Theory |
| SSI | Semi-structured Interviews |
| CSF | Critical Success Factors |

## 1. INTRODUCTION

Fashion is considered one of the world's major industries, generating $2.5 trillion in global revenues a year (Amed et al., 2018). However, projections for 2020 have been little optimistic due to disrupted financial markets and an expected economic growth rate decline by 1 to 2 percent year-on-year (Amed et al., 2019). With the outbreak of the worldwide COVID-19 pandemic, markets got even less predictable and arbitrary (Amed et al., 2020). Physical distancing and nation-wide lockdowns have resulted in a remarkable shift of more than 10 percent from physical to digital shopping since the start of the pandemic (Arora et al., 2020; see also Nosto, 2020), and new purchasing habits are expected to persist to a certain extent as offline stores fully reopen, permanently emigrating a certain percentage of brick-and-mortar sales to e-commerce (Amed et al., 2020; Arora et al., 2020; Gonzalo et al., 2020). The highlighted importance of digital channels as a primary way to connect to the consumer is urging retailers and brands to concentrate on the creation of digital interfaces most compelling to their user base (Arora et al., 2020; Embodee, 2020; Gonzalo et al., 2020). The upcoming generations of digital natives have already been more demanding than in the past, expecting memorable shopping experiences with high levels of personalisation and engagement beyond the purchase itself (Evans, 2018; Kahn et al., 2018; Lane, 2019). Adjusted consumer behaviours established during the crisis (see Arora et al., 2020; Bianchi et al., 2020) are reinforcing those demands, pressuring firms to start experimenting and engaging with immersive technology to survive in the new, highly challenging market settings (Singh & Thirumoorthi, 2019; Amed, 2020; Roberts-Islam, 2020a).

One immersive technology gaining increasing attention in this context is Augmented Reality (AR). Through the utilisation of viewing devices like smartphones or tablets, it changes the perception of the physical world by overlapping its real surroundings with virtual elements in real-time, allowing to bridge the gap between digital and physical shopping (Caboni & Hagberg, 2019; Cosco, 2020). These features facilitate the providence of 'try-before-you-buy experiences that allow users to make smarter purchasing decisions online (Harrisson-Boudreau, 2017; Tavolieri, 2019) and are considered helpful to solve one of the industry's major issues with online purchases – the so-termed suit & fit dilemma (see Pachoulakis & Kapetanakis, 2012). Classified in the category of high-involvement products, garments are desired to be touched, seen and tried on for a valid evaluation of their material and fit (Workman, 2010; Merle et al., 2012). While e-commerce is prone to be a convenient, time-saving way to shop from a broader collection of items without geographical constraints, it lacks the providence of sensory and tactile assessments (Beck & Crié, 2018; Zhang et al., 2019). Humans come in all shapes and sizes and with different tastes and preferences, which increases the challenge to sell properly fitting garments that are at the same time matching the personal predilections of the individual. The guesswork if an item fits and suits one's body turned out to be the shopper's most fundamental concern when purchasing clothing online (Pachoulakis & Kapetanakis, 2012; Lin & Wang, 2016; Morgan Stanley, 2018). More customers than in any other e-commerce segment struggle to pick the 'right' product which is reflected in feeble conversion rates (Chaffey, 2019; Coleman, 2019; Monetate, 2019), a nearly 70 percent average of cart abandonments (Baymard Institute, 2019) as well as massive product return volumes (Jack et al., 2019; Roberts-Islam, 2020b). To cope with issues on size and favour, which are, among other things, induced by missing global standardisations, clothes are intentionally over-purchased by shoppers, and more than half of all online orders get partly or fully returned (Sender, 2017; Cullinane et al., 2019; Reagan, 2019; Charlton, 2020).

This habit causes significant economic and environmental issues. Free delivery and return policies are considered key battlegrounds for competing online merchandiser despite their causation of massive business expenses resultant from shipping, processing and the disposal of ordered items (Sender, 2017; Cullinane et al., 2019). In average, just about 70% of the returned high-level garments can be restocked and resold while the rest has to be recycled, donated or thrown away, causing further economic losses (Reagan, 2019). Besides the squandering of resources, over-purchasing raises the need for new logistic centres, increased last mile deliveries and additional amounts of packaging materials. Consequences are heavier air and noise pollutions, the destruction of natural resources and greater waste production, causing further challenges on their own (e.g. Mangiaracina et al., 2015; Cullinane et al., 2019; Mangiaracina et al., 2019). The outlined economic and environmental issues could be mitigated with shoppers making smarter purchasing decisions due to the providence of augmented 'try-before-you-buy' experiences and more detailed, interactively presented product information. This would also be in line with the consumers' "*growing antipathy toward waste-producing business models and heightened expectations for purpose-driven, sustainable action*" (Amed et al., 2020; also Roberts-Islam, 2020a,d).

A rising number of fashion firms has already started to investigate the potential of AR try-on technology online. However, as shown by overviews of Watson et al. (2018), Caboni & Hagberg (2019) as well as Heller et al. (2019) the majority of applications is found in the segments of footwear, accessories, eyewear and beauty. For clothing, AR adoption still seems to be rare and almost exclusively applied in offline settings (see Poncin & Mimoun, 2014; Boletsis & Karahasanovic, 2018; Perry et al., 2019; Boardman et al., 2020 for offline examples). This raises the question why especially the garment industry hesitates to apply Augmented Reality solutions to their online channels despite their potentially high impact. While more and more scientific studies are examining the impact of AR in retail (see Caboni & Hagberg, 2019), knowledge on the technology's implementation criteria in the study's respective context is still lacking. Previous research on Augmented Reality mainly focusses on the adoption willingness of consumers as well as the technical background of AR applications, whereas research on how to implement AR at firm-level is rare. To the author's knowledge, a very restricted number of studies have examined adoption challenges and necessary preconditions that businesses are facing in the implementation process of Augmented Reality, and there are no studies yet addressing the clothing e-tail segment in particular. The present research follows the purpose to close this knowledge gap by providing new insights on critical adoption success factors that determine the effectiveness of AR implementation in the garment industry. Besides adding to extant knowledge, the gained study results have the potential to provide guidance to practitioners in the AR adoption process and can improve the understanding of the technology's deployment within the clothing segment.

The following two questions state the basis of this research:

*RQ1: What key challenges are being faced by firms in the online clothing industry when adopting Augmented Reality try-ons?*

*RQ2: What are the critical success factors for sustainable adoption of Augmented Reality try-ons by firms in the online clothing industry?*

The framework chosen to build the foundation of this study is the Critical Success Factor model by Leidecker & Bruno (1984). Due to the lack of respective studies and significant theoretical guidance, the current research is building on Grounded Theory as methodology in order to seek new insights and clearly understand present challenges and success determinants clothing e-tailers are facing in AR implementation processes. Qualitative interviews with experts in the field have been conducted and the analysed insights, compressed in a survey, were additionally related and ranked by all participants in a second data collection round.

The present research is composed of five chapters. Chapter 2 describes the concept, potential and technological state of AR-based product visualisations in clothing e-tail as well as the Critical Success Factor framework utilised as the research's theoretical foundation. Chapter 3 outlines the study's research methodology, its structure and the applied qualitative procedures. Thereafter, chapter 4 presents, analyses and discusses the insights gained from the data, including the developed conceptual framework as well as further findings obtained from the interviews. The last chapter concludes the paper and highlights research implications, limitations and future scope.

## 2. THEORETICAL BACKGROUND ON AUGMENTED REALITY IN FASHION ONLINE RETAIL

The respective chapter provides the theoretical baseline for the conducted study results by ensuring a common understanding on the concept, variations and technological state of Augmented Reality based product visualisations in clothing e-tail as well as their associated potential. Moreover, the study's underlying Critical Success Factor framework is presented, together with its attached procedures and linkages to former research in the respective field of Augmented Reality adoptions.

### 2.1. The Concept of Augmented Reality

As presented in *Figure 1*, Augmented Reality represents a subsection of Mixed Reality by being neither entirely physical nor creating a solely artificial environment. Instead, the user's reality is expanded by digital information that can be interacted with in the context of real-life surroundings (Suh & Prophet, 2018; Watson et al., 2018). By being a technology that is "*characterised by [its] symbiosis with other media platforms in which its features are embedded*" (O'Mahony, 2015, p.232), AR utilises subtype

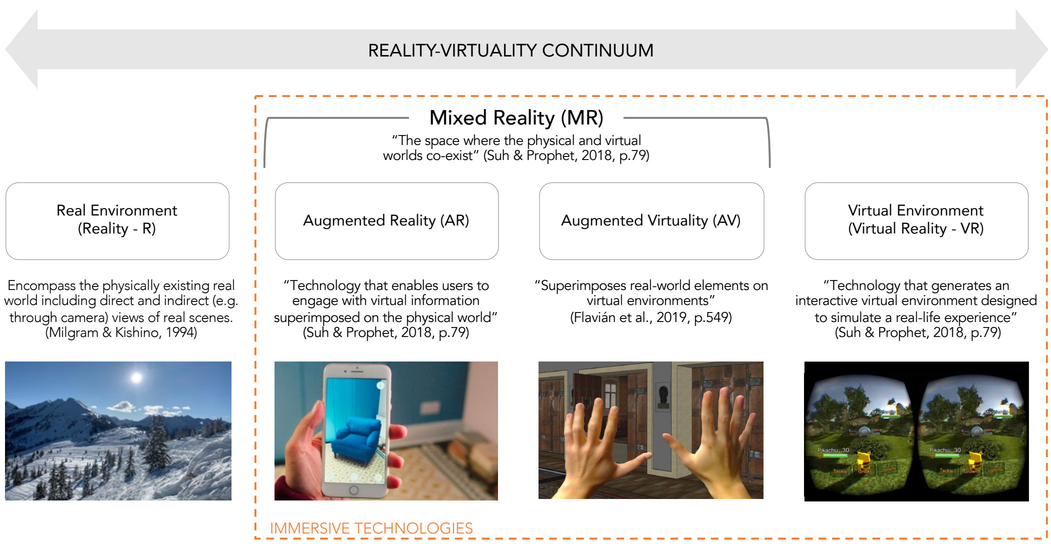
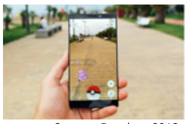
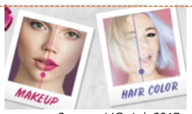
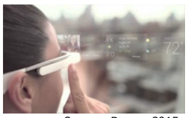
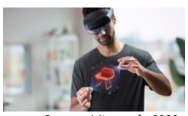



*Figure 1: AR Embedment within the Reality-Virtuality Continuum (own illustration)*

technologies and appears in a variety of forms as well as in a wide range of industries, reaching from entertainment over healthcare to military (see Heller et al., 2019, and *Table 1* for further examples). So far, there is no entirely uniform categorisation of existing AR technologies, but the most common distinction is currently made between the two overreaching categories of trigger-based and view-based augmentation, further defined in *Table 1*. While for fashion in general, AR is applied in many diverse forms (see e.g. Logaldo, 2016 for further details), it is primarily deemed to be a consumer-facing technology in online settings (Bonetti & Perry, 2017; Boardman et al., 2020) and mostly appears in the form of virtual try-ons or interactive product visualisations. By commonly deploying marker-based, generic or, more recently, dynamic AR (see *Table 1*), those applications are enabling consumers to utilise their smartphones to virtually try-out and visualise products prior to purchase and from any place of convenience (Caboni & Hagberg, 2019).

*Table 1: Typology Overview of Currently Defined AR Types (own illustration based on the author's elaboration)*

| | Type | Characteristics | Example | | References |
|---|---|---|---|---|---|
| TRIGGER BASED | Marker-based AR | It works with the help of image recognition and is activated by physical labels. Marker-based AR requires a unique and simplistic visual element in the environment (e.g. a QR code) that can be scanned to reveal additional digital information. |  *Source: Villeroy&Boch, 2020* | Villeroy & Boch AR App<br>All listed products hold a specific AR marker that can be printed and then positioned at any desired spot to be replaced with a virtual 3D version of the selected product. | *Edwards-Stewart et al., 2016; Prabhu, 2017; Collins, 2018; Aggarwal & Singhal, 2019; Poetker, 2019 Sarvaiya, 2019; Joshi et al., 2020* |
| | Location-based AR | The user's real-time location is dynamically matched with potentially interesting AR content retrieved from the apps backend or cloud servers by utilising means like GPS, compass, accelerometer or suchlike sensors pre-included in the applied device. Often referred to as marker-less AR. |  *Source: Poetker, 2019* | Pokémon Go App<br>Diverse Pokémon characters are placed at specific locations and displayed through the user's smartphone once such sites are reached. | *Edwards-Stewart et al., 2016; Prabhu, 2017; Poetker, 2019; Sarvaiya, 2019* |
| | Dynamic AR | Motion tracking sensors are utilised to ensure high responsiveness to changing or moving physical objects. Real-world images are detected and overlaid with digital media that has been scaled before to fit the identified items. It is seen as the most responsive type of AR. |  *Source: L'Oréal, 2017* | L'Oréal Paris' Virtual Makeup Tool<br>Allows users to virtually try-on hair colour and makeup products by either uploading a photo or trying the live try-on button that utilises build-in device cameras. | *Edwards-Stewart et al., 2016; Sarvaiya, 2019*<br>Most suitable for AR try-ons |
| | Complex AR | The dynamic view is extended with information pulled from the internet, which are linked to markers, the user's location and/or the recognition of specific objects. |  *Source: Ranes, 2015* | Google Glass (Smart Glasses)<br>A head-mounted display (glasses) that uses GPS to add virtual information to objects in the user's vision (e.g. names of historical sites) or lets access maps, calendars or other applications by voice commands. | *Edwards-Stewart et al., 2016* |
| | Outlining AR | Relies on object recognition and carries the primary purpose of recognising and highlighting contours and boundaries in the user's direct surroundings that are difficult to be detected by the human eye itself. |  *Source: Poetker, 2019* | Head-up displays in car windshields<br>Road boundaries or barely visible pedestrians are outlined in foggy weather or low light conditions to avoid accidents and increase safety. | *Prabhu, 2017; Collins, 2018; Poetker, 2019* |
| VIEW-BASED | Superim-position-based AR | Provides an alternative view of a concerning physical object within the user's environment by fully or partially replacing it with a digital image. In other words, the original view of an object is replaced by a newly augmented one, relying on object recognition techniques. |  *Source: Hong, 2019* | Augmented X-Ray Views – Healthcare<br>By using special glasses or other head-mounted displays, a virtual X-Ray view is superimposed on the patient's physical body part to provide better visualisation of tumour locations or damage to bones. | *Prabhu, 2017; Collins, 2018; Aggarwal & Singhal, 2019; Poetker, 2019; Sarvaiya, 2019; Joshi et al., 2020* |
| | Generic/ Non-specific AR | Compared to the other forms of AR, users are provided with the flexibility to render their desired 3D objects and place them on actual spaces without reference to the user-specific surroundings or conditions. |  *Source: Ikea, 2020* | Ikea Place App<br>Preselected items from the online catalogue can be virtually "placed" in real size/ proportion within the user's home to be checked for fit and favour. | *Edwards-Stewart et al., 2016; Sarvaiya, 2019* |
| | Projection - based AR | Instead of projecting digital content on a device screen, it is directly projected onto a surface or object of choice via light. By doing so, it creates 3D objects, precisely holograms, which users can interact with. |  *Source: Microsoft, 2020* | Microsoft Hololens 2<br>AR glasses that creates holograms users can interact with, virtually take apart, examine from different perspectives and so on. | Prabhu, 2017; Collins, 2018; Liao, 2018; Aggarwal & Singhal, 2019; Poetker, 2019; Joshi et al., 2020 |

## 2.2. Augmented Reality Try-Ons and Product Visualisations in Online Retail

While AR can be utilised in various business areas (Cranmer, 2017; Cosco, 2020), the focus of the present study lies on its product presentation features, aiming to bridge the gap between physical and digital shopping. In the context of clothing e-tail, AR visualisations fall under the category of image interactivity technologies (IIT) and can benefit interactions with both consumers as well as corporate buyers due to their high level of engagement and the providence of more detailed product information (Merle et al., 2012; Caboni & Hagberg, 2019). The applications of focus differ slightly in their purpose and will be examined separately since some are solely visualising an item's look, allowing users to assess personal mix-and-match styles more comprehensively, and others, are additionally incorporating predictions on a garment's actual size & fit. Common to both is the indispensable availability of digital, three-dimensional renderings of garment items intended to be utilised for the augmented experience.

*3D asset generations as a crucial precondition for utilising AR software:* The fashion industry is built on a 'pen and paper' mentality which constitutes, together with the still common practice of physical product samplings, an obstacle when it comes to the idea of implementing AR. Even brands that are already designing their products digitally are often facing compatibility issues when the resolution of digital design files is too extensive, or their format is not matching the one required to run the AR software (Cribbie, 2017; Embodee, 2020). Besides the costly and often time-consuming option to self-construct an integrated pipeline for the generation of 3D assets, there is a growing number of businesses offering tools and services to address the issue of product digitisations (Basnet, Beauchamp et al., 2020; Embodee, 2020). Over the past five years, photogrammetry software and 3D scanning have made significant advancements, and current technology allows to build detailed three-dimensional models and holograms true in dimension and realistically visualising an item's material characteristics (Tamuly, 2020). Some of the extant scanning firms (e.g. *Vizoo*) are specialised on digitising the utilised material's and their textures, which is particularly useful for those fashion companies already creating their products in digital design software like *CLO* or *Browzwear* and building on comprehensive digital libraries with photorealistic 3D visualisations of all utilised fabrics and clothing materials. Other firms offer the creation of 3D models for already produced items, either by scanning the physically present product on-site (e.g. *SCANBLUE* or *th3rd*) or by utilising recorded 360-degree videos (e.g. *NexTech AR Solutions*) and 2D images capturing the product from diverse angles (e.g. *CGTrader*). There are also more advanced solutions, like by *The Fabricant*, that are additionally animating the 3D scans to visualise how a garment behaves in motion (Your Majesty, 2019). Besides a smarter use of materials and a shorter time to market (The Interline x CLO, 2020), these 3D assets pave the way for AR try-ons since the digital garments can be projected into virtual environments.

*AR try-ons for look & style visualisations:* Once the intended garment products are digitised and available in 3D, they can be displayed with the help of Augmented Reality. AR visualisations are enabling online customers to gain more comprehensive information on digitally presented products by projecting virtual 3D objects either in the users own physical spaces (embedded experiences) or on their camera-captured bodies (virtual try-ons). First serves the primary purpose of observing a presented garment more realistically and in greater detail since the virtual, mostly static objects can be rotated and zoomed in to be assessed from all perspectives (McCormick et al., 2014; Bonetti et al., 2018).

Besides enhancing the user's impression of how a garment might feel and appear in the real world (Embodee, 2020), this also allows checking for colour and style variations with already owned garments, like a user's favourite pair of jeans (Darling, 2019). From a technological perspective, such static 3D visualisations of single fashion products are already fully feasible and applied by a growing number of brands, mostly in the segments of accessories and footwear though. Beyond their 360-degree visualisation, it is currently possible to configure the scaled holograms by swapping out single components like a sneakers' soles or laces, or adding individual embellishments (see e.g. *Embodee* or *NexTech AR Solutions*). In general, such AR visualisations can vary in quality as not every usage intention requires the same level of texture accuracy. In some cases, the colour and true-to-size dimensions of a product are more relevant than its detail of stitching which might be considered upfront since it determines a 3D asset's creation effort and price point (Basnet, Beauchamp et al., 2020).

Projecting digital 3D garments on a user's camera-captured body constitutes the secondly mentioned form of style visualisation try-ons and is of greater complexity. Similar to commonly known AR lenses popularised by *Snapchat* (also referred to as AR face filters, see Arcangel, 2018), it picks up the features of embedded AR experiences, but further projects the scaled garments either on a 2D full-body picture of the user and therefrom created static holograms (e.g. *Zeekit*), or it dynamically visualises them right on the user's body or one's personal avatar. On-body visualisations are, for instance, provided by companies like *Fitnect* or *Zugara* and work by projecting scaled 3D garments dynamically and in real-time on top of the user's camera-captured physical body (Kang, 2014, Gill, 2015*)*. Personalised avatars, in turn, are projected in the form of dynamic holograms in the users' camera-captured sight, and in place of seeing the digital garment on the own body, they are worn by an individualised avatar. The virtual figures are usually holding a user's personal characteristics like their gender, age, hair colour, approximate body shape, height, and even their dynamic facial expressions as captured in real-time by the camera (Beck & Crié, 2018; Bonetti et al., 2018). Recent applications like offered by *HoloMe* or *8th Wall* are providing increasingly realistic presentations since the created avatars are looking more like photorealistic copies of the consumer's physical appearance rather than animation characters common in earlier applications (e.g. *triMirror*). Both of the mentioned forms of dynamic AR try-ons (on-body, on avatar) are in the focus of the study at hand and rely on motion-capturing systems that track a shopper's movements (Kang, 2014). Their underlying concept allows shoppers to virtually choose and 'try-on' preferred clothing items in real-time, adjust style and colour, arrange self-chosen outfits sharable via social media channels and navigate back and forth on-screen by merely using hand gestures (Zhang et al., 2019; Kaewrat & Boonbrahm, 2019). Some of the applications also incorporate a fabric's physics like its stretch capabilities (see e.g. McCormick et al., 2014, p.76) or its behaviour in motion (see *The Fabricant*) to ensure a more realistic interaction with the digitally presented clothes.

