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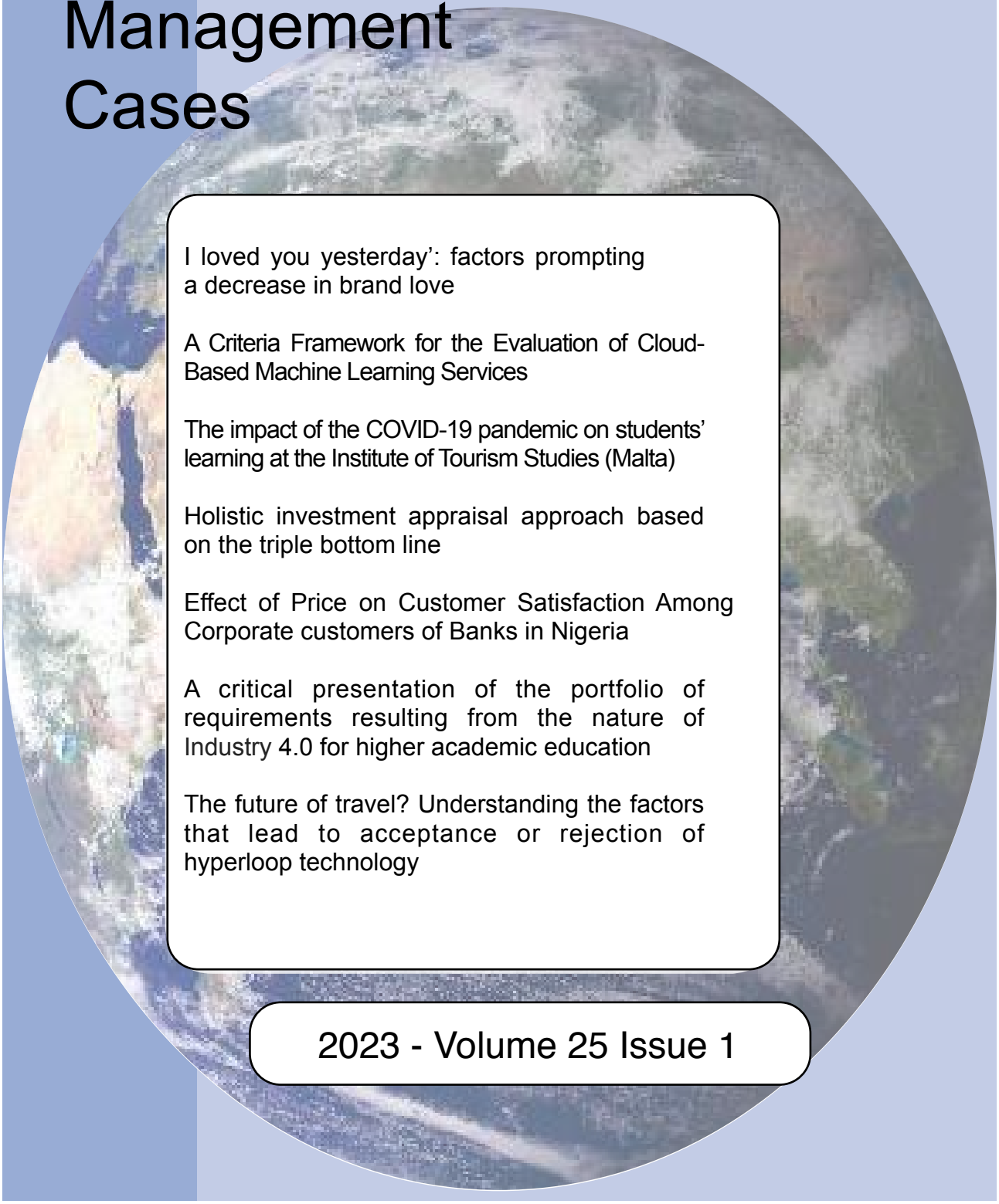

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Contents

‘I loved you yesterday’: factors prompting a decrease in brand love

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Abstract
Previous studies have focused on the constructs brand hate and brand love separately, and they were predominantly static. Based on Shimp and Madden (1988)’s understanding of brand love, this exploratory case study constitutes the first attempt to investigate whether the constructs brand love and brand hate are located on the same continuum and identify factors that lead to a decrease in brand love and integrate these findings in a comprehensive, dynamic model. The author conducted a qualitative case study using semi-structured interviews to test her preliminary conceptual framework. The participants were 14 German students who did not belong to a specific brand community, as the nature of the study was general and exploratory. This study found out that brand love and brand hate form part of the same continuum. Further, there is an intermediate stag of indifference. While all three dimensions exert influence on the decrease in brand love, the dimension liking was the most significant. Within this dimension, ethically reprehensible events were of paramount importance, as they could turn brand lovers to brand haters at once, whereas minor offences had to occur repeatedly. Due to the qualitative nature of the investigation and the homogeneity of the sample, the results are neither generalisable nor representative of the total population. Further qualitative research should include more heterogenous samples to expand the scope of the suggested framework. Moreover, quantitative studies should be conducted to verify the findings statistically. Brands should not only be interested in gaining new brand lovers but also retaining present ones. Thus, this study will be useful for managers, as it shows what needs to be considered in marketing to avoid the decrease of consumers’ love for their brand.

Keywords: Brand love, Brand hate, Indifference, Offences, Marketing

Introduction

Despite many obstacles, some brands are capable of establishing deep relationships with their customers. For some of the latter, this relationship is equal to a romantic relationship which in the context of brands is called brand love. When consumers love a brand, they feel very connected to it, they cannot go without it, and they are willing to pay premium prices (Langner & Kühn, 2010). While some brands are more successful, others struggle at establishing a strong and stable relationship with their customers. According to Twardawa and Wildner (2008), these brands are facing erosions of first choice buyers because 43% of their regular customers turn away from them. This development is extremely dangerous, as the proportion of first choice buyers on average amounts to 71.3% of the total turnover of brands (Twardawa & Wildner, 2008). While many brands try to solve this problem by means of acquiring new customers, the acquisition of new first choice buyers is cost-intensive and

conceals the problem without addressing its root. Twardawa and Wildner (2008) offer a suitable analogy: a leaky bucket is permanently replenished with water, but its drainage is not prevented. Alternatively, it would be more effective and less expensive to forestall the decline of brand lovers in the first place (Langner & Kühn, 2010).

Due to its obvious relevance for marketing, the construct brand love has recently gained much popularity in research. In spite of its significance, the research in the field of brand love is not very diverse and many questions relating to it remain unanswered (Langner & Kühn, 2010). The majority of models concerning brand love are static, meaning that they do not investigate the dynamics of the construct longitudinally (Palusuk et al, 2019). What is more, these theoretical approaches to the conceptualisation of brand love predominantly focus on the positive implications of the construct, whereas negative aspects and the connection to other constructs, such as brand hate, are rare in nature. In view of these shortcomings, the aim of this study is to reach beyond the existing literature by investigating whether brand love and brand hate are located on the same continuum and by identifying factors that could lead to a decrease in brand love based on the dimensions of triangular brand love according to Shimp and Madden (1988) (Klenke, 2020).

In order to bridge these gaps, the present study is separated into three parts. In the first part, brand love is defined and its significance for marketing is elaborated. Subsequently, the diverse conceptualisations of brand love are presented to provide insight into the research field. Due to the scarcity of publications addressing factors leading to a decrease in brand love, studies concerning brand hate, a dynamic model of the brand love/hate continuum (Palusuk et al, 2019), an empirical example of brand hate (Atwal et al, 2020), and an investigation regarding factors leading to brand love (Langner et al, 2013) are taken into consideration.