AR try-ons for style purposes were already recommended eight years ago as a way to effectively address suit and fit issues of online shopping (e.g. Pachoulakis & Kapetanakis, 2012) and meanwhile, there is a growing number of software-developing companies creating diverse AR try-on solutions to ensure a virtual fitting room experience (see CDI, 2020; Fortune Business Insights, 2020 and Stratagem Market Insights, 2020 for an overview of the current key players in the global virtual fitting room market). From an integrational standpoint, advanced options to smoothly embed AR visualisations in a firm's e-commerce platform are evolving, eliminating the necessity to download a software or app. Such integrated webAR solutions work by loading an item's linked 3D image into a native AR viewer that enables the user to visualise the desired product in their own space without the need to buy and install new software upfront (Basnet, Beauchamp et al., 2020). It also carries several further advantages, as outlined by Iram (2017). An exemplary company providing adjustable webAR solutions is *8th Wall*, and e-tailer like *Shopify* are already sourcing such services to offer their utilisation to corporate customers. Advertising platforms as Google, Unity, Facebook or Snapchat are also holding webAR applications for fashion firms that are ready to use. However, an issue with their utilisation arises from the diverse 3D-file format requirements each of the respective platforms has. To create AR experiences, the existing, digitally designed manufacturing files usually have to be optimised and converted first to match the required conditions. There is a small but growing number of software firms (e.g. *VNTANA*) offering to solve those compatibility issues with the help of software that is automatically optimising and converting digital manufacturing files into a range of compatible webAR formats. Such tools could replace the inefficient but still common practice of assigning internal designer or external agencies with rebuilding the same garments from scratch in a different format and are thus, help facilitating an adopting at scale.

Despite the significant technological advances and the increasing number of offered services, it has to be mentioned, that particularly dynamic AR try-on applications on the human body are not completely matured yet and still partly rough in their execution (Gill, 2015). The majority of currently existing applications for visualising a garment's style and look does not yet create an entirely realistic feeling of wearing a garment item because the superimposing of clothes is done in a rather artificial manner and partly deliver the impression of a digital mask (Boardman et al., 2020). One main issue to developers is to align the visualisations to the shopper's movements, like relevant for dynamic augmentations. When viewed head-on, facing the camera, the projected garment usually fits nicely on the user's body but tends to drift off the sides or up and down when changing the angle. Moreover, applications embedding advanced physic engines, to enable sophisticated animations and determine how garments will bunch, stretch or sway when the shopper moves around, are still very rare (Nichols, 2019). Yet, Scholz & Duffy (2018) found that e-tailing managers should not worry about the lacking maturity of dynamic AR try-ons. While augmentation quality is in fact of importance for the user's enjoyment of an AR application (Poushneh, 2018), it just has to be relatively well-executed and user-friendly, but not perfect to be successful. AR try-ons are not mainstream yet, and online customers were found to forgive minor imperfections and to credit brands and e-tailers a certain leeway (Scholz & Duffy, 2018). Moreover, industry experts state that AR technology will develop significantly over the next five years, allowing to incorporate precise size and fit measurements and thus, further bridge the gap between digital and physical shopping (Basnet, Beauchamp et al., 2020).

*AR applications for size & fit predictions:* Besides try-ons following visualisation purposes to mix and match garments and assess their fit to a person's look, there are growing efforts towards additionally including size indications that would ensure the actual fit of a garment to a person's body measurements. In an ideal situation, the shopper's measures are captured true-to-size by advanced 3D body measuring software, and perfectly overlaid by accurately sized 3D garments, indicating where on the user's body a garment sits loose or tense. That would allow representing an experience very close to physical try-ons. In practice though, these procedures still lack perfection and a garment's correct fit on the human body is currently still questionable, even though measuring technologies and their performance accuracy are rapidly enhancing (Morgan Stanley, 2018; Kaewrat & Boonbrahm, 2019). Researchers as Sheikh et al. (2019, p.17) also state that "*predicting size and fit on a personalized level has gained momentum in the research community*" and further outline some of the recent developments on this subject utilising deep learning systems and artificial intelligence for enhancing the quality of fit. Nevertheless, despite the existence of fairly advanced offline applications in brick & mortar stores that are utilising cameras with in-build laser technology (e.g. *triMirror* and *FXMirror*), and the availability of easily integrable body scanning systems suitable for e-commerce platforms (e.g. *MySizeID™*), there are no dynamic online applications of AR yet precisely and automatically accessing a person's body measurements and solidly predicting a garment's fit. Extant tools rather create size-customised avatars and virtual holograms of the shopper's body onto which the garments are projected. This is done by requesting data in the form of personal sizing information and shape characteristics directly from the user or by utilising a series of 2D selfies the user has taken and uploaded (e.g. *Reflective Reality*; *Metail*, *meepl, Lalaland,* or *triMirror*). With the help of colour-based fit indicators, which are incorporating both the provided body details as well as the fabric's physical properties like its stretch capabilities, it is then indicated how a garment fits on the user's body avatar, for instance, by utilising heat maps that mark tight-fitting areas in red colour (see triMirrorTV, 2015).

***Summary***: Taken together, it can be said that from the technological perspective the generation of 3D assets as well as AR visualisations of embedded, static 3D garments in physical spaces seem to be performing well and can be utilised already by brands and e-tailer. Dynamic try-ons and especially those involving projections on the human body are also sufficiently working in the segments of accessory and footwear, but still lack maturity for clothing. Researchers, as Scholz & Duffy (2018) recommend to utilise them anyway as consumers were found to forgive imperfections due to the novelty of the provided experience. Industry experts consent with this and emphasise the need to start experimenting with AR already to be prepared when the technology is matured enough, as expected to be happening within the next five years (Basnet, Beauchamp et al., 2020; Basnet, Burgar et al., 2020a, b). The combination of ongoing technological advancement and growing research attention will also make AR try-ons incorporating size predictions more feasible, and might ultimately lead to a holistic and affordable solution conveniently combining all steps required for enabling smooth AR experiences, reaching from a garment's digital design process over smooth webpage integrations up to a realistic presentation on the human body. Until then, the choice how and with which partners AR implementations are approached technology-wise depends on the present state of a firm's digital infrastructure and how digitisation efforts are distributed between supplier, brand and e-tailer (Embodee, 2020).

### 2.3. Attributed Potential of Augmented Reality Applications in Online Retail

AR try-ons are gaining growing attention in online retail, due to their attributed advantages for both user and firm. By offering comprehensive product information in a more intuitive, enjoyable and entertaining way and with a stronger relation to those obtained from physical garments in stores, an implementation allows e-tailers to provide customers with more extraordinary and more natural online purchasing experiences (McCormick et al., 2014; Yaoyuneyong et al., 2016; Poushneh, 2018; Suh & Prophet, 2018). With the chance to involve closer with a product's physical features, the user's confidence increases that a selected item really fits and matches one's individual needs, enabling wiser purchasing decisions and enhancing the user's willingness to buy (Poushneh & Vasquez-Parraga, 2017; Caboni & Hagberg, 2019; Perannagari & Chakrabarti, 2019; Smink et al., 2019; Basnet, Beauchamp et al., 2020). Further, digital products visualised with AR provide the value of new configuration possibilities to customise colour and variation of garment components easily, which is especially beneficial as customisation attaches extra meaning to products and has been linked to fewer returns (O'Brien, 2019; Basnet, Beauchamp et al., 2020; Basnet, Burgar et al., 2020a,b; Roberts-Islam, 2020b). It would also ensure to collect richer customer data, allowing a deeper understanding of the users' purchasing behaviours and the providence of customised content (Caboni & Hagberg, 2019; Smink et al., 2019).

Besides, businesses benefit from the possession of a new tool for an interactive, more organic advertisement that differs quite strongly from the existing methods towards which consumers already got insensitive and enables to engage with them before, during and after a purchase (Caboni & Hagberg, 2019; McDowell et al., 2020). Augmented content offers room for spacial storytelling that goes beyond advanced product visualisations and turns the product into a salesperson to, for instance, communicate the brand's mission (Basnet, Beauchamp et al., 2020; Cosco, 2020; McDowell et al., 2020). By utilising AR try-ons, fashion firms can further expand the user's possibilities to socially connect and interact since feedback and reviews on tried-on garments and looks can be directly obtained, shared or discussed through social media channels (McCormick et al., 2014), satisfying the human need for social interaction and making consumers feel closely related to the products and the brand (Brengman et al., 2018; ThinkMobiles, 2019). While playing and interacting with the virtual 3D garments, users are likely to dwell for longer on a firm' website (Basnet, Beauchamp et al., 2020) which offers, particularly for early adopters, the chance to build stronger brand-consumer relations and enhance customer loyalty if the applications are sustained well in the long run (McCormick et al., 2014; Bonetti et al., 2018; Caboni & Hagberg, 2019). Strengthening one's social media presence by utilising AR, also comes with the opportunity to increase the brand's general awareness and reach new or broader audiences (Nguyen et al., 2015; Cranmer, 2017; Caboni & Hagberg, 2019; Basnet, Beauchamp et al., 2020).

Those hedonic and utilitarian advantages of AR can provide a massive opportunity for greater conversion and sales (McCormick et al., 2014; Boletsis & Karahasanovic, 2018; Caboni & Hagberg, 2019; Perannagari & Chakrabarti, 2019) and less costly product returns thanks to a higher certainty in the purchasing decisions making process (Pachoulakis & Kapetanakis, 2012; Cranmer, 2017; Bonetti et al., 2018; Basnet, Beauchamp et al., 2020). While a growing amount of academic studies have already validated such benefits, performance numbers of AR try-on applications in practice are still rather rare and shared reluctantly, due to the novelty and experimental status of the technology. *Tenth Street Hats* is an exemplary online brand effectively exploiting the advantages of AR try-ons. The firm tested the application for its bestselling products and noted a 33% increase in its average conversion rate as well as a 74% increase in consumer engagement (Roshitsh, 2018; Taylor, 2018, Williams, 2018). *Doti.lt* experienced similar benefits (see PRNewswire, 2019) and also e-tailer like *Shopify* reported an *up to* 2.5 times increase in conversion for those of their buyers utilising the offered AR software (Basnet, Beauchamp et al., 2020, 00:14:22; Embodee, 2020).

Besides provided user benefits that at best result in increased sales and firm revenues, AR and its foundation of 3D assets can also support brands with decreasing internal production costs and boosting efficiency, especially if holistically applied from design over advertisement to sales (Basnet, Beauchamp et al., 2020). Moving away from physical pattern creations and shortening the design processes by using digital prototypes, allows to save time and mayor costs during product creation and gets products quicker to market by also reducing the firm's environmental footprint thanks to less sampling waste (Barrie, 2013; Cranmer, 2017; Zha, 2018; The Interline x CLO, 2020). With digitising the design process and delaying the need to produce a garment physically until it is displayed or sold, pattern creation is becoming much more size-accurate and faster. Design teams can also be more flexible and diverse in prototyping new items as they are no longer restricted to the availability of sampling materials (The Interline x CLO, 2020). There is also the opportunity to partly replace product photography on human models with virtual photo studios using CGI photography and photorealistic rendering which has gained particular attention during the COVID-19 pandemic (see Gonzalo et al., 2020; Roberts-Islam, 2020a, b) and allows to generate photos of infinite amounts of colour and variation that are quickly configurable and possible to be reused over and over again for varying purposes (Basnet, Beauchamp et al., 2020). Utilising 3D assets in combination with AR further provides the opportunity for digital B2B sell-ins where items can be presented to buyers and wholesalers via virtual showrooms, enabling digital fitting sessions and reducing the massive amount of physical product samples usually produced exclusively for those sales negotiations (The Interline x CLO, 2020; Amed et al., 2020). While the physical sample is unlikely to disappear entirely due to the provided assessment of a fabric's touch, their amount can still be drastically reduced by just bringing one physical sample of a specific pattern cut and presenting colour and style variations of it digitally. Selling garment items before they are being produced also offers the possibility to let buyers and/ or consumers self-configure special features as a shirt's colour, and generally allows to incorporate their provided design feedback easily or react to a lack of purchasing interest with adjusted style modifications that prevent unpopular garments from ending up on landfills, harming both nature and a firm's sustainability objectives (Basnet, Beauchamp et al., 2020; Embodee, 2020).

Despite their noted range of utilisation potentials, AR applications are still comparatively rare in the online segment of clothing. Like with any IT innovation, pioneering with AR comes with risks and costs (see Cranmer, 2017). However, if the technology's features are utilised wisely and thoroughly, those initial investments can be more than offset by exploited potentials (Pantano, 2016; Basnet, Beauchamp et al., 2020). To be able to do so, the present study aims to identify critical challenges clothing e-tailers are facing in the adoption process and outline success criteria that are essential to be considered for the technology's implementation.

### 2.4. Critical Success Factor Identification for AR Technology Adoptions

As outlined in the previous section, the implementation of Augmented Reality does not just have the potential to provide a significant number of benefits to clothing e-tailers but also reached a functional level of sophistication from a technological standpoint that enables a simplified and broader adoption compared to a few years ago. However, the number of AR application in the clothing sector is still somewhat limited and in order to identify the reasons behind the decelerated diffusion, key challenges and related critical success factors of AR adoption in the garment industry are aimed to be identified.

Critical success factors are defined as a small number of key result areas that have to perform well to ensure the firm's competitive performance (Rockart, 1979). The term includes "*those characteristics, conditions, or variables that when properly sustained, maintained, or managed can have a significant impact on the success of a firm competing in a particular industry*" (Leidecker & Bruno, 1984, p. 24). Besides business-controlled areas like those connected to internal processes, managerial strategies or their execution (e.g. Saraph et al., 1989), CSF can also comprise factors outside a manager's control that are critical or important for determining the operational effectiveness of a business project or venture (Belassi & Tukel, 1996). Thus, Leidecker & Bruno (1984) classify the concept of CSF in the three distinguished levels of firm, industry and environmental analysis. Each dimension forms a source for a specific set of potential CSF. While the firm-level analysis focuses on aspects related to the firm's orientation, internal processes and resources, analysing the respective industry addresses factors in the industry's basic structure that are impacting the performance of the on-site operating business. Environmental analysis instead follows a macro approach and covers CSF related to the technological, economic, political and social climates as well as the competitive and their resulting impact on the examined industry and/ or business.

### 2.4.1. Critical Success Factor Framework and Identification Techniques

In the present study, the term 'success' refers to the beneficial value a business and its stakeholders gain through the adoption of Augmented Reality. To identify those determinants critical to the successful implementation of an AR application, Leidecker & Bruno (1984) suggest a range of techniques from which two, the consultation with *industry/ business experts* and the conduction of an *environmental analysis,* are being utilised.

Following *the industry and business expert* approach for the identification of CSF entails the advantage of including knowledge and input from individuals being deeply involved in the clothing industry and related AR technology developments, and thus carrying comprehensive experiences, insights and relevant insider knowledge usually challenging to learn about when following more standardised analytical techniques. Although Leidecker & Bruno (1984) affirm that relying on expert insights provides a rich resource to identify CSF of importance with the help of qualitative data collection method, they still point out its subjective character and the attached risk that the gathered opinion might be biased to some extent. Keeping a clear focus and constantly securing that the 'right' competent sources are asked the 'right' questions and that the 'right' interpretations are drawn, is therefore important while applying this technique (Leidecker & Bruno, 1984). Like many other industries, the clothing sector is also affected by economic, socio-political forces, as recently shown by the present pandemic of COVID-19. Therefore, a macro approach for identifying CSF is applied next to the industry focus in the form of an *environmental analysis*. This technique can be built on a variety of methods to identify influential economic, social and political forces significantly impacting a company's performance (Leidecker & Bruno, 1984). In order to identify and analyse potential macro-environmental factors that are having a significant impact on a firm's performance during the implementation of AR adoptions, the PESTLE framework is adopted (Sammut-Bonnici & Galea, 2015). Compared to the classic PEST analysis it considers legal factors like data protection regulations and environmental factors as trend developments or pandemic influences next to technological, political, social and economic forces which is considered relevant as both showed to be impacting fashion industry practices in the past (e.g. Hobson, 2016; Wolf et al., 2018; Champbell, 2020; Grimson, 2020).

### 2.4.2. Critical Success Factors for Augmented Reality Try-On Adoptions

Most prior research on Augmented Reality try-ons for retail has explored the adoption intention and overall acceptance of the new technology by consumers and related effects on their purchase decision making (Javornik, 2016; Rese et al., 2016; Pantano et al., 2017; Bonetti et al., 2018; McLean & Wilson, 2019; Perannagari & Chakrabarti 2019; Yim & Park, 2019). As AR technology is continuously enhanced, there is also a growing base of literature focussing on technology readiness and technological features and functionalities, especially when it comes to the topic of size & fit (Gill, 2015; Januszkiewicz et al., 2017; Sheikh et al., 2019; Idrees et al., 2020). However, rarely any knowledge exists on common challenges and critical success factors retailer should be aware of in order to sustain the technology's organisational adoption and exploit attached benefits (see Chandra & Kumar, 2018; Caboni & Hagberg, 2019). An exceptions present Chandra & Kumar (2018) who examined factors that influence the organisational implementation of AR in general e-commerce, showing that besides the consumer's readiness, especially internal organisational characteristics as the present technological competence, a company's relative advantage, as well as the provided management support, are crucial for a sustained adoption. To the author's knowledge, there are no studies investigating key challenges and AR adoption success criteria for clothing e-tailers specifically though, neither in the critical success factor literature nor covered by research on technology adoptions. The present study aims to close this research gap and to extend the restricted knowledge in the field of organisational AR adoption by examining what has held back the implementations of AR in the clothing segment yet.

Research on the broader topic of technology diffusion has detected a variety of factors determining the outcome of technology adoptions by firms which might be applicable to this study's focus. Nevertheless, it also manifested that their ascribed influence varies considerably, depending on the examined adoption context. While firm size in some cases is considered to be a crucial criterion due to the assumption that investing in new technology is easier for larger businesses since those have greater slack resources and more comprehensive capabilities to handle potential risks (Zhu et al., 2006; Wang et al., 2010; Kim et al., 2011), other studies disproved such findings (Picoto et al., 2014; Bhattacharya & Wamba, 2015). Hofer and Schendel (1978) also argue that critical success factors usually vary between industries and differ in their influence on a firm's overall competitive position. Therefore, it is considered more reasonable to rely neither on the handful of existing studies on organisational AR adoption success factors which have been conducted in hardly comparable industry contexts like industrial engineering (e.g. Masood & Egger, 2019) or tourism (e.g. Cranmer et al., 2016) and address strongly varying types of AR applications, nor on success factors associated with new technology adoptions in general as the utilisation of those findings might provide the risk of biasing and restricting the investigation of potentially influencing criteria. Alternatively, the topic is approached by applying Grounded Theory as research methodology, which differs strongly from traditional research and is recommended in case sufficient theoretical guidance is lacking (O'Reilly et al., 2012). In place of replicating a research process by first examining existing literature based on which the research problem is defined, hypotheses are built, data is collected as well as analysed, and results and conclusions are reported, in GT a preceding literature review and the initial development of a theoretical understanding are not intended (Mediani, 2017). Instead, the research data is captured at first, and its collection, coding and analysis form a simultaneous process. Based on the gained insights, substantive theories are developed and in a final step linked to and reasoned by consulting prior literature in related areas. By doing so, new theory is generated rather than existing ones tested (Glaser, 1992; Mediani, 2017). Following this approach, it is therefore refrained from conducting a systematic literature review on critical adoption success factors in related areas to enter the research with as little predefined ideas as possible in order to reveal the most significant results (O'Reilly et al., 2012). Both approach and research methodology are further defined and justified in the subsequent chapter.

# 3. RESEARCH METHODOLOGY

As outlined in the previous chapters, Augmented Reality is still an emerging technology, especially in the context of online retail. Research concerning AR try-ons has strongly focussed on the technology's adoption by consumers but mostly neglected the examination of factors that determine the organisational adoption and its valid completion. Due to the lack of respective studies and significant theoretical guidance, this research follows an exploratory approach in order to seek new insights and clearly understand present challenges and success determinants clothing e-tailers are facing in AR implementation processes (e.g. Robson, 2002; Zikmund et al., 2009, Cooper & Schindler, 2013). In the following, the study's methodological foundation, its structure and applied procedures are outlined and explained.

## 3.1. The Study's Research Design & Strategy

A commonly used explorative method is *Grounded Theory* (GT) which is considered a suitable search strategy for the present study (Flick, 2009; Saunders et al., 2009; Milliken, 2010). Since it constitutes a methodology that primarily follows an inductive approach, it already includes an inbuild theoretical framework as it uses the gathered information and insights to progressively construct theory that is grounded into field data (Collis & Hussey, 2003; O'Reilly et al., 2012; Birks & Mills, 2015). Therefore, new theoretical concepts are built from data rather than extant theories are tested, as common for conventional research approaches (Jones, 2005; Engward, 2013; Mediani, 2017). Conducting Grounded Theory is an evolutionary, non-linear process that aims to construct theory from field data and involves comparative, iterative actions and their interplay with the essentially applied methods (Chun Tie et al., 2019). It follows a systematic set of sampling methods and analytical procedures which occur concurrently and in a constant comparative manner, as further outlined in the subsequent chapters. During this process, differences, similarities and interrelations within the collected field data are examined and steadily drafted and solidified towards a holistic theory (Collis & Hussey, 2003; Birks & Mills, 2015; Mediani, 2017). While in its initial form, GT was always required to result in the creation of a fully fledged and elaborated theory, Timonen et al. (2018, p. 4) states among others that in actuality, GT most commonly results in *"greater conceptual clarity, or a conceptual framework, which is short of theory in the sense of a comprehensive system of ideas intended to fully explain and predict something"* and thus, might not cover all stages, aspects, consequences, or the feasibility of a phenomenon or process. This is supported by Bryant (2017, p. 99) who mentions that applying the methodology should lead to the generation of grounded theories, nevertheless, those can also appear in the form of frameworks, models or conceptual schemas. As it has proven its worth in practice, the present study is also going with this definition.

The typical procedure of going back and forth between sampling, collecting and analysing data in GT implies that the final direction of the study is not determined by former literature, as the case in traditional research, but is derived from the insights gained once the first data is analysed. This deductive element in the methodology is referred to as *theoretical sampling* (Glaser, 1992; Mediani, 2017). Due to the specific approach, it is recommended practice in GT to not engage with relevant literature prior to data analysis, as presumptions originating from consulting former literature and the lack of a neutral view might cause the contamination of the emerging insights by concepts rather suited to other study areas and thus, keeps the study outcomes from being solely and genuinely grounded in data (Glaser, 1978; Glaser & Holton, 2004; Simmons, 2006; O'Reilly, 2012; Glaser & Strauss, 2017). However, even though it is recommended in classic Grounded Theory to "at first, literally ignore the literature of theory and fact on the area under study" (Glaser & Strauss, 2017, p. 37), this practice is not fully applicable to present research settings anymore. This issue is mentioned as the study at hand is also exposed to this matter. Institutional conventions, research requirements, as well as philosophical and ethical perspectives, have changed since the methodology's initial development in 1967 by Glaser & Strauss, making the engagement with extant literature a necessity to some extent, especially when it comes to research involving human participants (Charmaz, 2014; Foley & Timonen, 2015; Timonen et al., 2018; Chun Tie et al., 2019; Braun et al., 2019). There are various debates and competing suggestions going on around how to perform GT and what elements and procedures to include (Creswell, Hanson, Clark Plano & Morales, 2007; Chun Tie et al., 2019), which seems to rise the need to clarify to which extent GT is utilised in the present study. Apart from a minimum of prior literature engagement – further justified in the following subchapter on the literature examination methods – all core principles of Grounded Theory were remained in the research at hand though, including its iterative comparative approach to deeply engage with the obtained, context-related data gained through theoretical sampling and theoretical sensitivity, that has led towards building a conceptual framework truly grounded in data (see Timonen et al., 2018). For better comprehension, a visualisation of the research's design can be seen in *Appendix A*.

Grounded Theory was selected in opposition to other exploratory research strategies as it follows the specific goal of generating theory and is therefore considered particularly well-suited for investigating areas that have attracted little to no prior research attention or where former research lacks in depth and/or breadth to provide sufficient theoretical guidance, as both the case with organisational adoptions of AR try-ons (Sousa & Hendrics, 2006; Creswell et al., 2007; Flick, 2009; Saunders et al., 2009; Milliken, 2010; O'Reilly, 2012; Mediani, 2018). It is further recommended to be applied when the examined field of study and the contextual situation is precise in nature, same as when human behaviour or influencing factors within the management and organisational context are aimed to be explored, explained and predicted (Goulding, 2002; O'Reilly, 2012; Mediani, 2017). This has been considered applicable to the present research's focus. Another reason to go with Grounded Theory was its adjudged ability to determine what is actually happening in a specific context by providing insights into complex issues and helping to understand how problematic situations are really experienced and dealt with (Mediani, 2018). Fendt & Sachs (2008, p. 448) state that GT is supportive "*to come skin close to the lived experience and incidents of the management world and make sense of them*" which is expected to lead towards innovative perspectives. As Grounded Theory is a flexible methodology with fluid and holistic processes, it can be readily adapted to studies of diverse nature and is responsive to changing behaviours and developments (Milliken, 2010; O'Reilly et al., 2012; Braun et al., 2019). Other qualitative search strategies like case studies are less flexible and for instance, limited to a preselected number of participants sharing a specific background of expected relevance that limits the research's scope and outcome by restricting the researcher's ability to move beyond the specific, concentrated perspectives of initial focus and to consider new viewpoints (O'Reilly, 2012). With the core elements of theoretical sampling and theoretical saturation, it is avoided in GT that" *theories run thin when the same data is collected over and over again*" (Glaser, 1998, p. 158). Both such procedures were considered important for the present study as AR technology is still rather new in retail, and initially, it was not clear in which positions topic experts were to find at best neither what a suitable study size would be. Continuously following the shared recommendations and insights led, for instance, towards the realisation that the study's scope should not be restricted to the retailers' perspective but to further include brands and AR experts to gain a more holistic picture.

As a general methodology, Grounded Theory can utilise both data of qualitative and/or quantitative nature (Mediani, 2017). However, it is most commonly applied in a qualitative form which will also be the case in the present study (Locke, 2002; Denzin & Lincoln, 2005; O'Reilly et al., 2012). Qualitative data collection techniques are increasingly accepted in business research (Greener, 2008) and considered particularly suited for technology adoption research due to their capability to elicit richer information in comparison to quantitative survey data (Sherif & Vinze, 2003). As they lay emphasis on the participants' standpoints, experiences and subjective opinions, qualitative methods allow describing reality through the eyes of topic experts which provides researchers with a more detailed understanding of the topic (Collis & Hussey, 2003; Schutt, 2011; Hammarberg et al., 2016). Those characteristics are considered relevant for the present research that is leading in its field and therefore lacks a sufficient base of already identified adoption success factors that could be proven in their effectiveness with the help of quantitative techniques. In order to collect the data, one-to-one interviews were applied which is reasoned in the following section on the study's data collection process and was preferred towards other, more collaborative qualitative methods as the examined industry is characterised by great competitiveness and the number of professionals within each firm is still fairly limited anyway.

### 3.2. Procedures & Justification for Examining Relevant Literature

As just discussed, common academic procedures as the pre-formulation of research questions or the initial engagement with extant literature are eluded in classical Grounded Theory, which caused the emergence of conflicting perspectives and various modifications of the methodology over the last 50 years (see e.g. Chun Tie et al., 2019). While some researchers as Timonen et al. (2018) state that for present-day research it is inevitable to conduct an initial literature review and outline the literature's state-of-the-art, others like O'Reilly et al. (2012) still trust in the initial idea and argue that an 'a la carte' approach to GT, as applied by the majority of study's mistakenly claiming to utilise GT holistically (see also Braun & Clarke, 2006; Curtis & Curtis, 2011; Braun et al., 2019), is "*limiting the practical relevance* *and theory-building capabilities of the method*" and thus, takes away its power (p.256). As both perspectives have their justification, the study at hand follows a middle road by staying as close to the original approach as the current institutional requirements and study settings allow it.

To identify and justify the chosen research focus, there was an initial literature search conducted on studies addressing the organisational adoption and critical adoption success factors of Augmented Reality try-ons in the retail context. However, as the search results revealed a clear research gap in this area and Grounded Theory became a reasonable method to approach the topic, it was eluded to further engage with literature in related study fields or application areas (O'Reilly et al., 2012). Instead, the theoretical focus was placed on the present technological state of AR technology as well as available applications and the extent to which those are utilised in the retail industry already. Besides a fundamental understanding of technology adoption and transformation processes in general, this solid understanding of the examined market is frequently highlighted as a valuable asset to GT method as remaining theoretical sensitivity, a core element of classic GT, "*necessitates a theoretical understanding of the phenomenon under study to enable new theory development*" (O'Reilly, 2012, p. 255; see also Goulding, 2002). Without a fundamental understanding of the topic, relevant data incidents could hardly be discerned from extraneous ones (Fendt & Sachs, 2008; O'Reilly, 2012). Another point justifying the conduction of an initial and facile market review on AR try-ons has manifested during the first search of academic literature. Existing research on AR was often found to provide fragmented and even obsolete theoretical knowledge on the types and underlying functionalities of AR and even many of the more recently published studies are still building their findings on outdated reports on the technology's technical progress. To close that gap between real-market conditions and existing literature, it seemed necessary to point out the technology's current state-of-the-art in order to start the examination of key challenges and critical success factors of AR try-on implementations in online clothing firms with a realistic technological understanding.

Regarding followed procedures, the initial literature search conducted for refining the study's focus was performed by primarily utilising the search engines *Scopus* and *Google Scholar* where a series of search terms was applied in varying compositions (see *Appendix B*). To guide the initial search, research by Wolfswinkel et al. (2013) was used who propose a five-stage review process, visualised in *Appendix C*. Congruent with the utilised model, the initial search results were filtered for doubles, followed by screening their titles and abstracts to set aside those not fitting the selection criteria. The resulting sample was subjected to a more in-depth refinement, this time building on a full-text examination. In a fourth step, the refined selection of highly relevant literature was screened for forward and backward citations to further enrich the sample quality by following clues, filling knowledge gaps and clarifying uncertainties. All newly detected references likewise passed the utilised review process. Unlike the majority of conducted research on AR, the present study exclusively considers the organisation's perspective towards AR and respective adoption success factors. To not falsify the aspired research perspective, the examined literature was thoroughly checked for its organisational focus. While research on AR adoption from a corporate perspective is generally rare, there is, to the author's current knowledge, just a single study addressing the context of online retail yet (see Chandra & Kumar, 2018). Due to this and building on reasons outlined in the section on the Critical Success Factor Identification

Process, it was refrained from immersing deeper into related research and instead decided to follow an inductive approach.

Going back and forth through literature revealed the existent research gap that was causal for selecting Grounded Theory as methodology but also evinced additional insights pertinent for specifying and shaping the market review on AR applications for online fashion retail. To ensure the topicality of the gathered information from the market-related search inquiries, primary literature sources were mostly utilised as they are associated with an increased level of detail and a shorter time to publication (Saunders et al., 2009). This includes everything from industry and market research reports to journal articles, panel discussions, published interviews or Q&A sessions with industry experts, news reports and so on. Those were gathered by primarily using Google's general search engine and guided towards a number of utilised secondary literature sources, mainly focussing on new technical features of AR.

### 3.3. Data Collection Procedure

As outlined before and defined by Leidecker & Bruno (1984), the present study follows the *industry and business expert* approach for the identification of CSF. To consult with those individuals, qualitative, non-standardised interviews were utilised, which are seen as the key data collection method for conducting Grounded Theory (Charmaz, 2014; Braun et al., 2019. This decision was supported by findings of Cooper and Schindler (2013) who point out the method's high suitability for studies of an exploratory nature. Going with its particular subtype of semi-structured expert interviews (SSI) was considered appropriate as this form of qualitative research questionings allows to seek new insights and to gain deeper topic understanding through revealing the respondents' underlying motives, opinions and attitudes (Robson, 2002; Saunders et al., 2009). Seen as the most beneficial approach to answer questions of a more complex nature (Jankowicz, 2005; Easterby-Smith et al., 2008), SSI further offered the opportunity to guide the interview's direction with pre-formulated, open-ended questions (Alsaawi, 2014) while still leaving space for probing queries with the help of which participants were encouraged to build on and better explain their shared insights. This ensured a richer and more detailed understanding of the meanings they ascribed to a phenomenon and further pointed out formerly unconsidered aspects relevant for developing a profound theory (Saunders et al., 2009). Due to the geographic distribution of the interview participants and additional contact restrictions caused by COVID-19, the interviews were conducted entirely electronically with the help of video chats. As recommended by Saunders et al. (2009), each interview was audio-recorded after the participant's approval has been obtained and confidentiality was ensured. The recording and subsequent transcription followed the only purpose to ensure accuracy and to avoid missing any relevant information provided by the respondent, as often the case when taking notes (Saunders et al., 2009).

Following the procedures of Grounded Theory, interview candidates were selected pursuant to the methods of purposeful and theoretical sampling (e.g. Birks & Mills, 2015; Chun Tie et al., 2019). As a first direction for data collection, a purposive sample of 15 interview candidates was considered. Those informants constituted former or current business representatives of fashion firms that were found to be innovating with AR over the course of the conducted market review (see *Appendix D* for an exemplary overview). Each of them had a minimum of two years of working experience in the fashion retail industry and was holding a leading or core position related to the area of electronic commerce. An additional

*Table 2: Professional Positions and Operating Business Area of Final Interview Candidates*

| Acronym Participant | Professional Profile | Business Area |
|---|---|---|
| P1 | 3D Fashion Design & Development Engineer | Consultant |
| P2 | Mentor Technology & Executive Leadership | Consultant |
| P3 | AR/VR and Emerging Technology Strategist | Consultant |
| P4 | Director Business Development | Consultant |
| P5 | Product Owner | Online Retailer |
| P6 | Content Manager | Online Retailer |
| P7 | Head of Product | Online Retailer |
| P8 | R&D Engineer | Online Retailer |
| P9 | Director Digital Creation | Brand |
| P10 | Head of Business Intelligence & eCommerce | Brand |
| P11 | VP Digital Worldwide | Brand |
| P12 | Lead of Speed & Innovation | Brand |

selection criterion was to be directly involved with the product and responsible for actions around digital content, digital creation, technology innovation or virtual try-on and Augmented Reality applications explicitly, all in the context of online retail. No geographical restrictions were applied since experts on the topic are still rare to find and a broader scope was aimed to remain. The insights and contact recommendations obtained from these first contacts were used to redirect and specify the selection of additional candidates. This process of theoretical sampling led to the further inclusion of consulting AR experts not being directly employed by one of the identified fashion companies but holding valuable topic knowledge as they have counselled and supported respective firms regarding their AR implementation processes in the past. Additionally, it became clear that retailer and brands are differing in some perspective which led to the specific inclusion of an evenly distributed number of representatives from brands and online retailer in the final study sample (see *Table 2*). Common characteristics shared by all final participants were at least two years working experience in e-commerce, a profound background in the fashion industry and working experience at or with one of the known fashion brands that have already applied or experimented with AR. The primarily targeted market of the represented firms was mostly in Europe but also North America and Asia. The contacting happened over the social network *LinkedIn* as well as personal contact recommendations, and in the end, interviews with 12 experts were conducted, all between May and July 2020 and with varying durations from 25 minutes to an hour and 20 minutes.

Like typical for the applied type of non-structured interviews, an interview guide was created before initiating the empirical data collection (see *Appendix E*). As Grounded Theory studies are characterised by the procedure of theoretical sampling though, the initial and rather broad interview questions were adapted in the course of the collection process and got more and more refined towards higher relevance and focus (see O'Reilly et al., 2012; Mediani, 2017). While initially it was considered relevant to learn who is involved in the adoption process of AR within clothing firms, in order to refine the selection of approachable experts, this questions was soon replaced as it lost relevance. Instead, a query on the importance of supplier relationships was added, for instance, as the interaction with the supply chain turned out to be of high relevance. The design of all questions constituted a mix of open-ended and probing questions. Utilising an open-ended form enabled participants to give self-chosen responses, unanticipated by the researcher and encouraged them to provide extensive and more detailed insights on their personal knowledge and attitude (Grummitt, 1980; Mack et al., 2005). To additionally include probing questions allowed to add questions with a particular focus to seek deeper understanding and reasoning (Saunders et al., 2009).

During the data collection process, some of the criteria were mentioned more frequently than others, indicating that those might require greater attention when it comes to the allocation of resources in the adoption process. Indeed, Leidecker & Bruno (1984) declared among others, that the attributed relevance of a factor is determined by its impact on the firm's core activities, cost structures, profit margin or overall performance changes. To get a deeper understanding of each criteria's relevance, an additional prioritisation process was performed in a second data collection round. Besides indicating which factors commonly require the greatest initial attention and how they are interrelated, this step simultaneously ensured that the gained results were reviewed by each participant for their correctness and comprehensiveness and offered the opportunity for further remarks. Both the identified key challenges as well as the detected critical success factors were randomly listed and specified in a combined survey tool (*see Appendix F*) which corresponding link was sent to each of the former participants via email, along with the request to rank the factors individually according to their required attention in the firm's adoption process. For prioritisation, Arabic numbers were used with 1 stating the highest relevance and 6 the lowest. Participants were additionally invited to add factors that were still found to be missing and also, to suggest possible reformulations of terms when serving the purpose of more accurate comprehension. Depending on their number of overall mentions in the interviews and the rank ascribed by each participant in the second data collection round, the identified factors were eventually ranked in a count-attention matrix (see also Masood & Egger, 2019, p.190) which is visualised in *Appendix H* and addressed in the study's result and discussion section.

### 3.4. Data Analysis

As mentioned already, the analysis of the gathered research information occurs simultaneously to data collection in GT and thus, was not considered as an entirely separate process in this study. It built on a 3-stage coding procedure that united the processes of data collection, analysis and theory development as it allowed to conceive the gathered information and to identify schemes and conceptual reoccurrences based on which a data explaining theory was developed (Flick, 2009; Saldaña, 2013; Chun Tie et al., 2019). Every time after an expert interview was conducted and transcribed the content was reviewed for precise ideas relevant for the research questions, which were then separated, compared to previously collected data as well as each other, and categorised with the help of short, descriptive labels of condensed meaning (codes). This process of categorising and assigning a first meaning to the data is referred to as *initial coding*[1] and initiated that as many codes as possible were generated from the early data, checked for comparisons and utilised to set the further direction of the data collection (Charmaz, 2014; Maher et al., 2018; Chun Tie et al., 2019). For labelling the initial codes and all further

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[1] Since the three most commonly used genre of Grounded Theory – Traditional GT associated with Glaser (e.g. Glaser & Strauss, 1967); Evolved GT associated with the scientists Strauss, Corbin or Clarke (e.g. Corbin & Strauss, 1990; Clarke, 2003) and constructivist GT associated with Charmaz (e.g. Charmaz, 2014)– use different coding terminology for the same analytical stages, it was decided to go with the summative terms '*Initial'*-, '*Intermediate'*- and '*Advanced Coding*' defined by Birks & Mills (2015). 'Initial Coding' therefore covers the term *open coding*, 'Intermediate coding' refers to the terms of *selective -, axial- and focussed coding* and 'Advanced Coding' is representing *theoretical coding* and also *selective coding* as used by the genre of evolved GT in the last analytical coding stage (see Birk & Mills, 2015; Chun Tie et al., 2019).

ones, advice by Strauss & Corbin (2008) was followed, suggesting to utilise descriptive terms that have either emerged from the data, were mentioned by participants or have been used in former literature.

In the second analytical stage of *intermediate coding*, the initial codes and categories were reviewed and subsequently grouped under a smaller but refined number of overreaching categories. This iterative process of a constant comparative analysis is typical for GT studies and induced to steadily contrast the gathered data with new emerging information, codes, categories and concepts, which in turn were also constantly compared to one another and themselves to examine differences and consistencies (Maher et al., 2018). By reviewing the initial codes and categories, core categories became evident over time and relationships between individual categories could be identified. After the twelfth interview has been conducted, theoretical saturation was reached as no entirely new insights emerged anymore and the created categories were considered to be sufficiently explained (Birks & Mills, 2015).

The decision to create new codes, merge or separate existing ones, contrive a category or identify relationships in-between relied on informal analytical notes (memos) that annotated theoretical linkages in the data and were taken and utilised throughout the entire research process (Glaser & Holton, 2004, Birks & Mills, 2015). To create a full understanding of the factors that influence the AR adoption in online fashion firms and to produce a theory that is both explanatory and grounded in theory, Advanced Coding was conducted as a last analytical step (Chun Tie et al., 2019). The identified factors of relevance were put into context, explained and justified by additionally consulting existing research in the area of AR adoption and technology adoption in general, and further examined regarding their interrelations. Moreover, all identified components have been related and prioritised by each participant according to their relevance, as picked up in *Chapter 4* and visualised in the form of a count-importance matrix in *Appendix H* and *I*. This served the purpose of creating a storyline emergent from the data which explains what key challenges are determining the slow diffusion of AR try-ons in the digital clothing segment and facilitates the arrangement of the consequent adoption success factors in a conceptual framework, graphically displayed and explained in *Chapter 4.3* (Saldaña, 2013; Birks & Mills, 2015).

Next to coding procedures themselves, the qualitative nature of the study also implies an interpretative task for analysing the findings and extracting knowledge from them. This involves, for instance, the selection of relevant narratives for the study's elaboration section. Three criteria suggested by Castro (2015) were used concurrently in order to guide the interpretation. Arguments of highest meaning were considered to be those that fit the theoretical background of the study, appear repeatedly and with high density, and at the same time have been explicitly emphasised by the participants. The selected quotes from the interviews are following these criteria and were chosen according to their descriptiveness of the addressed aspect, as well as dependent on how well they summarise congruent insights shared by several participants. Additionally, narratives were selected for citation that stress or build the counterpart of specific points. Four of the interviews were conducted in German language, which is why no narratives have been extracted from them and indirect quotes were used instead. Overall it was ensured that a holistic storyline was created, as typical for Grounded Theory studies.