The second part of the study is devoted to the research methodology. First, the research approach and design, including research method and technique, are described. Second, the data collection method, sample selection and ethical considerations are presented. In the last part of the second chapter, the data analysis is explained in detail.

In the third and last part of the study, the results gathered from semi-structured interviews are presented and discussed in relation to the insights gained from the literature review. Subsequently, the main findings are summarised. Lastly, the study is concluded by addressing the limitations of the investigation and offering implications for further research as well as practical takeaways.

Literature review

Definition of brand love and its relevance for marketing

Due to significant commonalities ‘between the emotional feelings that people hold towards loved ones and those that consumers hold towards objects and material goods’ (Palusuk et al, 2019, p 81), many investigations (Carroll & Ahuvia, 2006; Albert et al, 2008; Bergkvist & Bech-Larsen, 2010; Batra et al,

2012) have revolved around the part which love plays 'in consumer-object and consumer-brand relationships' (Palusuk et al 2019, p 81). Thus, this notion has been made reference to as brand love in the context of branding (Palusuk et al, 2019).

The majority of researchers understands brand love as the most intense of all brand relationships, in which strong feelings of affection coincide with fear of loss (Langner et al, 2013). In analogy to interpersonal attachment in the context of psychology, brand love is defined as a lasting consumer-brand relationship characterised by strong and positive feelings for a brand and feelings of grief in the face of possible loss (Langner & Kühn, 2010).

Beloved brands have numerous as well as profound advantages over brands that are not loved: Brand love offers countless organisational advantages, like brand loyalty (Palusuk et al, 2019), positive word of mouth (WOM) (Carroll & Ahuvia, 2006; Batra et al, 2012; Palusuk et al, 2019) and brand advocacy (Fullerton, 2005). While consumers 'help the brand by providing positive information' (Palusuk et al, 2019, p 99), it is of paramount interest to consider that they likewise 'reduc[e] the potentially harmful implications associated with negative information' (Palusuk et al, 2019, p 99). According to Kang (2015), more positive brand associations as well as higher active engagement represent other favourable results of brand love that anticipate affective brand commitment and continuance (Albert & Valette-Florence 2010) as well as disposition to spend considerable sums of money (Albert & Merunka, 2013).

Conceptualisations of brand love within the research field

In general, there is a vast and growing number of investigations regarding brand love, especially in the context of marketing. However, the approaches to the phenomenon of brand love frequently diverge and differ to a significant degree predominantly concerning their theoretical bases (Fröhling, 2017, pp 47–48). Taking the theoretical bases of the concepts into consideration, one can see that there is no consensus on a singular canonical publication when it comes to investigating brand love. Nevertheless, the majority of research strands is based on theories of interpersonal love and, more specifically, on the theory of triangular love according to Sternberg (1986). Although the latter was developed almost four decades ago, it obviously is still highly relevant to brand love theories.

Theory of triangular love by Sternberg (1986)

Undoubtedly, the variety of scholarly approaches attests to the complexity of brand love (Palusuk et al, 2019). Several of these approaches to love in general are detailed and multi-faceted, yet Sternberg (1986)'s theory of triangular love seems to have particular relevance to consumer research (Palusuk et al, 2019). Although many scientists, like psychoanalyst Fromm (1978) or Sternberg (1986), deal with different types or factors of love, they do not explicitly define love itself. Nevertheless, they agree that it represents a strong feeling of affection for another person. Fromm (1978) considers the construct of love mainly as a means to avoid loneliness. Sternberg (1986), on the other hand, is more concerned with the factors forming the basis for different types of love

(Klenke, 2020). Like Lee (1977, 1988), he assumes that different types of love can be represented by a combination of three factors. Figure 1 shows that Sternberg (1986)'s three basic factors, intimacy (emotional component; appreciation, esteem and respect for loved ones, desire for others' well-being), passion (motivational component; intense desire and desire for union, but also devotion and attachment in general) and decision/commitment (cognitive component; short-term decision to love and long-term commitment to maintain love), form the vertices of a triangle (Langer & Kühn, 2010).

Figure 1: Forms of Love Relationships according to Sternberg (1988, p 122)

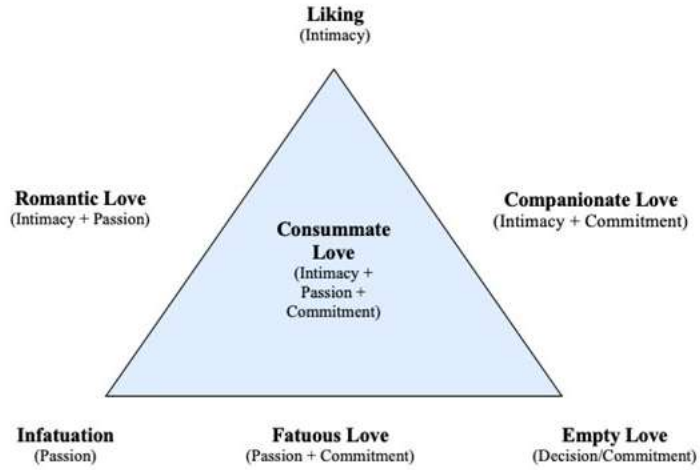
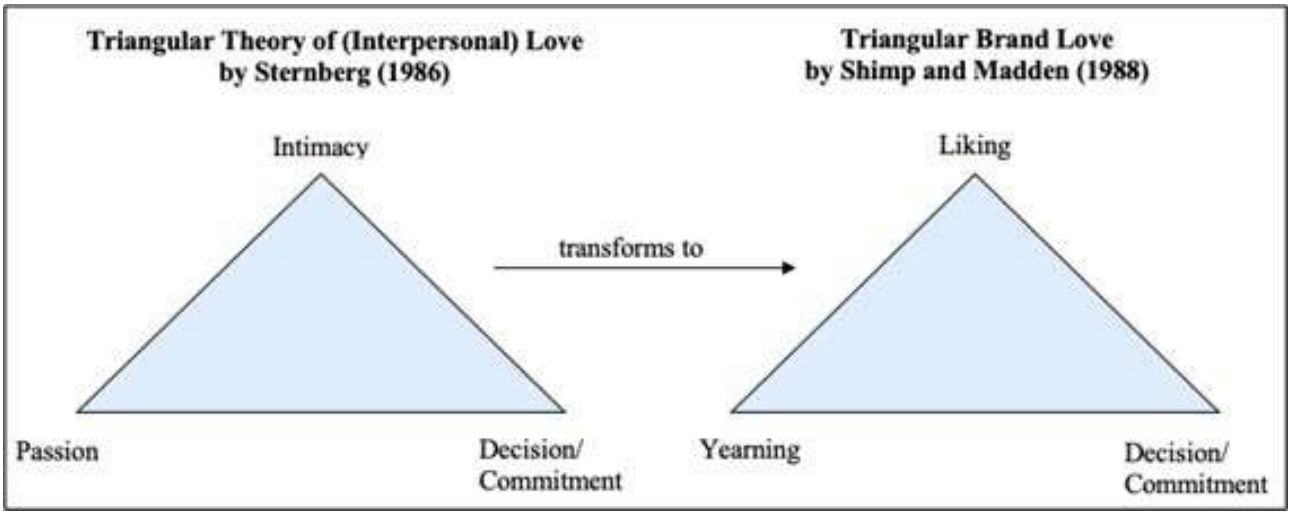


Figure 1 demonstrates that Sternberg (1986) distinguishes between eight prototypical forms of love relationships. In all illustrations of triangular love, only seven forms of love relationships are evident. Nevertheless, there is an eighth, implicit form of love, nolove, that occurs when none of the three factors is fulfilled (Fröhling, 2017). While some researchers question the suitability of this approach (Langner et al, 2015) and put into questions its validity (Langer & Kühn, 2010) as well as the independence of its three factors (Hendrick & Hendrick, 1989), Sternberg (1986)'s theory of triangular love has rightly received an enormous amount of attention in the literature, and constitutes the most frequently and extensively applied approach in this field of research.

Triangular brand love by Shimp and Madden (1988)

In this research field, Shimp and Madden (1988), who investigated object-related bonds, pioneered by referring to Sternberg (1986)'s theory of triangular love. Figure 2 shows how Shimp and Madden (1988) took Sternberg (1986)'s theory of triangular love as a basis and adapted its components to the context of brands.

Figure 2: Shimp & Madden (1988)'s Adaptation of Sternberg (1986)'s Conceptualisation of Love



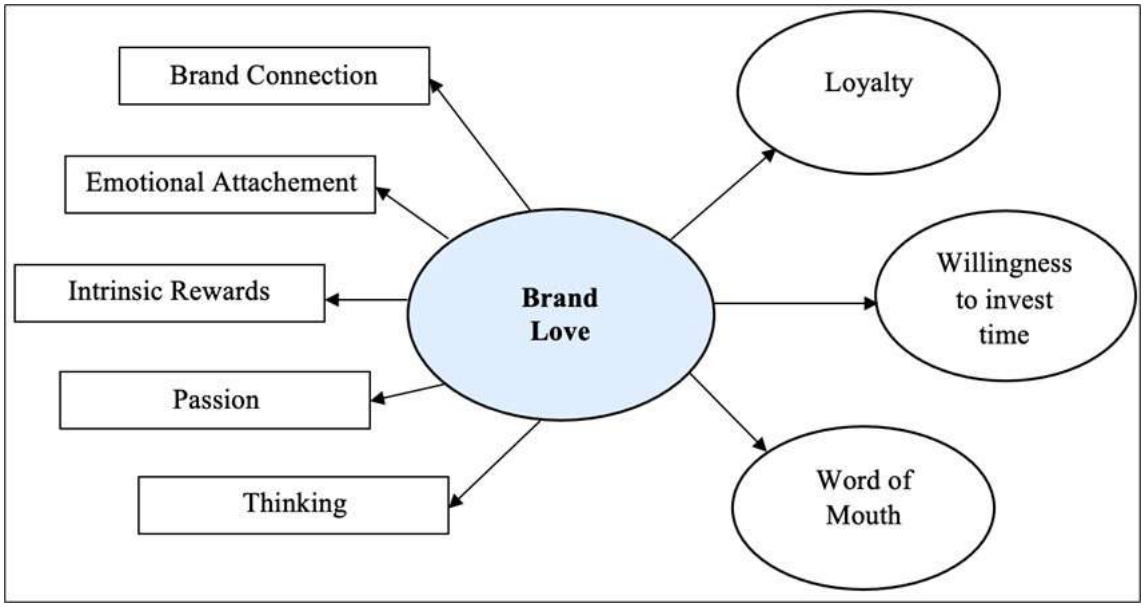
The dimension intimacy was changed to liking and describes closeness and attachment. The second component, passion, was changed to yearning and refers the deep desire for the brand. The third dimension, decision/commitment, alludes to the consumers' will to choose a beloved brand and their long-term loyalty to it. Table 1 displays Shimp and Madden (1988)'s eight forms of love which depend on the fulfilment or lack of the respective dimension.

Table 1: Types of Consumer-Object Relationships according to Shimp & Madden (1988) based on Sternberg (1986) (Fröhling, 2017, p 50)

Relationship Types	Components of the Relationship Types			
Interpersonal love by Sternberg (1986)	Consumer-object relationships by Shimp & Madden (1988)	Intimacy = liking	Passion = yearning	Decision / commitment
Nolove	Nolikin g	–	–	–
Liking	Liking	+	–	–
Infatuated love	Infatuation	–	+	–
Empty love	Functionalism	–	–	+
Romantic love	Inhibited desire	+	+	–
Companionate love	Utilitarianism	+	–	+
Fatuous love	Succumbed desire	–	+	+
Consummate love	Loyalty	+	+	+

Despite much criticism, Shimp and Madden (1988)'s pioneering work has been recognised as a conceptual foundation and frequently forms the basis of research on brand love to this day (Fröhling, 2017). One example for a recent adaptation is Martin et al (2020)'s model of brand love published in the International Journal of Sports which can be seen in Figure 3.

Figure 3: Recent Model of Brand Love by Martin et al (2020)

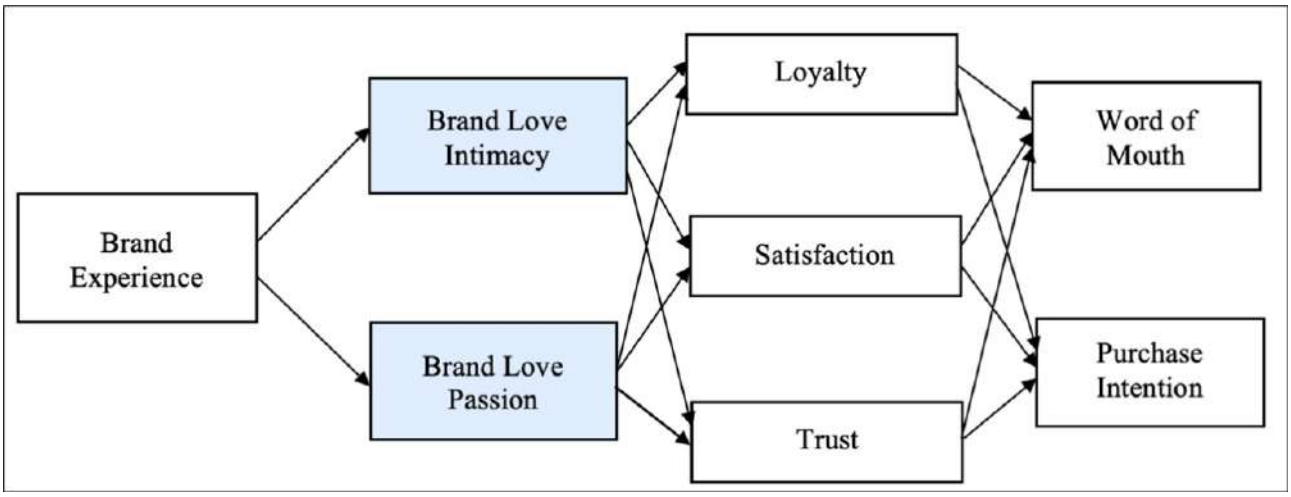


While Martin et al (2020) include new components, like thinking, which lead to brand love in relation to sport teams, this model exhibits major parallels to Sternberg (1986) and Shimp and Madden (1988). Martin et al (2020) have included the dimension passion and the component loyalty, the latter being an essential feature of the dimension decision/commitment. What is more, they took into account the component emotional attachment which forms the foundations for the dimension liking.

The case is quite similar with the model of brand love by Khan et al (2020) in Figure 4 who investigated brand love and brand experience in relation to halal brands using different variables, like loyalty, trust, and satisfaction.

In analogy to the previous model, Khan et al (2020) incorporated new components, for instance, brand experience and purchase intention. Notwithstanding, one can deduce that intimacy and passion still represent the cornerstones of their model. Additionally, the other components, like loyalty and trust, allude to Shimp and Madden (1988)'s third dimension, decision/ commitment. Undoubtedly, both recent models innovatively contribute to this field of research but, most significantly, they give proof of the relevance and validity of the initial model by Shimp and Madden (1988).