### 3.5. Reliability and Validity

To ensure validity and reliability is a key aspect of credible and trustworthy research and especially relevant for qualitative studies where standardisation is lacking (Brink, 1993). According to Brink (1993,

p. 35), reliability addresses the "*ability of the research method to yield consistently the same results over repeated testing periods*", meaning that different scientists may obtain the same information every time a specific approach is utilised (Easterby-Smith et al., 2008; Silverman, 2013). As qualitative research is characterised by a certain degree of flexibility that allows examining complex and dynamic conditions, an exact replication of the study and its outcomes is not feasible though (Marshall & Rossman, 1999; Leung, 2015). The initially involved informants would have already reflected on their former research participation, and further strengthened by influences of ongoing dynamics in the respective context, it would be likely that the individuals' perspective and understanding have changed or further developed. Due to this reason, reliability is still lying with consistency in this study's context, but holds a certain degree of versatility regarding the given settings and the richness of the repeatedly obtained findings. Instead of following the purpose to enable a precise replica of the research, the study's strategy, sample selection and execution are thoroughly outlined and graphically represented in the study's method section to give fellow researchers the chance to understand the research's settings, logic and meaning, build their own judgement about its credibility, and reveal, to a certain degree, comparable results if reapplying it carefully to an equivalent context (Brink, 1993; Marshall & Rossman, 1999; Carcary, 2009).

Besides consistency in the findings, the study's truthfulness and credibility were further aspired to be secured, meaning that the applied processes and tools just measure what is supposed to be measured and thus, only reveal results that are actually existing (LeCompte & Goetz, 1982; Brink, 1993). This is covered under the term *validity,* which is commonly distinguished into its two major forms of external and internal validity (see Campbell & Stanley, 1963). *External validity* is more commonly known as *generalisability* and refers to the extent to which the identified research findings are equally applicable across diverse study contexts and ethnic groups. As "*qualitative research using semi-structured […] interviews will not be able to be used to make statistical generalisations about the entire population*" though (Saunders et al., 2009, p. 327), mainly due to its common characteristic of building on an unrepresentative and small number of samples and its objective to explain developments in very specific research settings, external validity will not be an attribute targeted to be achieved in this study. However, the final results are still linked to existing theory in related fields of adoption literature to demonstrate their broader theoretical significance and allow their advancement and testing in other contexts (Bryman, 1988; Marshall & Rossman, 1999; Saunders et al., 2009).

Unlike its counterpart, *internal validity* is of high relevance in the present qualitative research and addresses the degree to which the study outcomes represent a truthful reflection of reality rather than consequences of irrelevant factors. In order to gain extensive access to the respondents' experience and knowledge, and thus ensure internal validity, the asked questions were clearly defined and clarified, meanings of answers probed during the interviews and subjects analysed from diverse angles (see Denzin, 1970/2009; Saunders et al., 2009; Leung, 2015). To ensure the honesty of the given answers and establish trust in the author and the credibility of its research, the study's nature, purpose and the way of data handling was clearly communicated to each participant and a copy of the final results offered for personal use. Further, the professional background and academic connections of the researcher were disclosed to each participant as contacting happened over LinkedIn and the researcher's accessible personal profile (see Brink, 1993; Shenton, 2004). To ensure the completeness of the data, the gained results were double-checked with the informants, consulted with fellow researcher and compared with each other and related literature findings (see Brink, 1993). Last, the importance of random sampling pointed out by Shenton (2004), was ensured. Following the approach of *systematic theoretical sampling*, as a core element of GT studies, assured that the gained insights from the first interviews were utilised to detect new potential candidates to contact. Already contacted informants were further asked for referrals of knowledgeable interview candidates which inhibited a sampling selection solely based on the researcher and thus avoided a biased and unbalanced selection of the final study participants.

# 4. FINDINGS AND DISCUSSION

In the following, the gained insights obtained from the conducted expert interviews are analysed and discussed regarding their meaning, their relevance in the AR adoption process as well as their interconnections. According to Strauss & Corbin (2008), the factors and sub-specifications identified through applying GT methodology share distinct relations in-between that contribute to the overall storyline and are suggested by the memos produced during the analysis of the gathered data. To verify those linkages as well as the factors relevance, extant literature of comparable research fields is subsequently involved (Creswell et al., 2007; Strauss & Corbin, 2008). Additionally, the observed challenges and derived critical success factors have been ranked and related explicitly by the study participants in a second data collection round. Purpose and procedure of the latter is explained in *Chapter 3* and visualised in the form of a factor attention matrix in *Appendix H*. The therefrom created storyline is outlined hereafter and combines the three considered perspectives of e-tailer, clothing brands and AR experts. Grounded in the findings on the identified adoption success metrics a conceptual model was furthermore built, explaining the indicated relations between the determined factors as well as their outlined effects on the adoption process and resulting economic profits. Moreover, based on additional remarks provided by the consulted experts and reports on future trend projections, an outlook of the technology's future development in the area of focus is delineated.

## 4.1. Key Challenges in the AR Adoption Process

Like with any other IT innovation, pioneering with AR technology is linked to new business opportunities offering the potential of greater economic profits and competitive advantage as outlined in section 2.2. However, it also puts businesses at risks of certain hurdles. To be aware of potentially occurring challenges is an essential step to initiate suitable measures that prevent adoption failure and enable the full utilisation of the technology's benefits. Obtained from the conducted expert interviews, six key challenges were identified (see *Table 3*) as outlined in the following and structured according to their ascribed level of attention in the AR adoption process (see *Appendix H*). Each of those challenges is linked to a number of CSF applicable to cope with such (see *Figure 2)* and defined in detail in the subsequent section.

*1) Digital Infrastructure & Organisational Processes* The on average most concerning obstacle occurring in the implementation process of Augmented Reality for online fashion was found to be the state of the company's digital infrastructure and organisational processes. The following four aspects were pointed out by the participants to be contributing to this challenge.

*Table 3: Identified Key Challenges For Adopting AR try-ons in Online Fashion, and their Specification*

| Key Challenges | Factor Specification |
|---|---|
| User Adoption | User acceptance; user privacy & security concerns; perceived body image & user self-esteem |
| Tech Characteristics | **Missing industry standards** for Technology & Sizing (no standard 3D asset creation software, no holistic standardised AR software; varying size measurements and size catalogues for clothing)<br>**Tool Selection Process** (Organisational fit of the tool incl. customisation potential; licensing & contracting conditions; affordability; compatibility; future prospects of the tool's use and compatibility)<br>**Tool availability** (missing holistic/ democratised solutions; immature size & fit software; insufficient hardware & device performance) |
| Lacking Knowledge Resources | **Lack of skilled workforce/ tech experts** (unique skillset/knowledge mix required; limited education incentives & available professional trainings; tech talents difficult to attract for retail)<br>**Internal knowledge gap** (lacking knowledge resources within firms; unawareness of tech capabilities) |
| Digital Infrastructure & Organisational Processes | **Hierarchical firm structures/ organisational boundaries** (internal decision processes)<br>**3D asset generation & compatibility** (new process requirements; implementation effort)<br>**Scalability** of 3D asset generation process (cost & time resources & their prioritisation; time-to-market)<br>**Trading partner dependencies** (knowledge & information exchange; cost distribution issue, copyright issues) |
| Change Resistance & Mindset | Organisational culture; industry nature; workforce mindset (Designers, Salesforce - pen & paper mentality) |
| Market Pressure | Competitors, customer; digitisation pressure due to COVID-19 |

*3D Asset Generation & Compatibility*: Participant 7 stated that "*with the products that you sell, you obviously need to create 3D models to make it work in […] Augmented Reality*". This would be ensured at best with a completely digital product development chain. However, most firms are still little or just partly digitised (P1), and people are "*used to doing everything manually*" as added by participant 11. It was further mentioned that many former versions of 3D generation software are not compatible with AR tools anymore and have to be replaced since converting the files to a suitable format and resolution would be too time and labour intensive. While the 3D asset has to be small enough to run on the AR tool, its quality still needs to meet a certain quality standard which is higher for real-time AR try-ons than embedded AR experiences. Participant 11 highlighted that the establishment of a 3D asset generation pipeline and the therefor required infrastructure "*was a complicated process*" that should not be underestimated and according to participant 1 can take between two to five years from the implementation decision till the complete integration. The issue of the technology's compatibility with current IT systems was also identified in a study on AR challenges in industrial manufacturing settings by Masood & Egger (2019).

*Scalability:* Several participants highlighted the issue of producing 3D assets at a large scale, especially if the required processes are missing within the firm (P4). To transform 50 to 500 fashion items still seems to be fairly inexpensive; however, most companies have thousands or hundreds of thousands of fashion products and to get each item available in AR constitutes a significant investment that is considered a bottleneck at this stage (P3, P5, P7). Participant 6 added that "*that way of producing content, it costs a lot of money and it costs a lot of time*" since "*the pipeline for it is relatively complicated*". For those firms operating within fast-fashion business models, it is especially challenging as speed to market is the key and producing AR-enabled 3D models is still considered to take a longer time than performing traditional photoshoots (P6, P7). If parts of the 3D generation process get automated over time, cost and lead-time will decline, and creation at scale becomes possible (P6; see also Basnet, Burgar et al., 2020a).

*Supplier & Trading Partner Dependencies:* The restricted availability of product information and copyright concerns were mentioned to be further challenges. To generate representative AR try-ons of a garment item, its exact measures, its fit and material characteristics have to be known, and particularly online retailers are dependent on brands to share those. Participant 5 stated that "*we need their information and as well their rights for that we can use it on their products*". Other participants also made the experience that *"brands were extremely protective of any kind of 3D design files that they had […] because it's all to do with copyrights"* (P6). As a brand representative, Participant 11 confirmed this aspect by stating to not provide the available 3D files of their products to anybody yet and adding: "*I think I would consider it but it costs a lot of money […] so what we would probably say is that we own that image, so they wouldn't be able to use it on their website*". The brand's high investments in 3D asset generations are also raising discrepancies about their cost distribution along the supply chain. According to participant 12, unresolved questions are "*Who will take it on, is it from supplier, is it from brand, is it a shared cost?".* Participant 6 further pointed out that with AR in general, expertise dependencies towards software providers are existent since it is "*quite a niche thing*" and "*most retailer don't have in-house tech teams*" that hold detailed knowledge on AR and thus, have to rely on external experts.

*Firm Structures & Hierarchies:* Hierarchical structures within the company were additionally noted to be a restraint due to causing time delays in the decision processes and complicating the authorisation process for intended procedures. Participant 7 highlighted that *"the more money you need to spend, the more time you need to actually get it through the whole company and select the right tool".* Technology implementation intentions usually have to be justified in front of the management, which is even harder if the latter does not carry essential knowledge on AR technology and its benefits (P3, P6). Participant 6 emphasised that "*saying to someone, we've not done this before, but we think it could be good, shall we spend a lot of money on it?"* is difficult, and depending on the ups and downs in the industry there are good and bad times to have those conversations. Even companies with partly external innovation departments are usually subordinated to a more conservative, higher management team that has a veto right for adoption decisions involving a firm's core processes (P1). Participant 3 mentioned that "it's *often those internal blockers that then stop the [adoption at] scale*". Small brands are considered to have the advantage of shorter decision paths that allow higher flexibility to experiment and take risks (P1, P3).

*Interrelations With Other Challenges and Assigned CSF*: As found from the interviews, the lack of underlying infrastructure is determined by the change resistance mindset of the industry. The commonly present pen-and-paper mentality among workforce and management, together with the prioritisation of other, more urging topics have slowed down the industry's digital transformation. To cope with this challenge, it was indicated that a clear, visionary strategy towards the establishment of holistic underlying processes is needed which is including the entire supply chain and initiates accompanying change management procedures together with training (see *Figure 2*).

***2) Tech Characteristics*** Still considered to be a fundamental challenge but meanwhile less concerning than the organisation's readiness, are the technology's provided features and its functionality. Concerns are originating from three major areas: the process of selecting the best tool, missing industry standards and the lacking availability of holistic solutions.

*Tool Selection:* Overall, choosing the right AR tool and vendor was mentioned to constitute a significant challenge to garment firms as the lack of a solid understanding of the technology is complicating the assessment of the newly occurring applications, and "there's *a very big difference between the fidelity of different companies and the type of product they put out*" (P3, also P4, P7). Nevertheless, P11 mentioned that the still small number of tools simplifies the process and "*you should be able to see some examples of how it works and […] you can talk to other people that use the software*". Besides this, concerns were stated regarding the tool's fit to the organisation and its matching with firm-specific quality requirements and product creation standards (P9), same as its utilisation at scale (P4). Factors like the software's affordability and future prospects regarding its updating potential and long-term usage were further noted (P6, P8, P10). Participant 5 pointed out that "to *get everything working between partners"* and arrange licensing and contracting procedures partly takes more effort than the technical aspects. Other concerns raised were the tool's functionality on web and app as well as its compatibility with existing IT systems (P5, P7).

*Missing Industry Standard – Technology:* It was highlighted that there is currently no standard for AR in the fashion industry, neither for the 3D design software and the format and resolution of the digital files nor for the AR application that is supposed to run them. Participant 1 and 12 explicitly pointed out that there is the risk for brands to invest in the "wrong" 3D technology that at first seems to become the industry standard but switches over time, causing that the particular program all staff was trained on is not used anymore. According to participant 12 "that's *the most difficult thing at the beginning of a new technology*". With brands using diverse software, file formats and compatibilities are also varying, making it especially difficult for resellers to unify and utilise the provided data (P9). The issue of alternating compatibilities due to the utilisation of different tools was also detected by Qiao et al. (2019). Over the last two years, AR formats like GLTF and GLP started establishing, which increasingly enables to exchange data that can be uploaded into most AR tools (P9). Still, participant 3 highlighted that compatibility issues remain, also because the present AR applications provided on the markets have diverse resolution and quality requirements for the files being uploaded. Since AR is an emerging technology, there is also the risk that once a standard is set, newly evolving forms like wearable AR, for instance, could require new processes and formats that are demanding further amendments (P3, see also Basnet, Beauchamp et al., 2020). The outlined issue of a missing AR standard was also identified by Martínez et al. (2014) in their study on general driver and bottlenecks for adopting AR applications.

*Missing Industry Standard – Size:* Besides technology standards, the lack of a unified sizing system for garments was noted to be complicating the adoption of AR try-ons, particularly for those addressing the garment's fit on the user's body. Participant 8 highlighted that "*each brand have their own targets, and they have their own measurements they target*" which complicates to find a common standard. Participant 5 pointed out the complexity arising for resellers who are aiming to adopt AR but have to manage garments from diverse brands holding varying numerical sizes and versatile definitions of the terms large, medium and small (see also Morgan Stanley, 2018). The issue of varying sizes already starts during the production process, as highlighted by participant 8. Fabrics are mostly cut in layers, and middle or bottom level can shift or be met in a different angle in the cutting process, causing variations of the same size by a few centimetres. For AR try-ons aiming to indicate the precise fit of a garment on the human body, "*this is exactly the starting point of why it can't, it doesn't work yet*" (P8).

*Tech Availability:* Even though participants stated that AR try-ons for visualisation are already working well enough to help people to understand whether a garment suits them, concerns towards the precision with which it is mapped onto the human body in real-time are addressed. Participant 9 highlighted the complexity behind tracking the users' movements through the screen and visualising the fabric accordingly, involving realistic representations of its fold, stretch or crunch behaviour in motion as well as shadow castings (see also Basnet, Burgar et al., 2020b; McDowell et al., 2020). As further mentioned, the technology to accurately recommend an item's fit on the user's body is not at a sophisticated level yet and still far from being utilisable at scale. Besides standard sizes for clothing and size-accurate consumer avatars, it was highlighted that those applications would require devices with high computing power and in-build AR engines which are currently still rare but expected to evolve soon (see also Martínez et al., 2014; Badouch et al., 2018; Basnet, Burgar et al., 2020a). Another technological challenge emphasised by the consulted experts is the present lack of a holistic, licensable and easily integrable AR solution performing all required steps in one. Participant 6 noted that so far "you've *got to piece stuff together"* and that "it's *going to take someone to come along with almost the total package for people to go [because] unfortunately, no one is really owning that end-to-end experience of it"* so far. Participant 10 further emphasises that offered solutions seem to provide no opportunity for mass adoption and relates that to the cultural mindset of technology developments in the western world. The lack of a holistic solution was also highlighted by Basnet, Burgar et al. (2020a) who noted that there are single software packages but not yet the perfect tool combining all at scale.

*Interrelations With Other Challenges and Assigned CSF:* With missing internal knowledge resources on the capabilities and features of AR applications, it has been identified from the interviews that the tool selection process is severely complicated and the possible consequence of selecting an application not fitting the assigned purpose is likely to reinforce user adoption concerns. To balance the concerns arising from the technology's characteristics, the data suggests establishing holistic underlying processes that enable the utilisation of available AR tools (see *Figure 2*). Involving the entire supply chain is furthermore indicated to secure that the selected applications are compatible with partner tools or at best narrowed down to a small number of standard software utilised throughout the entire supply chain and of high compatibility to avoid inefficiencies in the long-run. Additionally, the customisation of the tech solution is found an essential step to match consumer preferences best and integrate the selected tool smoothly into the user's purchasing journey.

*3) Change Resistance & Mindset* Another aspect that was found to require special attention in the AR adoption process but enqueues behind organisational and technological issues is presented by the industry's general mindset towards innovation as well as the change resistance shown by the workforce.

*Industry*: Participant 1 explicitly highlighted that fashion is not known as innovation driver which was agreed by participant 11 who further pointed out that particularly from an e-commerce standpoint, other industries usually lead first while fashion has always been a follower in regard to innovation and sustainability topics. Reasons for this could originate from the customer base (see section on user adoption), or the fear of the new (P11). As emphasised by participant 3, "*being first means that it's the most expensive, it's the most dangerous, it could completely fail, it's very public"*, and thus, most fashion firms prefer to remain in the wait-and-see mode to check out the doing of others first. This was confirmed by participant 7, stating "*we want to be the quick follower, not the innovator*". According to participant 2, fashion firms are most of the time in a 'fire-fighting-mode', focussing their attention on issues critical for the smooth running of day-to-day operations but leaving little thoughts for innovation. Participant 10 added that "*huge companies […] have to first think about their bottom line"* causing that technology investments in the industry are rather short-sighted. Same stated that "*I feel like the adoption rate and the development, the lack of resources that is going there is a cultural issue, much more than it's an issue of actual resources" (*P10). The present resistance towards change in the fashion industry was also examined as a potential bottleneck by Behr (2018).

*Workforce:* Besides those adoption challenges arising from industry-specific characteristics, the rather conservative mindset of the workforce is further considered to stall the diffusion of AR. Participant 10 emphasised that "*you move from a very paper and pen type of situation to an extremely digital one*" and as added by participant 11 "*even if the executives are saying to go do it, there's gonna be some resistance"*. To get people to change their working habits is considered very challenging as they have worked like that forever (e.g. P4). Participant 1 and 6 shared the experience that particularly manually working designers have extremely high resistance towards new technology, and with them refusing to work with the new tools, virtual try-ons are hardly being realised. It was further mentioned that "it's *difficult to implement because of the sales teams, the buying teams"*, since *"in the industry, people are so used to having all of these physical samples to touch and look at and coordinate together that in a digital platform there's part of that, that you miss*" (P12). Participant 12 noted that "It's *just a big shift in mindset that […] a lot of the buyers aren't sort of willing to do yet."* (P12) and as experienced by participant 9 the acceptance of wholesalers towards digital samples and AR visualisations in sales processes is even higher than the one by the salesforce.

*Interrelations With Other Challenges and Assigned CSF:* As suggested by the data, the workforce's resistance towards change interrelates closely with the unawareness of the potential that can be provided by AR try-ons and the accompanying digitisation of production processes. Further, the impression was given that it contributes to concerns regarding the firm's digital infrastructure as already pointed out. In order to face that challenge, visionary and innovative decision-makers were indicated to be of advantage in order to recognise suitable use cases of AR and initiate a thorough change management strategy that gets everyone on board and ensures both, a common understanding of the tool's benefits as well as the required skills on the part of the workforce to operate in the newly established processes and software (see *Figure 2*).

*4) User Adoption* Extant literature has already linked the introduction of consumer-facing technology like AR to issues concerning the consumer acceptance (Cranmer, 2017; Bonetti et al., 2018; Masood & Egger, 2019; Perannagari & Chakrabarti, 2019). This was confirmed by the majority of the consulted participants who highlighted the great uncertainty on how end-users will react to the new technology and further pointed out linked challenges arising from privacy concerns and body esteem.

*User Acceptance:* It was mentioned by participant 5 that "it's *more the scary part and not knowable part if customers will use it. […] you have no other metrics, and no knowledge beforehand, what it will do […]"*. These types of eventualities are considered especially concerning since "*the AR functionality that you have, […] the experiences that most people are seeing are still fairly basic*" (P6). Established purchasing habits of consumer who "*are used to just looking at photography and then just buying a lot of stuff in different sizes"* (P7), as well as their resistance towards change and innovation in the fashion context, were stated to be intensifying such concerns (see also Behr, 2018; Ionela-Andreea, 2019). The fear that customers do not like the newly offered experience was additionally highlighted to be enhanced by the high competitive pressure and struggles the fashion industry has been facing for the last five to ten years (P12). Extant literature has examined that there is a direct linkage between the dissatisfaction with new applications and a loss of brand trust and loyalty (Bonetti et al., 2018; Perannagari & Chakrabarti, 2019), however, in the opinion of participant 10 "*the adoption rate is a cultural phenomenon more than it is a technical phenomenon*", providing the example that Asian countries are" *much more dynamic in adoption of emerging tech than the US is"* since "*technology and technological development is seen as […] something that is a logical part of life*".