Figure 4: Recent Model of Brand Love by Khan et al (2020, section 'Methodology')



Further research on brand love

While these conceptualisations of brand love based on models of interpersonal might be very fruitful, there are important limitations. The semantic meaning of Sternberg (1986)'s nolove and Shimp and Madden (1988)'s noliking is not rejection or disliking, but simply the absence of positive feelings. Consequently, these concepts entirely omit negative feelings toward a brand. What is more, these models of brand love represent static, instead of dynamic investigations, meaning that they do not include longitudinal perspectives (Palusuk et al, 2019). Therefore, the concept of brand hate, dynamic and holistic conceptualisations of the brand love continuum, and empirical examples are of interest because they could offer clues to possible factors leading to a decrease in brand love.

Brand hate and its relation to brand love

While the research in this field is predominantly focused on positive notions about interpersonal love or consumer-brand relationships, there is an expanding interest in brand aversion (Park et al, 2013), brand betrayal (Grégoire & Fisher, 2008), and brand hate (Zarantonello et al, 2016; Bryson & Atwal, 2018). According to Zarantonello et al (2016, p 11), 'brand hate (…) is (…) the most intense and consequential negative emotion that consumers may feel toward brands' and it is deeply connected to both brand betrayal, a possible predicator of negative WOM and revenge (Grégoire et al, 2009) as well as brand aversion (Park et al, 2013). Opinions often differ as to whether brand hate is the opposite of brand love or a separate, independent construct. Most recent research in this field has shown that, instead of being 'on the opposite end of the continuum from brand love' (Palusuk et al, 2019, p 106), the relation between both concepts underlies 'complex and cyclical dynamics where love may turn into hate over time' (Palusuk et al, 2019, p 106).

Dynamic typology of the brand love/hate continuum

Brand love and brand hate have been investigated separately, whereas Palusuk et al (2019, p 108) established a conceptual framework based on studies in the respective fields. This conceptualisation combines all three approaches to the brand love/hate continuum (interpersonal, parasocial, grounded theory) and 'incorporates a developmental orientation via establishing different brand love trajectories, as approximated by the analogies of love marriage, experience-based relationships and arranged marriage' (Palusuk et al, 2019, p 107). This relational typology is based on four major theoretical approaches.

Firstly, Palusuk et al (2019) connected their categories love marriage, experience-based marriage, and arranged marriage to Sternberg (1986)'s theory of triangular love as well as typologies exploring the strength and form of customer-brand relationships (Fournier, 1998; Thomson et al, 2005). Secondly, they visualise 'the extent of congruence between the consumer's identity and the brand's identity' (Palusuk et al, 2019, pp 107–108) based on Sampedro (2017) and Reimann et al (2012). Thirdly, Palusuk et al (2019) drew on Langner et al (2016)'s conceptualisation of different trajectories of love. Palusuk et al (2019) only included the three of originally five trajectories, as the remaining two supposedly were less evident. What is more, they render Langner et al (2016)'s conceptualisation relevant because it takes into consideration the different onsets of relationships and 'their [positive as well as negative] development over time' (Palusuk et al, 2019, p 108). Lastly, Palusuk et al (2019) have adapted the conceptualisation of brand love by Zarantonello et al (2016) which takes into account the possible effects that may appear in case that brand hate emerges. The three types of strategies that Zarantonello et al (2016) established are 'avoidance-like strategies in response to negative brand perceptions and brand image; attack-like strategies in response to corporate wrongdoings; and approach-like strategies in response to violations of expectations' (Palusuk et al, 2019, p 109). They then connected each of the three strategies to their initial categories love marriage, experience-based marriage, arranged marriage.

Empirical example: the scandal around Dolce & Gabbana in China

One of many examples that brand love indeed can turn into brand hate over time was experienced by the luxury brand Dolce & Gabbana in 2018 (Atwal et al, 2020). Since it managed to build up international reputation, 'it had 44 stores in China alone [by 2018]' (Atwal et al, 2020, p 1). In light of an upcoming fashion show, Dolce & Gabbana launched a video advertising campaign on several social media platforms (Atwal et al, 2020). "The video series, called 'Eating with Chopsticks,' featured a Chinese model inexpertly attempting to eat Italian dishes (pizza, pasta and cannoli) with chopsticks. The campaign was accompanied with the hashtag '#DGlovesChina'" (Atwal et al, 2020, pp 1–2). Although they took the videos down, cancelled their fashion show and apologised, numerous 'Chinese e-commerce sites (…) remov[ed] Dolce & Gabbana products form their platforms' (Atwal et al, 2020, p 2). While this scandal is culturally specific, it demonstrates how quickly customers were willing to boycott a brand based on a single incident. Consequently, it proves that marketing actions can generate 'sometimes durable anti-consumption

behaviors that can have a significant impact on a brand's market performance' (Atwal et al, 2020, p 6) due to cultural sensitivities.

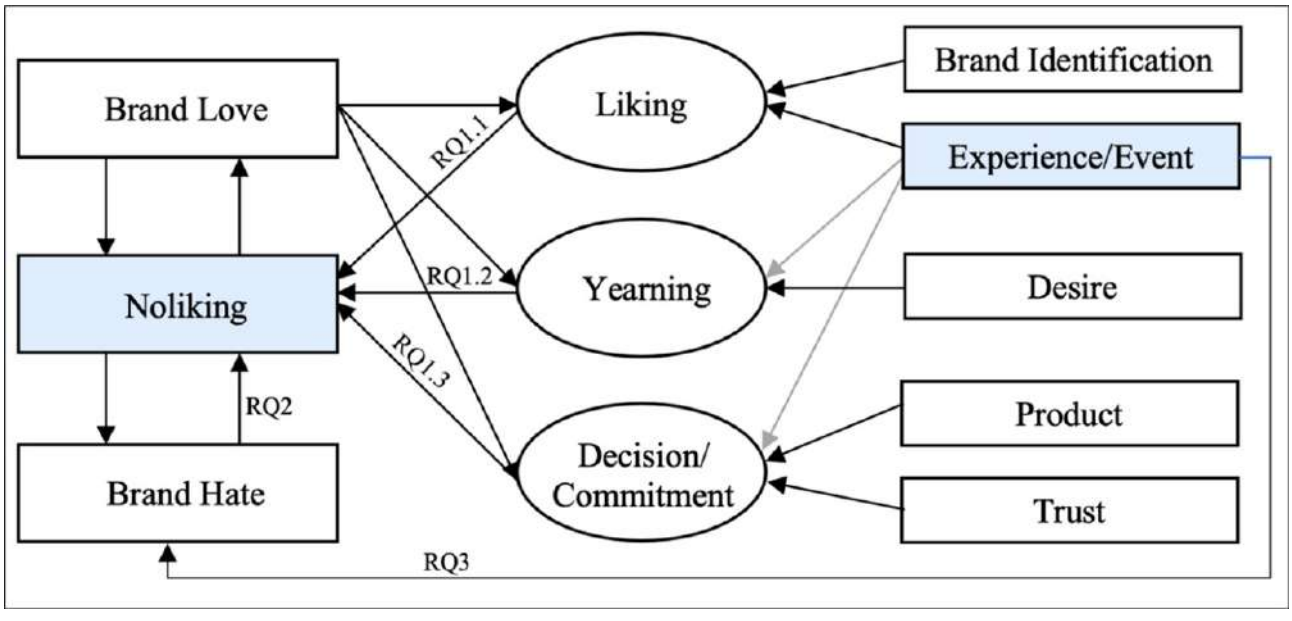
Influence of emotional experiences on the development of brand love