*User Privacy Concerns:* The study participants also highlighted the attention that should be shed towards potential privacy and security concerns on the part of the user. Participant 7 stated that "it's *also super important for customers that they feel secure with the technology. Because obviously, you have your camera open […]"*. Participant 11 added that "*doing anything proactive related to it, where it's not controlled by the consumer would be a mistake."* Another concern with AR try-ons was highlighted by participant 5 who stated that "*if you really do it on the customer itself, then you go with laws about how to go with privacy regulations and that kind of stuff"* (see also Collins, 2019). Literature found that privacy issues gain more meaning in the context of AR try-ons when not being compensated with a higher level of convenience (Linzbach et al., 2019; Perannagari & Chakrabarti, 2019; Qiao et al., 2019), and Feng & Xie (2018) examined that "*when users have high levels of privacy concerns, users tend to generate higher levels of perceived intrusiveness and more negative app attitude when viewing themselves trying a product in a virtual try-on app […]"* (p.1*)*. Badouch et al. (2018) argues that one of the main reason for the failure of the Google Glass was the issue of privacy and highlights that "*The security and privacy of information is a big question to study before any idea of service."* (p.4).

*Body Esteem:* Since AR try-ons are considered to be body-centric applications, firms were also found to be concerned about experienced body-esteem issues on the part of the consumer during use (see also Rosa et al., 2006). Participant 5 phrased it as "*I think sizes and clothing is a bit risky*" which was specified by participant 6 stating that "*If my technology only works when you're dressed in a small top and just like some short shorts, are you going to feel comfortable taking a picture of yourself dressed that way and then uploading it? Maybe not, that's the other kind of potential barrier."* Test runs have shown indeed that half of the people prefer visualisation on themselves, the other half on a model (P6). Participant 8 raised further concerns about the 3D scans that will become increasingly relevant once size & fit features are implemented in AR try-on tools. "[…] *you have to be wearing almost no clothes or very tight-fitting clothes, and then you scan. And when you see your body in a 3D scan, you don't want to see [that]. Even if it's a nice body […] because people have [a] very different image [of their bodies]"*.

*Interrelations With Other Challenges and Assigned CSF:* Like suggested by the data, the acceptance of the technology on the part of consumers is influenced by the performance of the applied tool and therefore also by its characteristics. As pictured in *Figure 2,* not just the customisation of the application but also of the creations of a simplistic, intuitive user interface in which it is embedded were stated to be potential measures to cope with the issue of user adoption. This requires visionary decision-makers that detect the need for such measures and gather the right people to ensure its realisation. Further, the digital infrastructure needs to be given, according to the gathered findings.

*5) Lacking Knowledge Resources* Another key challenge was mentioned to arise from the aspect that AR constitutes a "*drastically different type of tech and human-computer-interaction*" (P10), which entails firm-internal knowledge gaps as well as the lack of skilled workforce on the market.

*Internal Knowledge Gap/ Unawareness of Tech Capabilities:* Participant 10 highlighted that AR is still seen as a niche topic with a relatively small audience compared to other emerging technologies. It is well known in the entertainment or automotive industry, but clothing firms have not seen many convincing examples of AR applications which is considered to raise the cautiousness towards its application (P4, see also Basnet, Burgar et al., 2020a). Participant 4 and 6 noted explicitly that within fashion firms, the general awareness and understanding of the technology is low. The internal knowledge gap was stated to complicate the identification of suitable use cases and has additionally been linked to unrealistic expectations regarding the required implementation time and efforts. Participant 7 alluded that it requires the awareness that "*if you launch, for instance, a really good Augmented Reality implementation […] probably sales will not go up the first day. […] you need to keep working on that to make it one of the most used features.*" As mentioned by participant 11 "*most brands and most websites don't really have an effective use of it for apparel yet*" and participant 8 added that the main focus is currently on pattern creation with 3D instead of the customer aspect, even though "*the whole steps are in there, but not many brands are actually using it*". Participant 10 further highlighted that especially in large fashion firms there is usually" *a huge budget for investing into technological development*" but "*they don't know what to invest in*".

*Lack of Skilled Workforce:* Confronted with an internal knowledge gap, expertise needs to get sourced externally, but according to several participants, it is extremely difficult for fashion retail firms to find skilled workforce. Participant 8 and 10 explicitly highlighted the challenge originating from the unique skillset required to create AR experiences. While from the operation side usually no specific technical skills are necessary (see Lundberg et al., 2020), the application itself and its respective user interface is a complex issue "*because it's so many topics in one*" (P8, see also Roberts-Islam, 2020d). Participant 10 added that "s*omebody who has a mind for design and somebody who has a mind for technology is rarely the same person*" but "*[…] to drive a project like this, he has to understand both […], you need somebody to unify that vision*". This issue is affecting in-house AR developments same as AR solutions by external partners whose workforce skills determine the performance level of the applications being licensed by fashion firms. Overall, the topic of AR is not fully established yet (P2, P4) and as highlighted by participant 8, the small number of experts is mostly self-taught since official training or university degrees covering the creation of AR interfaces are lacking. It was further highlighted that the "*top development talent usually goes to [big] tech companies*" like Google (P8), as those are offering more diverse and innovative projects as well as higher remunerations compared to retail (see also The Interline x CLO, 2020). Participant 10 added that incentives to acquire relevant skills are generally missing for young people "*because there's just no industry [yet]*". Besides a technical understanding of AR, challenges already occur from the fact that most designers come with 2D knowledge and have to get retrained internally to be able to design in 3D (P6), including graduates since most study curriculums are outdated and not including digital design (see Roberts-Islam, 2020d). Participant 10 expects the new generations of digital natives to have the "*understanding that design and technology are not in conflict*" and together with updated education programs the challenge originating from a lack of skilled workforce would be slowly balanced (Lundberg et al., 2020).

*Interrelations & Assigned CSF:* As mentioned, the data indicates that lacking knowledge resources are interlinked with the industry's change resistance mindset and can at best be addressed by visionary decision-makers who define an adoption strategy that ensures a strategic change management and reoccurring training throughout the entire supply chain to get workforce and processes prepared on time (see *Figure 2*).

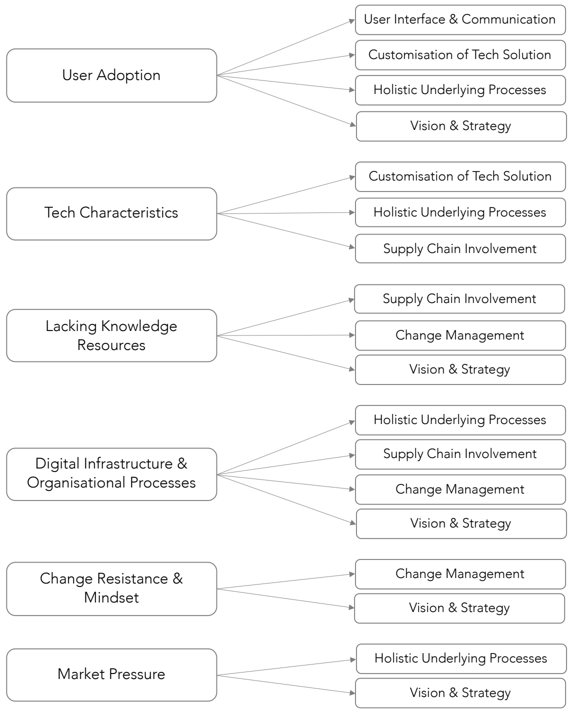

*Figure 2: Identified Key Challenges and their Link to CSF's, as Suggested by the Data*

*6) Market Pressure* Less concerning than the previous five but still recommended being taken into consideration is the increasing pressure originating from the markets, namely the competition, consumer and environmental influences as the COVID-19 pandemic. Participant 6 stated that "*competitiveness or that feeling for companies of like not wanting to be left behind, is something that's quite pervasive*" in the fashion industry. The more AR is going to be applied in the market, the higher the competitive pressure to follow which will be challenging though, if the required digital infrastructure to implement AR applications remains missing, as explicitly pointed out by Participant 1. The knowledge that the industry is in need of a digital transformation has been there for several years, but the pressure to act was missing so far, overlaid by more urging issues dominating the market (see Amed et al., 2019). Participant 4 emphasised that with the outbreak of the global COVID-19 crisis, the subject is now pushed to the fore, confronting every company with the necessity to digitise production processes, establish online channels and integrate consumer-facing technology in order to cope with social distancing and slowed down manufacturing processes (see also Basnet, Burgar et al., 2020a, b; Lundberg et al., 2020 & Roberts-Islam, 2020c). While the pandemic accelerates industry-wide endeavours to offer immersive technology, the findings indicate that consumer demands are expected to be their main driver in the end. The new user generations "*crave innovation, and that's what they want from the brands that they love*" (P6). Participant 10 added, that "*it comes from any customer that is going to be like Generation Z because they're just extremely digital* [and] *their virtual identities are part of their identity*". With the increasing application of advanced Augmented Reality solutions, the technology will transform in an essential must-have users get accustomed to, leaving their preferred brands with little choice than to adjust and implement it in order to keep up with the market (Boardman et al., 2020). It was annotated by participant 8, that market pressure does not necessarily have to be seen as a challenge but a motivator instead to improve business processes and enhance the interaction with consumers.

*Assigned CSFs:* The impression was left that being conscious about the potential pressure evolving from the market and reacting accordingly to it requires both, Vision & Strategy as well as the establishment of underlying firm processes in order to move quickly once the implementation of AR is demanded by consumers or constitutes a necessary step to keep up with the competition (*Figure 2*).

***Summary*** Taken together, all six factors were highlighted to demand particular consideration in the deployment process as each of them constitutes an essential challenge that is most likely to cause the undertaking's failure if being ignored (see also *Appendix H*). Nevertheless, the on average biggest concerns for AR adoptions in the industry were found to be addressing the state of the firm's existing digital infrastructure and extant organisational processes, followed by restrictions due to the technology's present state and suitability as well as the overall change resistance mindset within the industry. Therewith, organisational and industry-specific factors are considered greater challenges than user adoption, which still constitutes one of the major concerns but seems to be easier approachable than the three previously mentioned aspects. This is not reflected in former literature in this field which has mainly focussed on the adoption behaviour on the part of the consumer so far and the therefrom arising effects on the AR implementation process (e.g. Pantano et al., 2017; Roy et al., 2018; Caboni & Hagberg, 2019).

### 4.2. Critical Success Factors for AR Try-On Adoption

AR presents a fairly new technology and many aspects about it may have never been taken into consideration by people in an organisation (Collins, 2019). To cope with the outlined key challenges originating in the course of the AR adoption process, six critical success factors have been identified, obtained from the provided expert insights (see *Table 4*). Each factor is defined in the following and serves as foundation for the subsequently developed conceptual framework. As the interrelations between the identified CSF and their ascribed level of attention is outlined in the course of the model description in the ensuing chapter, this part is omitted here.

***1) Vision & Strategy*** It was explicitly highlighted by all but one participants that the effective adoption of AR try-ons requires a clear vision and thorough strategy from the side of the respective organisation. This involves proactive decision-makers who are able to detect the best fitting use cases, smartly allocate resources and at the same time ensure that the organisation is prepared for the time the technology becomes mainstream and its implementation a necessity.

*Visionary & Innovative Decision-Makers:* The data revealed that the implementation of AR try-ons is considered a complex and experimental transformation with an uncertain outcome and as phrased by participant 10 "you'll *have to just approach it with a vision and then the vision is just more or less a belief that it will develop one way or the other way*". Participant 2 agreed that it needs product manager and decision-makers who have an open mindset towards innovation and are willing to experiment. "*You have to have somebody who's just extremely futuristic minded to drive this kind of process, [because] for a business that just cares about its profit this year, next year, in the next five years, and so on and so forth, it's not immediately on the forefront of people's minds.*" (P10). It was further added by participant

*Table 4: Identified CSF for Adopting AR try-ons in Online Fashion, and their Specification*

| Critical Success Factors | Factor Specification |
|---|---|
| User Interface & Communication | **UX design** (utility, simplicity, convenience & fun; piloting & step-by-step introduction; full usage choice & control in hands of user; blending in well with the customer journey; clear usage guidance & instructions; data protection & data usage transparency)<br>**Clear & targeted user communication** (marketing strategy alignment; clear understanding of customer needs & preferences; target group specification; clear communication of customer benefit) |
| Customisation of Tech Solution | **Organisational fit** (brand fit; market & target group fit; purpose fit; fitting software capabilities; legacy system integration; long-term potential and updating prospects of tech)<br>**Smooth & aligned integration** |
| Holistic Underlying Processes | **Product life cycle adjustments** (time & cost savings through shortening and automation; compatibility issue prevention)<br>**Automated 3D asset generation pipelines** (digitisation of the entire product collection; creation of complete & unified 3D asset libraries)<br>**Workflow establishment** (new internal working processes, up-to-dateness insurance of tech & processes) |
| Supply Chain Involvement | **Smart Supplier Selection** (high level of digitisation/ innovativeness/ transformation willingness of supplier)<br>**Collaboration** (investing in good relations; information & knowledge exchange; innovating together; shared 3D asset generation)<br>**Tool & Process Standardisation** (ensuring compatibility of the utilised software within the supply chain) |
| Change Management | **Coaching** (Workforce motivation; full stakeholder & management involvement; external support through implementation experts/ consultants; full stakeholder understanding of tech, its benefits and use cases)<br>**Training** (recurring and high quality skill trainings to work with new tech) |
| Vision & Strategy | Visionary & innovative decision makers; realistic estimates of implementation times & effort; smart resource prioritisation; early transfer preparation; human capital investment efforts; identification of right use cases |

6, that if firms are not taking the risk, they will never end up doing anything in the area of innovation. The importance of innovative decision-makers for adopting new technology has, among others, also been examined in a literature review by Hameed et al. (2012). It was further found that by keeping an open mindset and a high degree of flexibility, firms can cope more easily with hurdles occurring in implementation processes (Bonetti et al., 2018; Collins, 2019).

*Identification of the 'Right' Use Cases:* To generate long-term benefits and get the most value from adopting AR, it was highlighted to identify the exact right use case and product, to which the utilised tool can be adjusted (see also Basnet, Burgar et al., 2020b; Lundberg et al., 2020). While examining the technology's capabilities, participants emphasised to keep asking oneself if those would really fit the organisational context (e.g. P2 or P3) and further, which existing customer problem is actually going to be solved with it (P5). McDowell et al. (2020) have also stressed the necessity of being very clear about the objective of the implementation since higher levels of engagement require a different approach than greater sales volumes. Fashion was mentioned to be a fast-changing industry characterised by seasonal designs and rapid trend developments which requires to choose wisely for which products an adoption actually makes sense (P7). While participant 12 suggested starting to experiment with never-out-of-stock products, participant 3 recommended just to do the math and estimate the worthiness by utilising available data from competitors or partners. To rank projects according to their hypothetical cost savings or level of impact was also an approach mentioned by Lundberg et al. (2020) who further emphasised that the required resources and managerial support need to be involved from the beginning to avoid potential barriers.

*Smart Resource Prioritisation & Human Capital Investments:* Among others, participant 6 mentioned that fashion firms "*got a lot of work competing*" (see also *Chapter 4.1*) and to allocate the restricted resources wisely was highlighted to be an essential component of visionary adoption strategies in order to get the project "*to the top of the list when there's all of these other requirements that are frightened to be prioritised.*" It was emphasised that "*businesses [really] need to be brave*" and should "*always attempt to run these kinds of more exploratory innovation type projects alongside the big business transformation pieces that go on*" (P6). Participant 12 noted that the allocation of resources for the new technology should not just stop after its establishment and generated cost savings could be used for reinvestments in software updates or workforce training. Literature has outlined that visionary decision-makers are usually also better with ensuring that the internal AR expertise is at a sophisticated level, whether by initiating training for the current workforce or by hiring new experts (Piotrowicz & Cuthbertson, 2014; Cranmer, 2017; Perannagari & Chakrabarti, 2019). As highlighted by participant 6 and 9 at least one expert who knows about the technology's capabilities and can communicate with external suppliers is recommended to be employed, and participant 1 added further to ensure technology aversion among the workforce since especially with digital working designers the transformation is going to be much faster.

*Getting Ready in Time & Realistically Estimating Implementation Time & Effort*: Especially the consultants under the participants stressed the need for fashion firms to start engaging with AR right away since the technology is enhancing quickly and companies risk being left behind once "it's *going to be ubiquitous*" (P3; see also Basnet, Burgar et al., 2020b; Boardman et al., 2020; Lundberg et al., 2020). Participant 3 emphasised that "[…] *it's so important to start now to see where that journey will lead because once consumers start to really engage in this hybrid reality […], and that's coming over the next three to five years, a company wants to really be prepared. They're not going to be able to just flip a switch and then suddenly engage. And so this is why now is the time to start doing these proof of concepts, directly with their consumers and start to understand where they fit in the digital landscape and what they want their products and services to be in the future. But they have to start that now because this does not happen overnight. It's a long process.*" (see also *Chapter 4.1*). It was further mentioned by several participants that consumers are not expecting perfection yet, making it the time to run pilot projects with enlarging groups of customers to get them used to the new technology and test how 3D content is at best received and engaged with before its providence will be commonly expected (see also McDowell et al., 2020). Literature outlined that it usually takes some time to exploit the advantages of Augmented Reality application (Jung et al., 2016) which supports the need to get prepared on time. Participant 6 also shared the experience that patience with performance outcomes is required because "*to get confident results back, we quite often need to test things not on like a few things but thousands of things.*"

*2) User Interface & Communication* Another aspect highlighted to be relevant for the effective adoption of AR try-ons is addressing the design and utility of the application's user interface as well as the targeted user communication surrounding it.

*User Experience:* Participants highlighted the importance of AR applications that not just function well from a technical perspective but are also embedded in a convenient, enjoyable user interface that ensures a high level of utility, simplicity and fun (see also Heller et al., 2019; Basnet, Burgar et al., 2020b). Masood & Egger (2019) further added the visibility of the information as an important aspect. Explained in the words of participant 3, "*It needs to be really, really easy for a customer to try on and to use* *whatever tech you're using because the minute they get frustrated, or it doesn't work properly, they're done. And then the utility pieces, 'wow, this is actually saving me time' or 'I get to try things that I wouldn't normally try'. And then the fun; and the fun factor is built-in because it's still new. But what we need to start looking at, is what's going to make it fun when everybody's used to this and this is everywhere."* As noted by participants, a well-made user interface design also enables customers to understand more easily how to utilise a new application and provides sufficient usage guidance which is considered important because what seems to be clear from the perspective of an engineer does not have to be self-explanatory for end consumers (e.g. P7, P8). Participant 10 noted that "it's *about the tool and how you show it to them. And there you just need design to work with. […] Because unless you nail the interaction design exactly correctly, then there's going to be no mass adoption."* It was further pointed out, that the experience "*needs to be seamless for people to actually interact with it in the first place* "(P6) and that it has to be blend in well in the journey of the customer (P7) to exploit the full potential of storytelling in the evolving 3D landscape and not just let it appear as a temporary gadget (P3, P5). Data usage transparency on the interface was another important aspect stated by several of the experts, together with giving each user full control over their privacy settings (see also Feng & Xie, 2018). Participant 7 emphasised to "*be really, really clear that the data is not stored anywhere or whatever*". It was further mentioned that user should be able to decide if a garment is visualised on their own body or in a neutral way as the experience was made that consumer preferences are split with regard to this (P6, P8; see also Plotkina & Saurel, 2019).

*User Communication:* Next to an intuitive user interface, targeted user communication was mentioned to be essential. Participant 5 emphasised to build a marketing strategy around the new application to let people know about its existence and features and to enhance the initial user engagement. Participant 6 noted that from the customer viewpoint the biggest issue with garment shopping is "*to understand if something fits them and if it suits them*", and as AR try-ons are considered to assist in making the right purchase, its advantages should be pointed out clearly to users to give a sensible reason to try engaging with it (P7, P11). Still, literature recommends keeping expectations towards the tool's performance at a realistic level to avoid frustration and an immediate loss of interest (Badouch et al., 2018; Trifonova, 2019). In the long run, the effectiveness of AR try-ons is dependent on the customers as highlighted by several participants, and thus, it was emphasised to listen carefully to users in order to understand their needs and act accordingly. Participant 3 noted that "it's *not just following kind of the trends of the technology, but follow the behavioural trends of the consumers in general.*". To not overwhelm customers with new input and features (Trifonova, 2019), it got mentions to introduce AR step by step to make sure it is understood and engaged with before scaling up (e.g. P10, Basnet, Burgar et al., 2020b).

***3) Holistic Underlying Processes*** Implementing AR at scale necessitates underlying digital firm infrastructures, integrated 3D asset generation processes and adjusted workflows, as highlighted by the majority of the consulted experts. To say it in the words of participant 11 "*You have to do the basics right […], basics first and then flashy stuff*".

*3D asset pipeline:* Digital product files are one of the basic requirements to run AR try-ons and participants emphasised the need to set up a 3D asset generation pipeline to enable their utilisation at scale in the future (see also Basnet, Burgar et al., 2020b; Basnet, Beauchamp et al., 2020). This would reach from reverse manufacturing ensuring that garment items are designed digitally first, all the way towards a pipeline that automatically converts the 3D design files into the required low-resolution format that allows their running in AR (P6, P9). Participant 3 noted that particularly brands with more restricted resources should look out for licensable solutions in the establishment of 3D asset pipelines and further highlighted that besides the already existing 3D generation and optimisation software, many new solutions are likely to evolve in the near future. Despite the entailed effort, it was particularly stressed to take a holistic approach and digitise the entire assortment in the long-run as the mix of physical and digital products would require to run two fairly different production and sales processes in parallel which was experienced to complicate the day-to-day business and consume lots of extra resources (P9, P12, see also Roberts-Islam, 2020b). Participant 12 stated that for sales "*we realised really the only way that you could potentially sell a collection is if the whole collection is digital, like there's no way you can try to sell part of it digitally and part of it physically*", giving the reason that wholesalers will always prefer the garments touched and felt over those presented digitally. Participant 11 further highlighted the perspective of consumers who would not understand why just parts of the collection are available in 3D, and with them increasingly getting used to digital content, a holistic approach would be demanded anyways (P3). Next to the establishment of a 3D asset generation pipeline, the accompanying compilation of complete and worldwide accessible 3D asset libraries was emphasised to be ensured which are supposed to include both, all the thousands of materials utilised to create the garment items digitally as well as the readily designed garment files themselves (P3, P4).