A study conducted by Langner et al (2013) constitutes the only dynamic investigation of factors that lead to brand love (Palusuk et al, 2019, p 106). Nevertheless, one can deduce factors leading to a decrease in brand love by reversing the implications that are made in their publication. According to Langner et al (2013), research tends to focus on the experiences directly triggered by the brand (brand-endogenous). Due to unique, brand-endogenous characteristics, beloved brands create a unique and outstanding product, shopping, or brand experience (Langner et al, 2013). According to Langner et al (2013) brand-endogenous experiences are necessary for building brand love but do often not suffice. However, the effect of individual, personal experiences (brand-exogenous) has hardly ever been investigated (Langner et al, 2013). According to their findings, the development of brand love predominantly depends on direct experience: More than 90% of consumers associate personal experiences with their beloved brands, whereas such experiences are hardly ever found with liked brands. Thus, the leap from a liked to a loved brand often requires exogenous brand experiences rather than endogenous brand experiences (Langner, 2013). While Langner et al (2013)'s assumptions do not mention factors leading to a decrease in brand love specifically, their focus on exogenous experiences shows that consumer-object relationships are highly dependent on Shimp and Madden (1988)'s dimensions liking, decision/ commitment, and especially yearning. Consequently, one can deduce that negative experiences, with very high probability, lead to a decrease in all three dimensions.

Conceptual framework

The conceptual framework in Figure 5 represents a collection of all the conclusions drawn from the literature review in order to unite them in a comprehensive overview.

Figure 5: Conceptual Framework



In the upper part, one can see the construct brand love which is comprised of Shimp and Madden (1988)'s dimensions of brand love. The dimension liking entails the components experience/event and brand identification. Yearning is to be understood as desire for a brand. Decision/commitment is composed of the components trust and product quality. The component experience/event exerts influence on all three these dimensions of brand love, but predominantly on the first. It relates to emotionally charged events directly connected to the brand. The arrows pointing away from the construct brand love indicate that as brand love decreases, all three dimensions decrease. RQ1.1 asks if a decline in the dimension liking leads to a decrease in brand love. RQ1.2 inquires if a decline in the dimension yearning leads to a decrease in brand love. RQ1.3 quetions if a decline in the dimension decision/commitment leads to a decrease in brand love. The innovative part of this framework is the intermediate stage to which the arrows of RQ1.1 to RQ1.3 point. The literature review gave grounds for the assumption that brand hate and brand love represent independent constructs on the same continuum with an intermediate stage of indifference, that is, the absence of any type of emotions. Consequently, RQ2 addresses this problem. Lastly, RQ3 investigates if overwhelmingly negative experiences, which may occur once or repeatedly, can change feelings of love towards a brand directly to hate without going through the intermediate stage noliking.

Research methodology

Based on the insights of the literature review, the present study pursues the goal of bridging the research gap by achieving the research objectives and finding answers to the research questions in Table 2 respectively. Thus, the following chapter describes and justifies the methodological approach which was employed in order to do so.

Table 2: The Research Design Part I

Research Aim	Research Objectives	Research Question	Sources
Identifying factors which have to be prevented in order to maintain consumers' love for a brand	RQ1 To identify the dimensions constituting the decrease of brand love	RQ1.1 Is a decrease of the dimension liking responsible for the decrease of brand love?	Klenke (2020), Fröhling (2017), Langner et al (2016)
		RQ1.2 Is a decrease of the dimension yearning responsible for the decrease of brand love?	
		RQ1.3 Is a decrease of the dimension decision/ commitment responsible for the decrease of brand love?	
	RO2 To identify factors which lead to a decrease of brand love	RQ2 Do noliking and brand hate belong to the continuum of brand love?	Benton & Peterka-Benton (2020), Palusuk (2019)
		RQ3 Does the decrease in brand love depend on an ongoing process or an individual event?	Atwal et al (2020)

Research approach and design

Given the lack of publications dealing with factors leading to a decrease in brand love (Klenke, 2020), the present work is exploratory in nature and calls for a new theoretical framework. Therefore, the present work follows a qualitative research approach (see Table 3).

Table 3: The Research Design Part II

Research approach	Literature research + qualitative research	
Research design	Research method	Case study
	Research technique	Interviews
Data collection method	Semi-structured interviews	
Sample selection	Sampling technique	Purposive sampling (+ snowball sampling)
	Sampling criteria	German students aged 20-25
	Sampling size	14 people (saturation)
Data analysis	Qualitative content analysis after Mayring (2015) (deductive + inductive approach) with MAXQDA (2020)	

As the research aim and objectives in Table 2 show, the present work tries to answer to “more explanatory [‘how’ and ‘why’ questions]” (Yin, 2018, p 44) by analysing a contemporary process in depth (Creswell & Creswell, 2018). Consequently, a case study seemed to be most suitable as research method in contrast to the other methods. Since this study depends on ‘elicit[ing] views and opinions from the participants’ (Creswell & Creswell, 2018, p 263), interviews represent the research technique of choice.

Data collection method

Since unstructured interviews lack specificity, as they focus on more general areas, and structured interview do not do justice to the open-endedness of question, as answers are predetermined, semi-structured interviews were perceived to be the most appropriate method for data collection. After creating a non-standardised interview guideline, possible participants were approached. This was mainly done via social media channels such as LinkedIn, XING, Instagram or Facebook. People who agreed to be interviewed were not sent the questions in advance because it was intended that they answered the questions as intuitively and honestly as possible. All interviews were conducted in the native language of the interviewees, which was German, because their statements should not be impeded by language barriers or lack of comprehension.

Sample selection

In the present work, purposive sampling was predominantly used as sampling technique. Nevertheless, snowball sampling was also used, as the participants sometimes recommended other participants.

In total, this study is comprised of fourteen interviews. The criteria for the participants in this study were that they were German students aged 20 to 25

from Baden Württemberg, Germany. In the research field of brand love, there are two main traditions concerning sampling criteria: Some researchers consider more narrow criteria, for instance, hedonistic products, like designer handbags; others refrain from focusing on such a niche, they only consider, for instance, age and gender as relevant criteria. In the context of the present investigation, the second tradition was deemed more appropriate for two reasons: Firstly, the basic idea of the present work is general and does not refer to a specific niche. Secondly, possible factors leading to a decrease in brand love are the subject of interest. Therefore, it seemed illogical to investigate particular brand communities in the context of this study, assuming that people who do not love a brand anymore do not form part of specific brand communities.

Ethical considerations

Since '[r]esearch involves collecting data from people, about people' (Creswell & Creswell, 2018, p 144), ethical issues need to be anticipated. According to the German Data Forum (RatSWD, 2017), there are three major pillars of ethical considerations in academics: academic quality and integrity of the researcher, consent on behalf of the participants, and avoiding harm.

Prior to the study, the participants were informed about the objectives, the research method, and their rights as participants, that is, that participation was voluntary and that they had the chance to withdraw without any consequences (RatSWD, 2017). The participants were asked for consent anew before the start of their interview. Due to the recent COVID-19 pandemic, video-recorded instead of audio-recorded face-to-face interviews were conducted. The participants were assured that the recordings would be deleted after transcription. Additionally, they were given the chance to check their transcripts before they were used for the analysis.

What is more, it was of utmost importance to avoid any harm to the participants. Therefore, the anonymity of their personal data was guaranteed by replacing their names with the tags R1 to R14 and by making sure that no third parties had access to their information (RatSWD, 2017).