*Adjustment of the Entire Product Lifecycle:* As just outlined and particularly highlighted by participant 6, there are currently quite a few stages to take before an augmented experience can be presented to the consumer. In order to create 3D models at scale and initiate AR try-ons, it was emphasised that the entire product development process needs to be adjusted and digitised since the manual scanning and converting of single garment items turned out to conflict with available cost, time and labour resources (see *Chapter 4.1*). Participant 3 also highlighted that *"if you're just scanning a few items at a time, and you're doing some testing, that gets really expensive"* and added that *"those holistic plans are where they build an economy of scale*". In order to do so, 3D assets will have to go through their own workflow, starting from manufacturing, "*to the e-tailer's 3D Asset Library, and then it might go into a brand story, and then it will go on to the e-commerce site*" (P3). Participant 4 also emphasised not to take an isolated perspective and think that once the tool is purchased the issue is solved. No matter what technology is utilised, underlying business processes and infrastructures are key in the end, which is yet often forgotten to be considered (P4; see also Lundberg et al., 2020). Participant 9 also gave the recommendation to establish a holistic process that holds digital design files as a starting point and ensures that, once physical samples are created, style adjustments on those are concurrently mirrored to the digital design files. To be able to do so, an end-to-end process has to be established which covers the product creation up to the AR process all in one pipeline and is as close to the product as possible to ensure a continuous flow of information (P9).

*Workflow Establishment:* Lundberg et al. (2020) highlighted that besides the digital infrastructure, also internal workflow processes and functions need to be adjusted, which was congruent with the insights shared by the consulted experts. Participant 6 noted that it is "*not only the investment in* *actually producing the content, it's also the investment in that workflow, or, doing the integration or the backend system as well, that needs to support these new ways of working or these new content types that you might have."* Participant 4 emphasised to integrate AR try-ons into existing structures and not treat them as an isolated topic. Same added further, to deploy newly required platforms and systems for data transportation, quality insurance and related processes as well as to secure process transparency and data exchange throughout the company and along the supply chain to enable a smooth running of the new product life cycles. While participant 7 highlighted the advantage of agile ways of working, participant 9 mentioned the importance to assemble different teams responsible for process rollouts, technology updates, the respective adjustment of related workflows or else, to cope with the constantly reoccurring changes. Masood & Egger (2019) highlighted as well to align the AR system not only to the IT infrastructure but also current practices, like those concerning health or safety.

*Up-to-dateness:* It got further mentions that both, the implemented AR tool as well as its accompanying systems, infrastructures and workflows require regular updating to correspond to changes in consumer behaviours and new technological developments (see also Jung et al., 2016). Participant 8 highlighted that *"if it works, people will come back"* and as further added by participant 10, continually updating and coming up with newer, better applications facilitates, on the one hand, additional benefits and on the other the compatibility with emerging technologies that might become an integrated part of AR solutions in the future (P3).

*4) Customised Tech Solution* Ensuring the organisational fit of the applied tech solution was identified to be another relevant component for effective AR adoptions (see also Masood & Egger, 2019) and is involving several aspects. The first is the tool's fit to the company's business model. Every firm is unique, and to identify the most suitable application and processes might require some testing (P4). The second addresses the brand fit of the tool. Participant 6 highlighted to invest additional work into this to "*make it look and feel like it's [us] rather than it just being something that we bolted onto what we do.*". The third is the adjustment of the tool to the offered product types. Participant 7 highlighted that for firm's with primarily seasonal designs, the selected solution needs to allow quick and cost-effective generations of 3D asset and participant 3 and 4 added that it should also be explored how well the quality and detail actually has to be for the utilised product types since a t-shirt requires a lower fidelity than shoes for instance. Fourth, the application needs to be customised to the target market as well as its specific user group. Participant 10 highlighted to ensure that the market is mature enough to go into the next step of innovation and that there are no, more fundamental problems to solve still. Participant 11 noted the importance to adjust the solution and the provided experience to the customer base and "*find out if they like it, they think it's useful first*". Last, the tool's compatibility with legacy systems as well as web, mobile and cloud application was emphasised to be ensured, same as its updating potential and future prospects in order to keep the technical performance state-of-the-art (P5) and ensure the easy integration of other emerging technologies like blockchain, AI, robotics or cloud and edge computing that will likely be part of these solutions at scale in the future (P3).

*5) Supply Chain Involvement & Interaction* Next to customisation efforts, the collaborative interaction with either supply chain partners or brands was highlighted to play an important role in AR adoption processes, addressing the components of collaboration, standardisation and smart supplier selection.

*Brands:* From a brand's perspective, it was noted that "*if you have suppliers, really a lot of suppliers, globally, maybe they can be using three different technologies. So it's like, who takes on the cost of investing in these new technologies and the training and all of the things that go into it*?" (P12). The stated solution was to invest in good supplier relations and develop a collaborative innovation strategy with manufacturers to share 3D generation efforts and get them designing digitally from the start (P9). To standardise the utilised tools along the supply chain and ensure their compatibility with each other was further mentioned to be crucial in order to avoid inefficiencies or the loss of information. Aligned with the expert insights, Amed et al. (2019) and Roberts-Islam (2020d) emphasised to facilitate collaboration and the exchange of data, strategies and insights to share the burden along the supply chain and form strategic partnerships with manufacturers. If innovating together is not an option, it was outlined to intensify the efforts to cooperate and form strategic relationships with manufacturing firms already operating at a highly digitised level. Participant 12 described those companies as "*little campuses that you come and visit, and everything's done there - like the fabric is made there, the garments are made there, they have graphic designers there and printing there, designers there in general. These kinds of companies, they're the ones investing in the digital technologies, because they have the customer need for it and also, they're quite big companies with huge turnovers.*".

*Online Retailer:* From a retailer perspective, the investment in good brand relationships and an active exchange of knowledge and information was highlighted in order to ensure the direct providence with digital 3D files most brands are holding anyways. Participant 3 further noted that *"if they also make those 3D assets from the designs available now to their retailers, then that shortens the life cycle to getting that product out there"* because online retailers do not have the need to scan or recreate each physical item themselves to utilise it with AR, which is considered to be extremely time- and resource-intense anyways (P8, P12). Participant 8 further highlighted that to ensure size & fit realistic AR try-ons in the future, brands would also need to share their target measurements and the exact pattern measures due to reasons outlined in *Chapter 4.1.* "*If we could have from brands the sewing patterns, the measurements that would be a very different story. It would be much easier, it would be more precise even, if they were correct."* (P8).

***6) Change Management*** The last factor found to be critical for effective and lasting adoptions of AR try-ons is an overall change management to cope with resistance and prepare all involved stakeholders for making the required organisational changes. It comprises both coaching as well as training efforts.

*Coaching:* Full company commitment together with a clear stakeholder understanding of the technology and its provided benefits were highlighted to be essential adoption components that can be assured with the help of thorough coaching measures. Participant 3 stated that "it's *a lot of internal challenges. The external challenges, they actually resolve* "but for the internal ones you need to *"get everybody at a company aligned."* This includes relevant strategic partners, internal departments, as well as the firm's management. To facilitate greater commitment, it was pointed out to ensure that all stakeholders involved clearly understand the purpose and need of the new application. Participant 10 further added that *"when people understand the technology well, they also present the technology very well to the customers"*. In particular design, sales or buying teams were emphasised to be placed in focus because to get those "*people that were doing things analogue […] to doing everything on a* *software*" (P11) was experienced to be an essential step. Participant 3 also noted that "*especially [in] companies where they're manufacturing their own products, there's a resistance to change*" because commonly designer *"put so much heart and soul into what they're creating, and somehow there's a belief that digital is somehow a lesser product.*". To closely involve the buying and sales teams was particularly emphasised by participant 7, among other things *"because they have a strong opinion on how we should present their assortment of course, and they also work together closely with the brands that we sell."* Besides the workforce, also the (top) management needs to understand the technology and related benefits because "*for anything new and that's a significant investment, it goes all the way to the top of the company. So essentially, it needs to be signed off by CEO and our executive directors.*" (P6). This turns managerial support into a critical factor for technology adoptions which has already been examined by extant literature (Hameed et al., 2012; Dikert et al., 2016; Yeh & Chen, 2018; Masood & Egger, 2019). Participant 11 also reported that executive support facilitates the implementation process and ensures that all departments are on board. Corporate education days with C-level executives over to key personnel were mentioned to be a suitable mean at the beginning of transformation processes as they enable to present the technology's features, come up with company-specific use cases and facilitate to get everybody committed (P3). Participant 3 shared the experience that after those sessions, stakeholder often *"don't just buy-in, but they're actually genuinely excited"*, and emphasised that "*companies should do that internally or they should invite companies in to do those kinds of demos for their internal teams."*

*Training:* To ensure stakeholders are capable of handling the newly established software and tools, investments in training were emphasised to be required. *"If the trainings are done well, if it's explained well, as the upsides are explained well, if it's sold well enough so everybody has been bought into the premise that this will be good for them - then it's very easy.*" (P10). Participant 11 highlighted to particularly get the designer used to work in digital software and further points out the benefit of peer experts in each team, helping out colleagues with tech and change related questions. Participant 10 added that "*one thing that you need to ensure is, as your rotation of people changes, they have to get the same quality of training as the first cast of people that was the one initially adopting it. Because especially in retail, the rotation of the team is very high. So I feel like the quality of the training has to be very consistent.*", and further mentioned to include "*a refresher from time to time about what exact advantages it gives"*. To do so, participant 9 noted the compilation of responsible training teams.

### 4.3. Conceptual Model

Grounded in the discussed study findings, a conceptual model is built, explaining the suggested interrelations between the identified adoption success factors and their potential effects on the firm's economic profits and competitive performance.

As depicted in *Figure 3* and suggested by the data, all six parameters have to come together and be balanced to ensure an efficacious implementation of AR visualisations in the industry of focus (see also *Appendix H*). *Vision & Strategy* was found to constitute the starting point for a prosperous implementation of AR visualisations due to its explicit relation to each of the other five success components. Along with the success metrics *Holistic Underlying Processes* and *User Interface & Communicati*on, which are framing the remaining three critical success factors, it was highlighted to

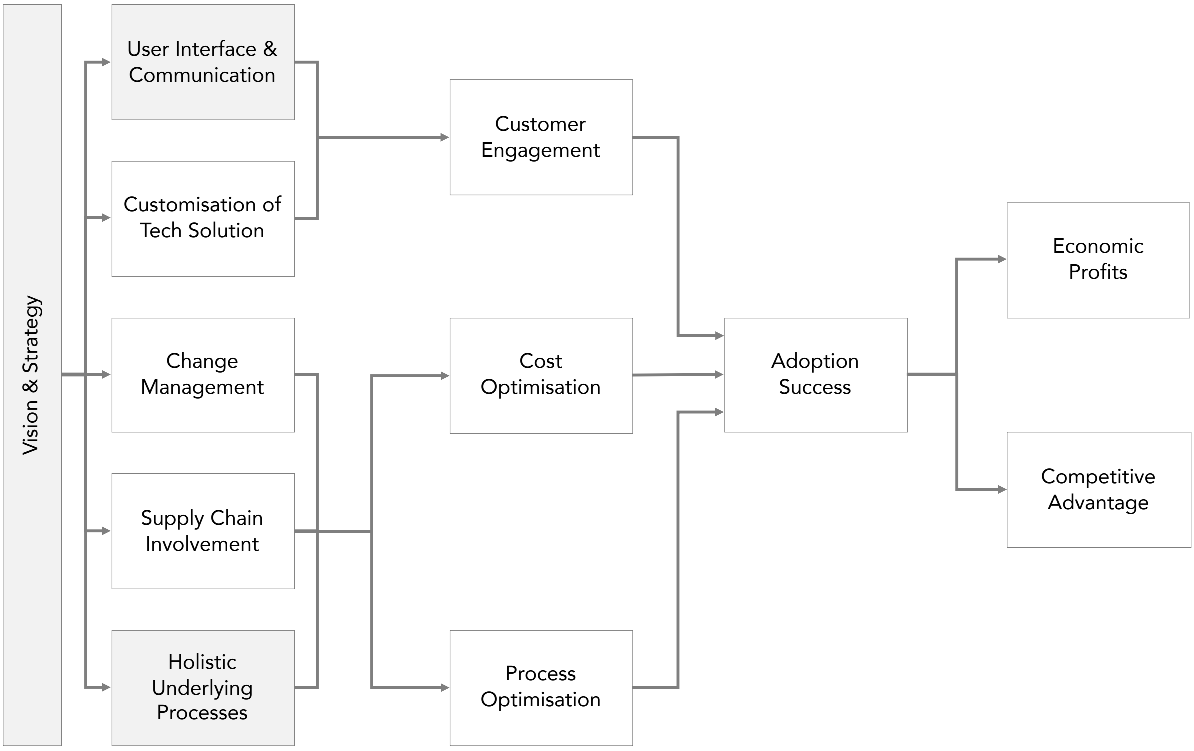


*Figure 3: Conceptual Model of the Identified CSF, their Indicated Interrelations & Potential Effects for Online Fashion Firms*

form the key pillars for a lasting, prosperous adoption outcome. While all six factors of importance implicitly interrelate, the impression was shared that some are interlinked more directly. The data indicated that the design of the user interface is likely to be influenced by the level of customisation provided by the utilised AR solution. The better the technology fits the required use cases and gets smoothly integrated and aligned, the greater is the 'utility – simplicity – fun' aspect for users while engaging with it. If executed well, those two factors are leading towards greater consumer engagement and a higher acceptance of the new technology. Further, the gained insights suggested that the establishment of holistic underlying firm processes is likely to necessitate the inclusion of the firm's supply chain partners as an overall adjustment of the product life cycle and the creation of integrated workflows are involved. To enable a smooth transition to newly implemented tools and adjusted work processes on the part of the workforce, it was highlighted that both success factors are requiring a thorough change management. If the interplay between those three success metrics is performed well though, greater process efficiencies and decreased costs can likely be expected. Naturally, process improvements facilitate cost optimisations and the saved expenses can be utilised to scale up further, fund change management efforts and invest in new technology. This suggested beneficial loop of greater user engagement, process and cost optimisations eventually leads towards an effective adoption, manifested in higher economic profits and the establishment of a competitive advantage.

### 4.4. Additional Findings and Future Prospects of AR try-ons in Online Clothing and Fashion

In the past, technological constraints were the primary reason why Augmented Reality fell short regarding the commercial promise it was expected to have (Taqvi, 2013; Garnham, 2019). Driven by recent developments, inter alia in the areas of 3D asset generations, 3D depth lenses and real-time motion tracking, AR has finally matured enough to turn from a fun division into an auspicious retail element (Bellini et al., 2016; Barberie, 2019). This section provides an outlook where the technology's development is expected to be heading in the future and outlines further aspects concerning the examined industry that were mentioned by the consulted participants.

As indicated before and confirmed in the interviews (e.g. Participant 4 and 12), 3D renderings have already reached a level of sophistication that enables firms to digitally create garment items that are hardly distinguishable from a photograph of the real product. However, their generation at scale is still considered costly and particularly challenging to be realised on the part of smaller fashion firms (Participant 2). Facilitated by newly evolving software tools and the imminent digitisation of internal design processes, this is expected to change within the next three to five years, paving the way towards a broader diffusion of Augmented Reality in fashion retail (Participant 3; Basnet, Burgar et al., 2020a). In the course of the mentioned time frame, also tools for product visualisations and virtual try-ons are going to mature, reaching a level of sophistication that "*allows to interact with technology in a truly organic way*" (Participant 3). With the continuing democratisation of the technology, a growing range of firms will be able to offer AR try-ons and eventually, the utilisation of entirely virtual goods for purchasing processes will turn into common practice and an inherent part of the consumer's everyday life (Participant 1 and 3; Basnet, Beauchamp et al., 2020, Basnet, Burgar et al., 2020a). While the topic of size & fit is currently not a feasible option, their fixed integration in AR try-on tools will be facilitated through both, increased accuracy of garment sizes, enabled through the shift from physical to digital prototyping procedures, as well as continuously enhancing body scanning technology utilising Artificial Intelligence and cameras with integrated lasers, collecting thousands of accurate measuring points in a fraction of seconds (Morgan Stanley, 2018; Lane, 2019). Besides accurate sizing, technology that is simulating haptic virtual experiences like a fabric's digital scrunch behaviour (McCormick et al., 2014) is expected to be steadily embedded in AR try-on solutions, elevating digital experiences closer towards physical shopping (Chiu & Safian-Demers, 2020).

With democratising AR technology and consumers becoming more and more comfortable with exchanging personal information online (Curtis & Cotton, 2019; Lane, 2019), try-on applications will provide fashion firms with a series of new opportunities to customise user experiences and decrease product return volumes to under 10%, entailing lower expenses, higher profit margins and the reduced waste of resources (Morgan Stanley, 2018; Goldman Sachs, 2019). Collected data on the users' general style preferences can be employed to predict fashion trends more reliably and to create clothing designs that are more likely to match present expectations (Martin, 2019). User-specific data enables firms to offer personalised garment recommendations (see Biswas, 2017) and is especially beneficial for those individuals struggling to make good fashion choices on their own. The amassed amount of body-shape data and size measures that will be accessible once size & fit applications become marketable can be used to assist shoppers in finding garments best fitting their individual body shape and further offer new opportunities for custom-made clothing (Lane, 2019; Martin, 2019). In the long run, manufactures can analyse the gathered data to create representative sizing charts that are based on actual consumers rather than outdated assumptions on a target group's body ideals which were repeatedly found to cause an overall dissatisfaction with the general fit of garments on the part of users (LaBat & DeLong, 1990; Morgan Stanley, 2018; Shin & Damhorst, 2018; Saaludin et al., 2019).

The access to behavioural consumer data makes it possible for marketers to get to know their users beyond transaction habits and to provide personalised, targeted advertising content at scale that is integrated more naturally in the customer's shopping journey (Basnet, Beauchamp et al., 2020). It additionally opens new doors for the commercial exploitation of influencer marketing since the possible interaction with virtual items is going to replace the required supply with physical test products. Over time, AR is expected to turn into its own retail sector where user-generated AR content becomes a feasible option, providing individuals with the ability to personalise and self-design garment items, record self-conceptualised AR content to share online and utilise their personal avatar twin for more humanised interactions in the virtual world and a method to represent themselves in the best way (Participant 11; Basnet, Beauchamp et al., 2020; Tamuly, 2020). Despite all advantages, utilising personal consumer data involves moving on a thin line between optimised experiences and the intrusion of the users' personal space (Zaruba, 2019). In the future, new social norms and legal regulations are going to be defined, not only to regulate the handling of consumer data but also to support marketers with preventing user harassments in virtual spaces, regulating entering permissions and avoiding damages within or to the virtual environments caused by unwanted invaders or cyber-attacks (Collins, 2019; Basnet, Beauchamp et al., 2020; Lundberg et al., 2020).

The providence of immersive, personalised user experiences is expected to be fostered by the planned transition to 5G network which rollout has already undergone testing in nations like the UK, the US or North Korea over the last 18 month (Cha, 2019). Faster mobile internet with download speeds up to 20-times higher than the current average will enable users to be constantly connected and stream high-quality video content on-the-go without requiring wi-fi connection. For fashion firms, this provides new immersive opportunities to reach out, interact and engage with consumer anytime, anywhere and by using richer immersive content (Cha, 2019). With powerful mobile networks the projected evolvement of new shoppable formats, like live commerce, will be encouraged and mobile devices equipped with true-depth cameras and stronger processors capable of performing advanced Augmented Reality applications are expected to become market standard (Lin, 2019). Due to the devices' worldwide distribution and its enhancing technical state, the movement of AR is assumed to be primarily smartphone-driven in the next two to three years. Smartphones are expected to be leveraged by the mass as a new tool to enjoy memorable augmented experiences, take 3D scans of their bodies and make purchasing decisions by simply utilising their device camera and screen (Billinghurst et al., 2015; Boletsis & Karahasanovic, 2018; Morgan Stanley, 2018; Basnet, Beauchamp et al., 2020). The resulting wide and easy accessibility for end-users is a major advantage of AR over Virtual Reality which is not expected to have a retail adoption rate at scale any time soon due to higher initial hurdles like the need for specific devices and the setup of entirely virtual environments (Participant 9 and 10). Besides smartphones, tablets and computers, more diverse AR devices for end consumer usage are going to evolve over time. A new frontier of smart TV shopping and virtual closets with integrated AR try-on tools is expected to emerge (Nicolon, 2019; Basnet, Burgar et al., 2020a) and in the long run, AR glasses are considered to penetrate the market, once they reach a level of comfort, prestige and accessibility that facilitates their adoption by the mass. Latter is probably not going to happen on an end consumer level within the next three years, but leveraging wearables within enterprises to examine store layouts for instance, constitutes a considerable option (Participant 3 and 10; Basnet, Beauchamp et al., 2020).

The outlined future developments expected for AR try-ons are assumed to be accelerated by the outbreak of the global COVID-19 pandemic. The fashion industry was already facing transformational changes, but with lasting contact restrictions and occurring supply deficiencies, the need for digitisation increased drastically, pushing forward the implementation of immersive technologies (Participant 8, 9 and 10). While fashion is considered to be a fast-moving industry adapting quickly to market changes and shifting consumer demands, it is rather known as a reactive than innovating sector. Still, first initiatives in the form of virtual catwalks, digitised fashion shows, or AR filter campaigns have been realised, mainly by high fashion brands which are also expected to be heading the upcoming movement towards AR until democratised applications are evolving (Participant 10 and 12; McDowell, 2020). On the whole, the study's participants agreed that it is at the time to start piloting with Augmented Reality applications or at least prepare for their future implementation. First test runs revealed the high interest in AR try-ons on the part of the users as well as their existing tolerance towards minor performance imperfections of the tool (Participant 3, 4, 6, 8 and 11; see also Almousa, 2019; Roberts-Islam 2020a). Also wholesale buyers were found to be open-minded towards virtual showrooms and digitally presented garments, partly more than the firm-internal sales staff themselves (Participant 9). Implementing AR try-ons does not happen overnight, as explicitly pointed out by some of the consulted study participants (Participant 1, 2 and 3). Depending on the firm's level of digitisation and available underlying infrastructures, the required time frame can reach up to three or more years, emphasising the need for a clear Vision & Strategy, discussed in section 5.2.

Taken together, even though AR technology is expected to require a few more years to fully mature and its implementation is linked to significant time and costs efforts, the presence of Augmented Reality try-ons and product visualisations in online retail is likely to become an integrated part of the consumers shopping journey in the future, making it mandatory for fashion firms to offer immersive experiences and provide their users with a greater level of engagement. If utilised wisely, the technology's development will provide fashion firms with a massive amount of new opportunities outlined in the previous chapters as well as broader customer coverage. As stated by AR pioneer Tom Emrich: "*If you're not in Augmented Reality or Virtual Reality, you're only making money in one reality. Why would you only make money in one reality*?" (Basnet, Beauchamp et al., 2020, 00:42:16).

## 5. CONCLUSION AND FUTURE RESEARCH

Augmented Reality try-ons are expected to become an integrated part of the consumer's purchasing journey and will help to bridge the gap between physical and digital shopping. The objective of this study was to answer the two research question of *"What key challenges are being faced by firms in the online clothing industry when adopting Augmented Reality try-ons?"* and *"What are the critical success factors for sustainable adoption of Augmented Reality try-ons by firms in the online clothing industry?"*. This was done by following a Grounded Theory approach and conducting qualitative interviews with 12 professionals constituting in equal parts representatives of clothing brands, online fashion retailer and industry consultants.

This study has shown that the main challenges with AR implementations are of diverse nature, originating from industry-related concerns and those addressing the firm's and technology's readiness. Key challenges found to be involved with AR implementations are *Digital Infrastructure & Organisational Processes, Tech Characteristics, Change Resistance & Mindset, User Adoption* and *Lacking Knowledge Resources*. Further, *Market Pressure* was considered a potential implementation barrier, but of lower influence. The respective CSF to cope with these potential hurdles are circling around the importance of organisational measures and were identified as follows: *Vision & Strategy, User Interface & Communication, Holistic Underlying Processes, Customisation of Tech Solution, Supply Chain Involvement* and *Change Management*. While overall, the factors have to be balanced, they are of highest relevance in different time sequences. The first three factors constitute the key pillars of effective AR adoptions and are embedding the remaining ones. A thorough vision and implementation strategy are considered the ideal base for effective AR implementations in order to prepare for the transformation in time, ensure a smart prioritisation of resources and identify the best fitting use cases. On that basis, the establishment of holistic underlying processes within the firm can be initiated. Those can ensure both the generation of 3D assets at scale and the required digital infrastructure that guarantees compatibility with the future AR applications. A holistic approach will be challenging to be realised without involving and cooperating with supply chain partners. Furthermore, to ensure full company support and in order to get everyone used to the adjusted workflows and comfortable with the new tools, accompanying change management procedures with training are considered critical. The creation of an intuitive user interface forms the third key pillar of lasting AR adoptions, together with clear user communication. First includes, for instance, the smooth step-by-step introduction of the desired application and a high level of utility, simplicity and fun for users. Latter ensures to include the consumer in the implementation process and prevents unrealistic expectations and usage concerns towards the unfamiliar application. Blending the new application in well with the customer journey might be difficult without the possibility to customise the technology solution, which is why this factor is necessary to be secured as well.

Even though no guarantee can be given, taking the outlined challenges and presented Critical Success Factors into consideration will most likely lead towards the effective adoption of AR visualisations in the online garment industry and resulting economic profits. Over the next years, AR applications in fashion e-commerce are expected to be utilised more widely, subjecting a steadily growing number of enterprises to the outlined adoption issues. The present study can be used as a first foundation in the search for guidance through the implementation process, contributing to an increasing number of effective AR exploitations.

### 5.1. Contribution

As outlined before, the mainstream adoption of AR try-on applications in online retail is still lacking despite the growing number of use cases and its attributed potential (Xiao-Jun et al., 2013). The great majority of extant adoption research on Augmented Reality has focussed on the customers' perspective, suggesting that the technology's perceived ease of use and perceived usefulness constitute key determinants in a user's adoption decision (Roy et al., 2018). The required subsequent step of deploying AR within the organisational context and ensuring its corporate fit and smooth performance implies a different focus though and has not gained much research attention yet. By following an exploratory approach and building on the Critical Success Factor framework of Leidecker & Bruno (1984), the present study addresses the outlined research gap. The essential need to ensure awareness and a clear understanding of occurring adoption challenges is outlined, as well as guidance given on how to address and handle potential bottlenecks in order to form a business strategy around the new technology that is able to target value creation and competitive advantage. As one of the very first studies in its field, this research presents further implications relevant for both academia and practice.

To the academic knowledge base, the study at hand contributes in five essential ways. *First*, it extends literature on AR implementations in the domain of Information Systems by examining the understudied organisational view. As mentioned, the great majority of respective research focusses on the technological advancements and general understanding of AR (e.g. Harborth, 2017) or its acceptance and adoption by consumers (Chandra & Kumar, 2019; Boardman et al., 2020). By focussing on adoption factors determining an organisation's efforts to implement AR, the study at hand verifies the significance of examining the adoption of new technologies from a firm's perspective and sets a foundation for further research in this field. *Second*, the present research also extends literature on AR technologies in general and is conducive in growing the interest of future scientists regarding the utilisation and implementation of AR try-on technologies. *Third*, by grounding the findings in data gained from industry and business experts rather than consulted extant literature, the study revealed a range of recent challenges and CSF's enhancing adoption literature by different factors and holding the potential to guide future research on AR. *Fourth*, the study's constructed conceptual framework extends the literature on adoption success factors and offers a theoretical basis for comprehending the determinants of effective adoption processes and their interrelations. Future research could study the identified factors and their connection in greater depth to extend the gleaned selection. Further, the framework can be utilised to examine the adoption of related technologies like Virtual Reality in the same or comparable contexts. *Fifth*, the utilisation of the CSF framework allowed the study to frame the empirical findings in an academically acknowledge way but also contributes to referring literature by proving the framework's suitability for identifying adoption success factors for Industry 4.0 technologies.

Besides implications for academia, there are also a number of contributions for practitioner provided by the present study. *First*, the research points out the potential AR technology holds for clothing e-tailers, especially in times of physical contact restriction due to an ongoing global pandemic. AR technologies are still not exploited to the fullest despite their capability to facilitate both enhanced efficiency of internal firm processes as well as greater online experiences and a higher level of user engagement. The present research emphasizes this value of AR technologies, but further points out challenges likely to inhibit an effective adoption if not being faced. Garment e-tailers and clothing labels can use the identified key challenges and related CSF's as a starting point to find guidance on which aspects are crucial to be considered prior to and throughout the implementation process. Further, it provides them with the possibility to directly address potential barriers in their adoption strategies and immediately adapt or extend necessarily needed resource capabilities to reduce the risk of adoption failure and ensure the effective implementation of AR try-ons. As AR technology is expected to reach maturity over the next ten years and thus, will be applied more and more widely (Basnet, Beauchamp et al., 2020), a rising number of businesses will be facing adoption challenges and looking for guidance or best practices for which the present research sets one first baseline. To simplify AR adoption from a technological standpoint, AR vendors can use the gained insights and revealed differences between brands and online retailer (see *Appendix I*), to develop and provide more customer-centric technology.

*Second*, the study highlights the key driver for implementing AR applications and calls on practitioners to genuinely consider the outlined factors associated with an effective adoption of AR try-ons targeting value growth. Compared to other technologies, AR tools hold a higher level of complexity and innovativeness, resulting in greater efforts required to integrate and align them smoothly to an e-tailer's or clothing label's business processes. Along with former studies highlighting that consumers primarily depend their usage intention and acceptance towards a new technology on the application's ease of use and perceived utility (Rese et al., 2016; McLean & Wilson, 2019), the present study suggests to pay attention to the provided user interface and a clear, targeted user communication. For instance, if users experience the provided try-on application as an enjoyable balance of convenience, simplicity, utility and entertainment and clearly understand its purpose and benefits, they are more likely to build loyal customer relationships (van Esch et al., 2019).

*Third*, the research suggests to customise the applied AR solution and design, develop and adopt new AR try-on applications at best in alignment to the respective business strategy and context. The data indicated that practitioners need to spend efforts on identifying the right use cases within their business and on clearly understanding their customer base to address the right target groups and include software features best responding to their needs. Latter also applies to AR vendors as customizable tools with favourable long-term prospects are going to attract greater attention.

*Fourth*, the study emphasizes not only the importance of establishing holistic underlying firm processes but also the involvement of a firm's main supply chain partners. It was found from the interviews that without the necessary infrastructure and a digitised product portfolio, implementing AR will not be a scalable option in the long-run. The necessity for clothing brands and retailers to prepare now and lay down the basic conditions for integrating AR, while software vendors are simultaneously working on refining AR try-on solutions, is urged by the research at hand.

*Fifths*, the relevance of a clear vision and an aligned business strategy is highlighted by the data, accompanied by thoughtful performed coaching and training to escort the digital transformation process. A firm is incentivised to concentrate on putting visionary and innovative decision-makers in charge of setting realistic time estimates for AR implementations and prioritising or procuring resources smartly. According to the insights gained from the interviews, all relevant stakeholders further need to be capable of performing their new tasks and require a full understanding of the implemented application, its purpose and benefits to not hamper or block the efforts taken.

Overall, the current research provides an essential foundation for clothing e-tailers, and perhaps also comparable firms, to decrease adoption failures and ensure the long-term performance of an AR application along with its contribution to a sustainable competitive advantage. It emphasizes that it is vital for practitioners in the online clothing segment to proactively shed attention to the identified challenges and create a clear vision and business strategy that is fully exploiting the outlined adoption success determinants for greater value delivery. Rather than technological features and therefrom resulting barriers, the identified results highlight that inter-organisational characteristics and the firm's underlying processes play a primary role when adopting new AR technology. Within the fashion segment, Augmented Reality solutions are on average still not seen as the most beneficial business case since the lack of self-made experiences and a sufficient number of best practice cases brings concerns about high investment costs and rather low resulting effects on conversion and returns further to the fore. The technological state and costs of AR are not the main issue though, as the technology will mature over the next years, driven by digitisation. Those e-tailers and brands not interested in being early adopters are therefore encouraged by the present research to start adjusting their internal structures and processes already in order to be ready to act immediately once the technology is democratising and becomes market standard.

### 5.2. Limitation and Future Research Agenda

Next to essential contributions to research and practice, this study also holds limitations, indicating directions for further research. *First*, the generalisation of the findings can be seen as an issue, as already pointed out in the method section (*Chapter 3*). The developed conceptual framework is based on application- and industry-specific insights and not yet proven to be transferable to other contexts. Fellow scientists are encouraged to conduct qualitative research in equal or similar contexts with broader or more defined samples to verify and extend the outlined adoption factors before proceeding to quantitatively testing them via survey questionnaires. Additionally, future studies could examine the identified factors in more depth and verify their relations. The present research focusses on the organisational standpoint towards AR adoptions which constitutes a relatively new field of Information System literature. Future research could aim to provide more guidance to practitioners, for instance, by examining what it takes to embed AR smoothly in a fashion firm's business strategy or by specifying the provided implication for the establishment of holistic underlying processes compatible with AR try-ons.

*Second*, it has to be noted that even with paying close attention to the obtained challenges and success factors, the effectiveness of adopting AR try-ons cannot be fundamentally guaranteed. Businesses are diverse in their internal structures or target markets, and the research is rather offering a guideline than an exclusive solution. Due to the topic's novelty, a general approach to analysis has been comprised by the present study, including perspectives of both firm-internal professionals as well as external industry experts. By questioning e-tailers, brands and AR experts, more comprehensive insights and a holistic picture were possible to be obtained. A deeper, more detailed level of analysis would not have been productive for the early stage of research in that area. Future studies though, could distinguish between brands and online retailer to examine potential challenges and adoption determinants solely applicable for one of the two parties. Additionally, it could be examined if the results vary between large and small firms or, alternatively, if there are differences between AR try-ons following visualisation purposes versus those also aiming to address the topic of size & fit predictions.

*Third*, as the conceptual framework was designed specifically for AR try-ons in the area of online clothing, it is likely that in different contexts additional factors and relations exist that have not been discovered yet but also play a significant role for AR adoption processes. The present research focussed on practitioners mainly operating in Europe and North America and the gained results could differ for countries in the Asian Pacific area like South Korea or Japan where advanced technologies like AR are more deeply integrated (Research and Markets, 2020). Therefore, further studies could replicate the present research in different geographies or industry sectors as well as for Brick & Mortar store settings or other media types like Virtual Reality or wearable devices. It was also pointed out by one of the participants (P8) that market pressure could be seen as motivator rather than challenge. Fellow scientists might explore this issue in detail and potentially examine other motivational factors for adopting AR.

*Last*, the developed conceptual model builds on a cross-sectional approach, providing a snapshot of the technology's success determinants rather than a profound understanding of its evolution in the course of time. Perceptions are likely to change, and stakeholders get more familiar with the technology and its features over time (Davis & Venkatesh, 2004). Due to this, fellow scientists are encouraged to conduct longitudinal studies on the topic to complement the developed theoretical framework by more dynamic factors.

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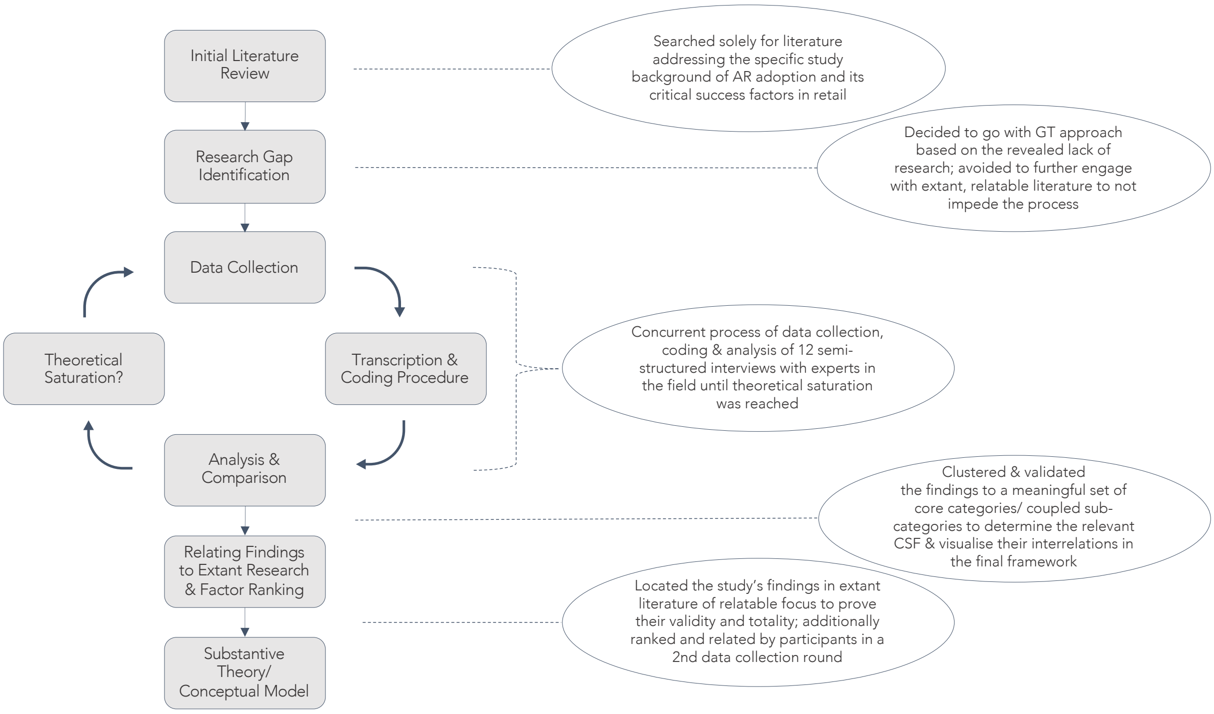
# APPENDIX

## Appendix A.

*Applied Research Design, following a slightly adapted Grounded Theory Approach*




## Appendix B.

*Most relevant Terms and Search Strings for the Initial Literature Search*

a. *Compilation of the Most Relevant Search Terms Used for the Initial Literature Search on SCOPUS and Google Scholar:*

| Search Terms of Highest Relevance | | | |
|---|---|---|---|
| Augmented Reality | Online retail | Success factors/ criteria | Firm Perspective/ Approach/ View |
| Immersive Media | e-commerce | Decision factors/ criteria | Organisational Perspective |
| Fashion | electronic retail/ e-tailing | Adoption/ Implementation | Management/ Manager |
| Virtual try-ons/ Virtual fitting rooms | Online Fashion/ clothing/ garment/ apparel | Assessment/ Application/ Acceptance | Marketing/ Adoption Strategy |

b. *Compilation of the Most Relevant Search Strings Used for the initial literature search on SCOPUS and Google Scholar, including the number of search results for the search strings of highest relevance (last update: August 7, 2020):*

| Label | Search Strings of Highest Relevance |
|---|---|
| 1 | "Augmented Reality" AND ("e-commerce" OR "online retail" OR "e-tailing" OR "electronic retail") |
| 2 | "Augmented Reality" AND ((Organisational OR Firm OR company OR business) AND perspective) |
| 3 | ("Augmented Reality" OR "try-ons") AND ((success OR key OR adoption OR implementation) AND factors) |
| 4 | "Augmented Reality" AND (fashion OR clothing OR garment OR apparel) |
| 5 | (Success OR adoption OR implementation OR decision) AND factors AND retail |
| 6 | "Virtual try-on concepts" OR ("virtual try-on" AND "technology") |
| 7 | "Augmented reality" AND ("try-on" OR "try on") |

SCOPUS Search Results:

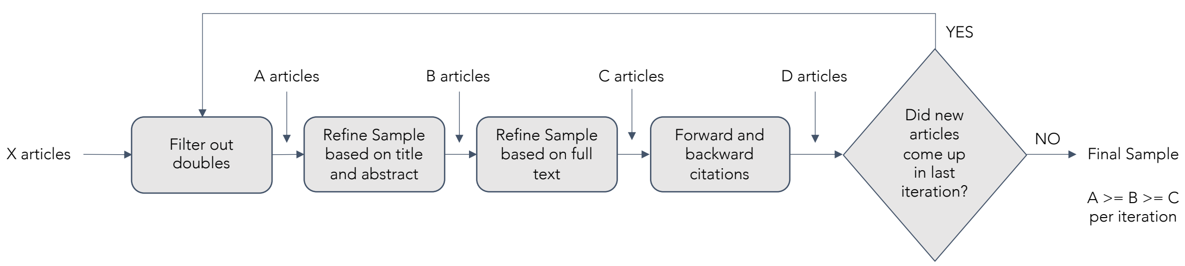
| Year / Search String Label | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 2020 | 6 | 18 | 46 | 17 | 133 | 8 | 6 |
| 2019 | 20 | 17 | 65 | 30 | 207 | 14 | 14 |
| 2018 | 13 | 16 | 59 | 42 | 177 | 10 | 7 |
| 2017 | 17 | 16 | 39 | 24 | 155 | 8 | 6 |
| 2016 | 6 | 9 | 31 | 15 | 165 | 10 | 9 |
| 2015 | 7 | 6 | 22 | 14 | 131 | 7 | 6 |
| 2014 | 6 | 5 | 23 | 11 | 110 | 5 | 2 |
| 2013 | 10 | 9 | 24 | 13 | 135 | 4 | 4 |
| 2012 | 6 | 4 | 18 | 16 | 105 | 2 | 4 |
| 2011 | 2 | 2 | 11 | 12 | 109 | 4 | 5 |
| Total (2011-2020) | 93 | 102 | 338 | 194 | 1427 | 72 | 63 |