Data analysis

The data analysis was conducted by means of qualitative content analysis according to Mayring (2015). This investigation followed a mixed procedure, as a deductive and inductive approach were merged to form categories. Based on the extensive literature review and the conceptual framework, deductive categories (first-rank) and subcategories (second-rank and third-rank) were determined. Subsequently, the video-recorded interviews were transcribed via Microsoft Word and entered into the computer program MAXQDA (2020). On the basis of the individual transcripts, analytical units were determined. These units were then paraphrased and eventually reduced to inductive categories. With the exception of the second-rank subcategory quality (from the first-rank category experience), the inductive categories predominantly constitute third-rank subcategories.

Research results

Decrease in brand love

Brand identification, values, and image

Brand identification seems to be one of the most important factors why brand love can wane. Almost all of the interviewees stated that brand love diminished when identification with the brand was no longer possible: In addition, the respondents very often addressed the issue of values or image in relation to the question of what factors could cause brand love to become weaker. For instance, R2 voiced that in case that a brand changed in the attitudes, norms, and basic principles that a brand communicates to the outside world to such a degree that these values no longer corresponded to their original values, identification was made impossible. Some respondents uttered that a loss of brand love could be due to differing values: While the real nature of these instances might be debatable, as their interpretation strongly varies interindividually, statements or marketing strategies of the brand which are perceived to be racist, sexist, or generally morally reprehensible constitute factors which can cause brand love to fade. It is also important to note that corporate values do not necessarily need to be conveyed by the company itself. The corporate values communicated by third parties, such as the media, decisively influence the image of a brand. Nevertheless, negative WOM by the respondents' peers seems to matter to a higher degree.

Aging / individual change

Other components that emerged from the interviews are the aging and individual change of the respondents. Many of the interviewees communicated that they had 'outgrown' brand love (R3). Their love for a brand did not decline because of any negative event or scandal, but due to aging and changes in the respondents' characters, views, desires, and cravings. The respondents clearly gave to understand that they believed they have changed over the years while the brand has remained the same, or that they did not reflect on the brand's values at first, but only after hermeneutic activity when they got older and more mature.

Desire

Although they were specifically asked about it, only a few of the respondents stated that the decrease in desire for a brand had been or could be the reason the fading of brand love. While the respondents affirmed the assumption that the fading of desire for the brand and its products constitutes a crucial factor in the decrease of brand love, it seems that the decline of desire was more of a symptom than an actual trigger. The interviewees' answers produce prove of the interconnectivity and interdependence of the components, as aging and individual change were connected to brand identification and image. Notwithstanding, the interviews give grounds for the assumption that the component desire increases due to dissatisfaction, but rather than being a component on its own, it represents a separate dimension.

Product Quality

The vast majority of respondents undoubtedly stated that a drastic drop in the quality of a product could certainly lead to a loss of brand love. Apart from dissatisfaction, several respondents shared the opinion that the price-performance ratio of a product had a great influence when it posed a threat to their basic needs. On the other hand, some respondents stated that brand love could potentially cloud their judgement: changes in quality would only be noticeable if the it dropped drastically, but not if dropped slowly over a period of time or if it was significantly worse than the products of competitors. Consequently, this leads to the belief that quality is crucial to establishing brand love, but, more importantly, it appears to be less significant to the decline of brand love in general, depending on the severity of the decline in quality. Additionally, although eleven out of fourteen respondents stated that the declining quality of a brand could hypothetically lead to a loss of brand love, none of them had a concrete personal example.

Trust

Only few of the respondents had already experienced that their 'trust was abused' (R13). Almost all of the other respondents articulated that they could hypothetically imagine specific scenarios in which their trust was abused and that they could generally imagine that brand love diminished due to a breach of trust. While the interviewees often voiced that brand love declined over a longer period of time in the context of other components, their utterances indicated that, in the case of trust abuses, brand love dropped very abruptly. Since trust abuses presuppose rather extreme incidents that disrupt the trust of consumers, they happen less regularly than other factors. In addition, the respondents' utterances lead to the belief that the components desire and trust are of paramount importance, but their decrease frequently requires a disturbance of another nature, like identification or customer service.

Customer service

Around one third of the respondents actively stated that a lack of outstanding customer service was often the reason why they had distanced themselves from a brand and, consequently, brand love waned. Since customer service is perceived to be the 'speaking organ' (R6) of a brand and it usually is the first and possibly even the only point of contact where consumers have a direct contact with a representative of the brand, it is often equated with the brand. This circumstance offers opportunities, but also various risks. The perception that their love is not reciprocated can relatively immediately lead to a feeling of disillusionment which, in turn, might lead to a decrease in brand love.

Continuum (brand love – indifference – brand hate)

Brand Love

The respondents associated intimacy/liking with 'something private' (R1, R6, R11, R14), 'sympathy' (R2, R13), 'identification' (R1, R14), 'closeness' (R5), 'interest' (R12), or 'affection' (R13). Three participants were of the opinion that

both dimensions were completely irrelevant in the context of brand love. Ten of fourteen interviewees claimed that both terms were not synonym. While only two of them deemed the term liking more appropriate in the context of brands, seven others were convinced that intimacy was more appropriate and liking was more superficial.

The dimension passion/yearning was associated with 'desire for a product' (R1, R2, R3, R4, R6, R8, R9, R10, R11, R12, R13, R14), 'enthusiasm' (R5, R10), 'willingness to spend money' (R7, R11), or 'unconditional devotion' (R1). While one respondent was of the opinion that both terms were synonym, nine of them assumed otherwise. According to some of the participants, yearning was not a fitting term in the context of brands. Interestingly, all interviewees unanimously shared the view that the dimension passion/yearning was clearly connected to the construct brand love.

Brand Hate

The majority of the respondents stated that it was possible to switch from brand love to brand hate. Moreover, the interviewees explained that it was also possible to move from brand hate to noliking, that is, indifference. However, many interviewees held the opinion that if the main point of criticism was changed, their hatred would subside. These findings suggest that brand love and brand hate are located on the same continuum and that consumers' feelings can move along this continuum from love to hate.

Noliking

Noliking describes a feeling of indifference toward a brand, meaning that there are neither positive nor negative emotions regarding the brand. Twelve out of fourteen respondents stated that they had already loved a brand once, however, no longer loved it but also do not hate it, that is, they are indifferent to the brands they once loved. Descriptions of indifference varied from 'doesn't matter' (R3), and 'unimportant' (R14), to 'uninteresting' (R8), and they were frequently used by the respondents.

This new stage of indifference naturally raises the question of whether former brand lovers who are now indifferent to the brand can possibly become brand lovers again. Ten of the interviewees verified that they could become brand lovers again. However, almost all of them tied their statement to the condition that the factors that had led to the decrease of brand love would have to change for the better. The three interviewees who thought that it was not possible to love the brand again stated that the incidents that had led to the loss were too severe and the damages to the consumer-brand relationship were irreparable. Nonetheless, the responses suggest that, at least for a large proportion of respondents, it is possible to move from noliking back to brand love.

Experience

Quality

As a premise for the change from brand love to brand hate, a vast majority of interviewees identified an extremely bad or negative event that had taken place to cause this change. Examples of such events predominantly were breaches of trust in the form of scandals that brand lovers found 'ethically reprehensible' (R2). These scandals mainly referred to 'racism' (R2, R4, R10), 'sexism' (R2, R4, R10), 'human rights' (R2, R4, R9, R10), or to 'political sentiments' (R3, R11), that is, (perceived) connection to right-wing parties. Surprisingly, a few of the respondents stated on their own accord that it would not be possible for them to switch from brand hate back to brand love after an extremely bad experience.