Google Scholar Search Results:

| Year / Search String Label | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 2020 | 1320 | 6890 | 9830 | 3470 | 21600 | 182 | 203 |
| 2019 | 2310 | 11800 | 16300 | 6100 | 40800 | 298 | 378 |
| 2018 | 1940 | 9260 | 15200 | 5120 | 51400 | 196 | 290 |
| 2017 | 1390 | 7040 | 12100 | 4000 | 53000 | 154 | 206 |
| 2016 | 897 | 4900 | 8190 | 3050 | 57200 | 165 | 149 |
| 2011-2015 | 2700 | 14400 | 16400 | 9320 | 293000 | 572 | 451 |
| Total (2011-2020) | 10557 | 54290 | 78020 | 31060 | 517000 | 1567 | 1677 |

# Appendix C.

*Method for Reviewing Academic Literature by Wolfswinkel et al. (2011)*



## Appendix D.

*Exemplary Overview of AR Practice Cases in Fashion Retail*

*Random Selection of Clothing Brands/Online Retailer which have Launched AR Features in the Past (firms featuring Virtual Fashion Shows or Virtual Mirrors in physical brick & mortar stores are not included; data elaboration based on firm websites, industry reports, academic and newspaper articles, blog and marketing posts)*

| Industry | Brand (title of application) | Launch | Short Description |
|---|---|---|---|
| Clothing | Tobi.com (Fashionista) | 2009 | Virtual try-on of garments (not available anymore) |
| | Zawara ("Virtual Fitting Room") | 2009 | Virtual try-on of garments (not available anymore) |
| | JC Penny | 2011 | Virtual try-on of garments (2011 for their temporary 'Back To School' marketing campaign - not available anymore; 2019 for their 'Modern Bride Collection') |
| | Net-A-Porter | 2012/ 2017 | Photo-based AR Filters (temporary during launch of new collection) (2012 & 2014);<br>Virtual AR "wardrobe" to see garments in 3D and interact with them (test run in 2017) |
| | GAP ("DressingRoom") | 2017 | Virtual try-on of garments (on customised avatars projected into real surroundings) |
| | Tommy Hilfiger | 2017 | Virtual try-on for one garment collection (temporary test run) |
| | BlinQ | 2019 | Virtual try-on of clothing including body measuring & size recommendation |
| | ASOS ("Virtual Catwalk") | 2019 | AR visualisation that allows users to view models as if they are walking in the room with them (testing stage) |
| | Hugo Boss | 2019 | 3D product designs and product prototyping with AR |
| | Inditex/ Zara ("Shop The Look") | 2019 | AR app to visualise animated 3D/AR mannequins wearing garments (testing stage, US area) |
| | ASOS ("See My Fit") | 2019 | Virtual try-on of clothing on a range of 16 models (so far) of different shapes and sizes; taking account of the size, cut and fit of each individual garment (testing stage) |
| Footwear | Converse (The Sampler) | 2010 | Virtual try-on of sneakers (not available anymore) |
| | Lacoste | 2014 | AR campaign to visualise and try-on sneaker (simpler marker-based execution, temporary campaign) |
| | Shopify [retailer] | 2018 | Virtual try-on features for shoes offered to each brand |
| | Wannaby ("WannaKicks") | 2019 | Virtual try-on of sneaker + additional AR filters |
| | Dr. Martens | 2019 | Full 360-degree 3D visualisation of new four-piece shoe collection + 3D superimposition onto surrounding using AR |
| | Gucci | 2019 | Virtual try-on of popular and customisable 'Ace Sneaker' collection |
| | Nike ('Nike Fit') | 2019 | Virtual try-on of sneakers including size & fit measuring scan |
| | Adidas | 2019 | Virtual try-on of sneakers |
| | Goat | 2019 | Virtual try-on of sneakers |

## Appendix E.

*Exemplary Interview Guides*

*Final versions of the initial interview guides that have been slightly adopted in the course of the study and were in some cases specified to the interviewee's background, both typical for Grounded Theory studies.*

Interview Guide – Online Retailer & Brands

1. How do you see the current developments & potential of 3D real-time visualisations and AR applications in the area of fashion eCommerce?
2. What are in your opinion the main aspects affecting the diffusion of new technology as AR try-on applications in the online fashion industry?
3. To what extend does your company utilise 3D/AR visualisations so far?
   a. Do you have 3D renderings of all your products?
   b. What were main reasons for the company to start considering forms of AR?
4. Which aspects play a key role for the decision on whether or not to implement new technology as 3D real-time visualisations and AR try-on tools?
5. Does it take effort from the side of employees & consumers to understand how to use and work with product visualisation tools as AR try-ons?
6. What challenges did you already experience or are common in the decision-making and implementation process of new technology applications?
7. How essential is the brand-retailer interaction/ relation when it comes to the implementation of new technology or AR? (Which supply chain partners need to be involved? How does the communication look like with retailers or other parties? What are related issues/ criteria that need to be considered when AR try-ons are aimed to be implemented?)
8. In your opinion, how is the long-term success of new technology ensured at best?
9. How do you see the future development (of AR) in the fashion industry?
10. Do you have any open questions or additional remarks on the topic?

Interview Guide - Consultants

1. How do you see the current AR developments and the potential of AR in the area of fashion eCommerce?
   a. How do you evaluate the potential & development status of AR Try-On Tools specifically?
2. What are in your opinion the main aspects affecting the diffusion of AR-based virtual try-on applications in the online fashion industry?
3. Based on which criteria is decided if an implementation of AR makes sense for a company?
4. Based on which criteria should firms select AR tools and development partners/ resources?
5. How much effort does it take for firms and their employees to understand the use and implement AR try-on technology (or comparable product visualisation tools)?
6. What are common challenges and issue that are faced in the implementation process?
7. How essential is the brand-retailer-relationship when it comes to tool implementations? *(What are issues or criteria that need to be considered when AR try-ons are aimed to be implemented?)*
8. How is the long-term success of a newly implemented technology ensured at best?
   a. How do firms track the AR tool performance and outcomes at best?
9. Which customer problem is supposed to be solved the most when implementing AR?
10. How do you see the future development of AR?
11. Further questions or remarks?

# Appendix F.

*Survey and Factor Descriptions - 2nd Data Collection Round*

## AR in Fashion eCommerce

### Prioritisation Ranking of the Identified Results

The purpose of this step is to identify which of the determined challenges and success factors requires the most attention in the AR adoption process.

Please ensure that each factor's meaning is clear to you before ranking the identified challenges and success factors by your perceived priority.

Thank you for your help!

* 1. What's your name?

* 2. Please rank the identified **key challenges** by your perceived priority (1 = highest priority, 6=lowest priority).

**Digital Infrastructure & Organisational Processes**

Specification:
- *Hierarchical firm structures/ organisational boundaries* (internal decision processes)
- *3D asset generation & compatibility* (new process requirements; implementation effort)
- *Scalability* of 3D asset generation (cost & time resources & their prioritisation; time-to-market)
- *Trading partner dependencies* (knowledge & information exchange with manufactures, brands, retailer, AR software firms; cost distribution issue, copyright issues)

**Change Resistance & Mindset**

Specification:
Organisational culture; conservative industry nature; workforce mindset (mainly resistance from Designers and Salesforce - pen & paper mentality)

**Lacking Knowledge Resources**

Specification:
- *Lack of skilled workforce/ tech experts* (unique skillset/knowledge mix required; limited education incentives & available professional trainings; tech talents difficult to attract for retail)
- *Internal knowledge gap* (lacking knowledge resources within firms; unawareness of tech capabilities)

**Market Pressure**

Specification:
From competitors, customer and digitisation pressure due to COVID-19

**Tech Characteristics**

Specification:
- *Missing industry standards for Technology & Sizing* (no standard 3D asset creation software, no holistic standardised AR software; varying size measurements and size catalogues for clothing)
- *Tool Selection Process* (Organisational Fit of the tool incl. customisation potential as well as licensing & contracting conditions; affordability; compatibility & future prospects of the use and compatibility of the tool)
- *Tool availability* (missing holistic/ democratised solutions: no common, convenient tool yet that combines the entire process of 3D generation up to web and app compatible AR solutions; immature size & fit software; insufficient hardware & device performance yet)

**User Adoption**

Specification:
User acceptance towards the technology; user privacy & security concerns; perceived body image & user self-esteem restricting the willingness to use AR

* 3. Please rank the identified **critical success factors** by your perceived priority (1 = highest priority, 6=lowest priority).

**Vision & Strategy**

Specification:
Visionary & innovative decision makers; realistic estimates of implementation times & effort; smart resource prioritisation; timely transfer preparation; human capital investment efforts - get/attract experts

**User Interface & Communication**

Specification:
- *UX Design* (utility, simplicity, convenience & fun of application; piloting & step-by-step introduction of the technology; full usage choice & control in hands of consumer; blending the application in the customer journey; clear usage guidance & instructions for users; data protection & data usage transparency)
- *Clear & targeted user communication* (marketing strategy alignment towards the newly implemented application; clear understanding of customer needs & preferences; target group specification of the application's functionalities; clear communication of customer benefit)

**Holistic Underlying Processes**

Specification:
- *Product life cycle adjustments* (time & cost savings through shortening and automation; compatibility issue prevention - same or compatible software throughout the product life cycle)
- *Automated 3D asset generation pipelines* (digitisation of the entire product collection; creation of complete & unified 3D asset libraries)
- *Workflow establishment* (new internal working processes, up-to-dateness insurance of tech & processes - keep it updated)

**Supply Chain Involvement**

Specification:
- *Smart Supplier Selection* (high level of digitisation/ innovativeness/ transformation willingness of supplier)
- *Collaboration* (investing in good relations; information & knowledge exchange; innovating together; shared 3D asset generation)
- *Tool & Process Standardisation* (ensure compatibility of the utilised software within the supply chain)

**Change Management & Trainings**

Specification:
- *Coaching* (Workforce motivation; full stakeholder & management involvement; external support through implementation experts/ consultants; full stakeholder understanding of tech, its benefits and use cases)
- *Training* (recurring and high quality skill trainings to work with new tech)

**Customisation of Tech Solution**

Specification:
- *Organisational Fit* (brand fit, use cases fit, market & target group fit; fitting software capabilities; long-term prospects and updating potential of tech);
- *Smooth & Aligned Integration*

4. Optional: Do some of the factors hold unsuitable terms or is a very relevant point missing?

5. Optional: Any other remarks?

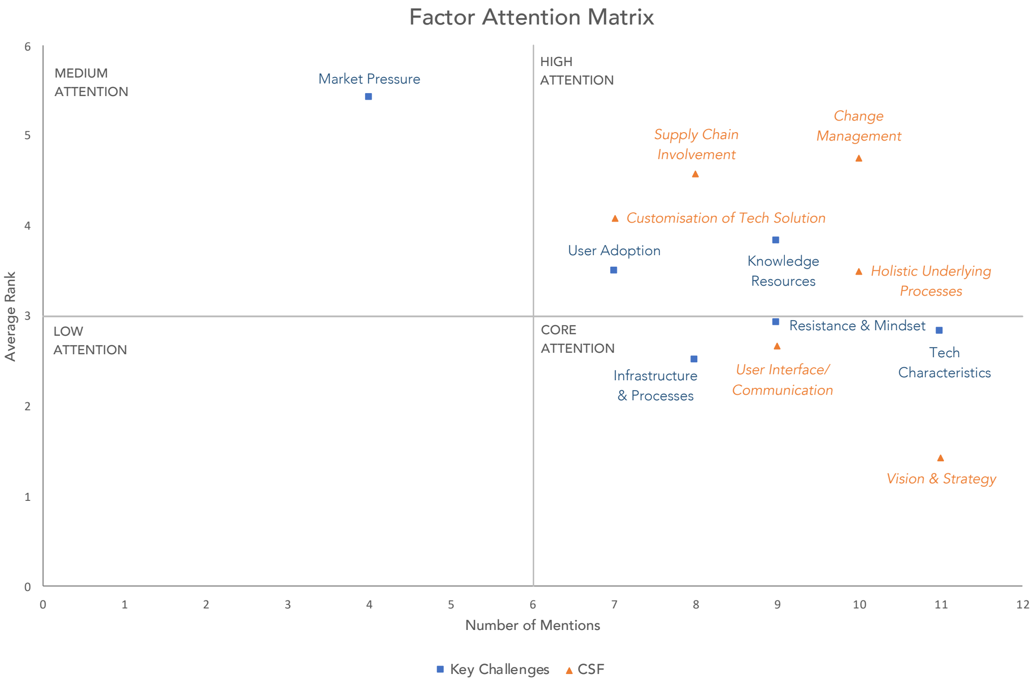
# Appendix G.

*Factor Ranking Results from the 2nd Data Collection Round*

| | | | PARTICIPANTS + PRIORITIES | | | | | | | | | | | | AVERAGE RANK | AVERAGE RANK | AVERAGE RANK | AVERAGE RANK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 | Overall | Consultants (P1-P4) | e-Tailer (P5-P8) | Brands (P9-P12) |
| CATEGORIES | Challenges | User Adoption | 2 | 6 | 4 | 3 | 2 | 1 | 1 | 4 | 4 | 4 | 6 | 5 | 3,50 | 3,75 | 2 | 4,75 |
| | | Tech Characteristics | 6 | 3 | 2 | 5 | 1 | 5 | 2 | 1 | 2 | 5 | 1 | 1 | 2,83 | 4 | 2,25 | 2,25 |
| | | Lacking Knowledge Resources | 3 | 2 | 5 | 2 | 6 | 4 | 4 | 5 | 5 | 2 | 4 | 4 | 3,83 | 3 | 4,75 | 3,75 |
| | | Digital Infrastructure & Organisational Processes | 1 | 4 | 1 | 4 | 3 | 3 | 3 | 3 | 1 | 3 | 2 | 2 | 2,50 | 2,5 | 3 | 2 |
| | | Change Resistance & Mindset | 5 | 1 | 3 | 1 | 5 | 2 | 6 | 2 | 3 | 1 | 3 | 3 | 2,92 | 2,5 | 3,75 | 2,5 |
| | | Market Pressure | 4 | 5 | 6 | 6 | 4 | 6 | 5 | 6 | 6 | 6 | 5 | 6 | 5,42 | 5,25 | 5,25 | 5,75 |
| | CSF | User Interface & Communication | 3 | 2 | 2 | 6 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2,67 | 3,25 | 2,25 | 2,5 |
| | | Customisation of Tech Solution | 6 | 4 | 4 | 5 | 5 | 3 | 4 | 4 | 3 | 3 | 2 | 6 | 4,08 | 4,75 | 4 | 3,5 |
| | | Holistic Underlying Processes | 1 | 6 | 5 | 1 | 2 | 5 | 2 | 2 | 6 | 4 | 4 | 4 | 3,50 | 3,25 | 2,75 | 4,5 |
| | | Supply Chain Involvement | 4 | 5 | 6 | 3 | 3 | 6 | 6 | 5 | 4 | 5 | 6 | 2 | 4,58 | 4,5 | 5 | 4,25 |
| | | Change Management & Trainings | 5 | 3 | 3 | 4 | 6 | 4 | 5 | 6 | 5 | 6 | 5 | 5 | 4,75 | 3,75 | 5,25 | 5,25 |
| | | Vision & Strategy | 2 | 1 | 1 | 2 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1,42 | 1,5 | 1,75 | 1 |

# Appendix H.

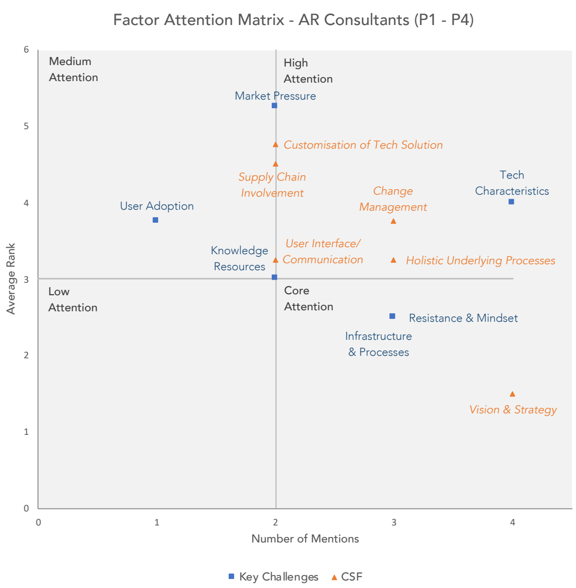
*Factor Attention Matrix*

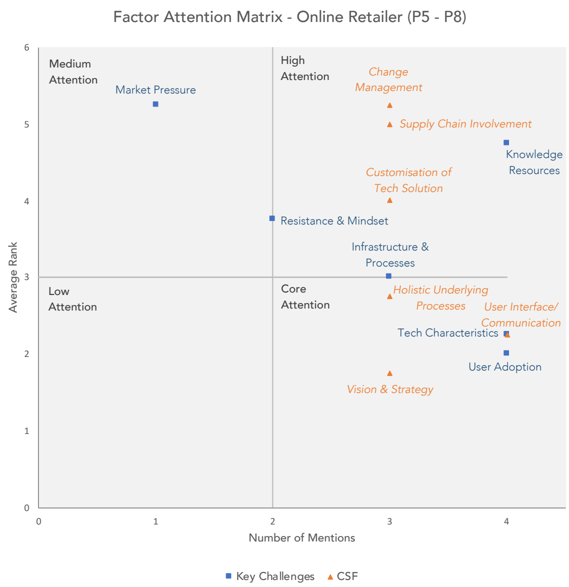


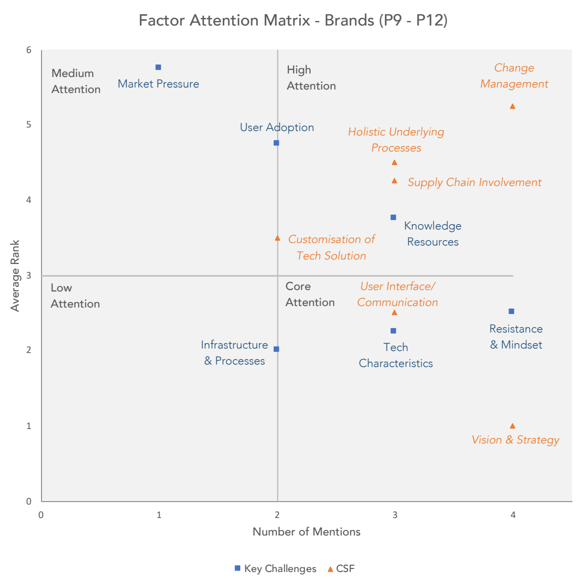

Critical Success Factors and Key Challenges based on Count and Rank Given by the Study Participants: To combine the three considered perspectives of e-tailer, clothing brands and AR experts, get a deeper understanding on which of the identified factors demand the greatest efforts in the adoption process and to verify the suggested relations between the factors, the observed challenges and derived critical success factors were ranked according to their overall number of mentions and the ascribed need for attention (see Appendix G). Latter was declared respectively by each of the twelve study participants in a second data collection round. Starting with the identified key challenges, the graphic displays five out of the six barriers in the high to core attention area. This is indicating that all of those factors are demanding particular consideration in the deployment process as each of them constitutes an essential challenge that is most likely to cause the undertaking's failure if being ignored. Market Pressure, as the only key challenge placed in the medium attention area, is still noted a relevant barrier but entails fewer concerns within the AR adoption process in comparison with the other five aspects. Besides the observed challenges and their attributed influence, the matrix also maps the level of attention that should be devoted to the identified critical success factors. As can be seen, each of the six CSFs is positioned in the high to core attention area, indicating that all parameters have to come together and be balanced to ensure an efficacious implementation of AR visualisations in the industry of focus. While all listed success metrics are of high importance and constitute necessities for effective adoption, Vision & Strategy is ranked first, indicating to be the success metrics to focus on as a start since it is strongly and implicitly interrelated to the other five components. Along with an intuitive user interface as well as the establishment of holistic underlying firm processes, it forms the key pillars of AR adoptions onto which the remaining factors are building and without which there will hardly be any success, as explicitly pointed out by two of the research participants (P3 and P8). The individual factors and their interrelations are examined and discussed in-depth in *Chapter 4*. It is highlighted that the ascribed positions of the factor in the attention matrix build on average values and are therefore likely to vary depending on a firm's specific characteristics and market position. To gain deeper insights which of the identified factors play, on average, the most important role for each of the three questioned perspectives, and how they vary, see Appendix I.

## Appendix I.

*Factor Rankings by each of the three Questioned Parties*




The three graphics represent the rankings of the identified challenges and success factors regarding their required attention in the AR adoption process, segmented in the respective perspectives of clothing brands, e-tailer and industry experts/ AR consultants (four interviewees each). As shown by the three figures, all critical success factors are positioned in the high to core attention areas, indicating that all of these factors have to come together and be balanced to ensure the adoption success of AR. Despite their overall importance, it is indicated that the focus points of the three questioned parties still vary slightly. Brands, for instance, are prioritising the customisation potential of the tech solution over holistic underlying firm processes, indicating that their digital infrastructures are already on a sophisticated level or on a good way there and thus, less of a concern.

The identified key challenges are also all constituting barriers necessary to consider in the implementation process; however, the perceived pressure emanating from them, also seems to be validated differently by the three questioned parties. While e-tailers appear to be most concerned about the acceptance of the new technology by consumer, brands, and industry consultants perceive change resistance and the mindset of the workforce as greater barriers. Not surprising in turn, is that both brands and e-tailer are almost on a par concerned about the technology's performance and features while industry experts, familiar with recent developments in the area of AR applications, expect the technology to reach a sophisticated level within the next two to five years depending on the applications complexity. This time is assumed to be needed anyways by most fashion firms to get their internal business processes ready for the implementation.