Quantity

The interviewees also talked about how frequently these disruptive events had to occur in order to cause brand love to fade. Almost all of the interviewees stated that there were different conditions to whether a single incident was sufficient or whether incidents had to occur more frequently, but they agreed that both options were possible. On the one hand, both R5 and R6 reported the fading of brand love. While it took only one scandal for R6's feeling of brand love which had been built up over years to become undone, R5's love faded over the course of time due to the lack of satisfactory product quality. The interviews provide clear evidence that the nature of the event determines how often it has to occur in order for brand love to fade. Whereas minor events must usually occur repeatedly for brand love to decrease, a single morally reprehensible scandal is enough to cause brand love to wane.

Discussion

One of the goals of the present work is to verify whether the dimensions mentioned in the conceptual framework and their respective components are the origin of the decline of brand love. The results regarding the dimension liking confirm what was anticipated in the literature: the components quality and brand identification are the most frequently addressed reasons for the loss of brand love (Langner, 2013; Palusuk, 2019). Taking into account that all of the participants are in their early to mid- twenties which is a period characterised by many insecurities, the component identification was naturally mentioned very often. What is more, the interviews show that previously unnoticed components, like image and values, equally contribute to the loss of brand love. While the assumption that experiences affect all three dimensions of brand love (Langner et al, 2013; Palusuk et al, 2019) was confirmed by the interviews, the results most importantly show that the dimension liking is the most relevant in terms of a decrease of brand love, as crucial memories and negative events were the predominant driving force for the fading of brand love.

Concerning the frequency of extremely negative events it comes to light that scandals with media coverage play the most crucial role. Scandals that put the brand in a racist, sexist or inhuman light can lead not only to a loss of brand

love within minutes, but to the transition from brand love to brand hate. Since consumers generally wish to identify with a brand, their disappointment and anger about the brand's behaviour is all the greater if such scandals come to light. The superiority of the dimension liking is supported by another fact: In case of disruptive components belonging to the other two dimensions, these components had to be affected repeatedly until a loss of brand love occurred, that is, a unique disruption was not sufficient.

Contrary to the prior belief that desire was a central component of the motivational dimension passion/yearning (Sternberg, 1986; Shimp & Madden, 1988), the interviews unexpectedly show that the respondents never address desire as a reason for the decline of brand love. While the results confirm the relevance of desire in the context of brand love, they rather imply that the decrease of desire for a brand is rather a symptom than a reason for the fading of brand love. desire does not constitute a component of the dimension passion/yearning, but rather represents the dimension itself. Moreover, it should be mentioned that the components aging and individual change belonging to the dimension yearning are one of the few components that companies can hardly influence. The circumstance that customers lose their love for a brand because of changing desires is normal and must be taken into account. If brands were to try to constantly adapt their identity and basic structures according to the changes of brand lovers, they could obviously never to justice to all of them and would probably lose more brand lovers than they could keep.

Regarding the cognitive dimension decision/commitment (Sternberg, 1986; Klenke, 2020), the results prove that a disruption of one of its components, for instance, trust or customer service, can result in a decrease of brand love. However, it also came to light that the individual components are highly interconnected: While the decision or commitment to love a brand may change over time, the results uncover that the dimensions liking is always affected when there is a decline in the other two dimensions. Arguably, these findings support the assumption that the dimension liking plays a key role regarding factors that may lead to a decrease in brand love.

The results demonstrate that the dimensions coined by Shimp and Madden (1988), liking, yearning, and decision/commitment, are generally suitable. While they believed that liking and yearning were more appropriate terms in the context of brand love, the findings show that the original terms intimacy and passion by Sternberg (1986) resonated more with the participants. Thus, the latter two terms should be used, as Shimp and Madden (1988)'s terminology was perceived to be too superficial.

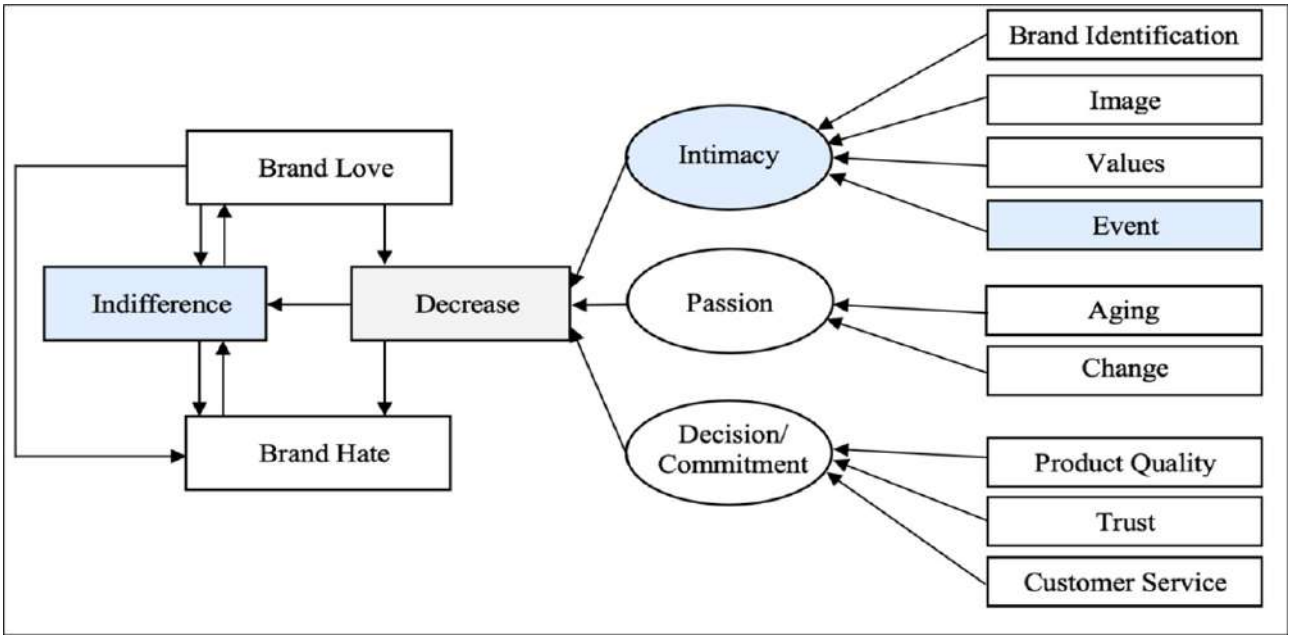
Although brand love and brand hate are gaining in popularity, there is significantly less research on brand hate. While many researchers assume that brand love is the exact opposite of brand hate, others are certain that brand love and brand hate are two entirely separate constructs (Bryson et al, 2018; Kühn, 2018). The present investigation has shown that brand love and brand hate can be clearly distinguished from each other but definitely form part of the same continuum. Although brand lovers or brand haters can thus move along this continuum, brand lovers may become brand haters, but brand haters may not become brand lovers without an intermediary.

The most innovative finding of this work is probably that there is an intermediate stage, indifference, on the continuum between brand love and brand hate. Almost all of the respondents stated that there are brands which they once loved and now do not hate but are indifferent to. Additionally, the results demonstrate that when brand love decreases, most respondents stop at the intermediate stage noliking except for extremely negative experiences with the brand that go against their moral convictions.

Obviously, this brings many opportunities for companies. In case that consumers' brand love decreases, their love is not necessarily lost forever. It might be easier to turn former brand lovers which are now indifferent back into brand lovers than generating new ones, as the interviewees claimed that there were already grounds for a relationship, and it did not have to be established from scratch. Consumers which feel hate toward a brand may also become brand lovers again, but in order for that to happen companies need to take some measures to change the relationship to the intermediate stage noliking and eventually back to brand love.

After the content analysis and during the discussion, all findings were compared to the preliminary conceptual framework. Based on this comparison, necessary adaptions were made. These changes include the use of Sternberg (1986)'s terminology, the incorporation of inductive categories, and changes of the arrows between the continuum of brand love – indifference – brand hate. The continuum and the factors leading to a decrease in brand love are conceptualised in the following manner:

Figure 6: Revised Framework



Conclusion (limitations and recommendations)

The concept of brand love is increasingly gaining popularity in research due to the circumstance that it can be an enormously valuable construct for brands. Previous research addressed the question of how brand love is conceptualised or which factors affect it positively, that is, how brands can generate brand lovers. Arguably, it is equally of paramount importance for brands to understand which potential mistakes need to be avoided in order to retain their customers. The main goal of this paper was to investigate which factors lead to a decrease in brand love. In order to reach this goal, an overview of the different conceptualisations of brand love was given. Due to its similarity to interpersonal relationships, the conceptualisation of brand love by Shimp and Madden (1988) was deemed most appropriate. Since investigations of brand love are static instead of dynamic, and they do not take the decrease of brand love into consideration, several publications (Langner et al, 2013; Palusuk et al, 2019; Atwal et al 2020) were reviewed in order to create a preliminary conceptual framework containing the assumptions about the brand love – brand hate continuum and possible reasons for the fading of brand love. Subsequently, the research design and approach were presented. This investigation is a qualitative case study which was conducted via semi-structured interviews of fourteen German students aged 20 to 25. In a next step, the interviews were analysed using qualitative content analysis according to Mayring (2015). The results of the data analysis were then presented and discussed. The main findings were the following: Firstly, Sternberg (1986)'s terminology for the three dimensions of love were more appropriate than those by Shimp and Madden (1988). Secondly, the dimension liking is the most important one when it comes to the decrease of brand love because it affects consumers on an emotional level. Thirdly, the most innovative finding was the verification of the intermediate stage indifference on the brand love – brand hate continuum. Eventually, the conceptual framework was revised based on the findings and the discussion, resulting in a new conceptualisation of the decrease of brand love.

Limitations and implications for further research

Due to the scarcity of research in this area, free assumptions had to be made which could hardly be supported by references and numerous categories had to be established inductively. In general, the use of interviews is subject to limitations because the presence of the researcher possibly can bias the responses of the interviewees. Additionally, the insight gained by means of interviews may be limited because respondents are articulate or perceptive to different degrees. While researchers should establish appropriate conditions for qualitative interviews, the author felt that the circumstance that the interviews were conducted digitally and video-recorded had a negative impact on the depth of conversation and openness of the interviewees.

The demographics of the interviewees may have restricted the findings. Thus, similar investigations could be conducted which focus on different age groups, cultural backgrounds, or specific brand communities in order to get a more differentiated idea of this area of research. Due to the exploratory nature of this enterprise, the use of qualitative research was deemed suitable. However, qualitative research methods do not allow verification and generalisability, as

they are not statistically representative, which is why quantitative research is obviously needed. What is more, the individual components of the dimensions need to be investigated quantitatively in order to understand their relevance, to verify their applicability, and to find out what other components there might be.

Brands do not only need to understand how to gain brand lovers, but also how to retain current customers. Since the fading of brand love is possible at any time, it is of utmost importance to listen to brand lovers and pay attention to their needs and their feedback. The predominance of the dimension liking and especially the component event showed that the moral convictions of consumers play a key role in the decrease of brand love. Thus, marketing managers should either be trained concerning ethically sensitive topics, like sexism, racism, and politics, or management should comprise managers of different genders, age groups, and cultural backgrounds to do justice to the needs and wishes of their diverse consumers and prevent possible mistakes.

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A Criteria Framework for the Evaluation of Cloud-Based Machine Learning Services

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Abstract

Artificial intelligence (AI) is one of the most promising technologies of the post-pandemic era. Cloud computing technology can simplify the process of developing AI applications by offering a variety of services, including ready-to-use tools to train machine learning (ML) algorithms. However, comparing the vast amount of services offered by different providers and selecting a suitable cloud service can be a major challenge for many firms. Also in academia, suitable criteria to evaluate this type of service remain largely unclear. Therefore, the overall aim of this work has been to develop a framework to evaluate cloud-based ML services. We use Design Science Research as our methodology and conduct a hermeneutic literature review, a vendor analysis, as well as, expert interviews. Based on our research, we present a novel framework for the evaluation of cloud-based ML services consisting of six categories and 22 criteria that are operationalized with the help of various metrics. We believe that our results will help organizations by providing specific guidance on how to compare and select service providers from the vast amount of potential suppliers.

Keywords – Machine learning as a service; MLaaS; Artificial intelligence as a service; AIaaS; Cloud AI

Introduction

Artificial intelligence (AI) is one of the most relevant topics of the 21st century and the economic potential of this technology cannot be ignored. AI is widely considered to be the engine that drives future economies. According to a study by the consulting firm McKinsey & Company, AI-based innovations can increase global GDP “by about 1.2 percent a year” (Bughin et al. 2018, p 3) until 2030. Cloud computing technology can simplify the process of developing AI applications. Well-known cloud providers such as Amazon Web Services (AWS) or Google Cloud Platform (GCP) offer a wide range of cloud services, also containing a variety of AI focused services, including ready-to-use tools, e.g. to train machine learning (ML) algorithms, develop intelligent voice assistants or develop image recognition software. Besides these large players, there are also many smaller companies that specialize in solving certain types of ML problems, such as image processing or text classification. Consumption-based billing, almost limitless scalability, lower entry barriers and simple user interfaces also allow private individuals or medium-sized companies to create productive AI applications (Rashid & Chaturvedi 2019, pp 421–423). According to a survey of decision-makers in the regions of Germany, Austria and Switzerland, around 34% prefer an AI solution from the cloud (Interxion 2020), despite existing concerns in the area of data protection and compliance.

However, comparing the vast amount of services offered by different providers and selecting a suitable cloud service is a major challenge for many firms. This is due to the fact that the cloud market offering is subject to strong heterogeneity, as basically the same resources are offered in various ways (Brogi, Cifariello & Soldani 2017, p 269). It is therefore important to make today's offerings transparent and establish a clear guidance and method to evaluate cloud-based ML services. A considerable amount of literature has dealt with developing criteria frameworks and procedures to evaluate services in related contexts, such as cloud services in general or quality of services (QoS) of web services (Ran 2003; Zeng et al. 2003; Franca & Werner 2019; Yoo & Kim 2018; Kalepu, Krishnaswamy & Loke 2003; Wang & Liu 2013; Bardsiri & Hashemi 2014). Given the specific characteristics of cloud-based ML services, it is, however, questionable whether the results of these related studies are completely transferable to the context of this study, and whether the frameworks have to be complemented by additional criteria. Therefore, criteria and metrics to evaluate this type of service remain largely unclear.

Hence, the overall aim of this work is to develop an overarching framework to evaluate cloud-based ML services which allows a systematic comparison of services. The overall aim can be broken down into two more specific objectives. First, to define criteria for the evaluation of the services, and, second, to identify metrics to make these criteria measurable.

The work has been designed according to the rules and procedures of the Design Science Research (DSR) methodology (Hevner et al. 2004). Our research design is based on a combination of methods, including a hermeneutic literature review, a vendor analysis and expert interviews, to build our framework, which has subsequently been evaluated by applying it to a sample of services. This paper is organized as follows. First, a literature review is presented in order to provide a theoretical foundation of our research and give a brief overview of related studies. Next, our methodology and research design are outlined, before the results are presented and discussed in detail. Finally, we conclude by summarizing our contribution to knowledge and discussing both, limitations of our study, and future research opportunities.

This study contributes to knowledge by presenting a novel framework to evaluate cloud-based ML services, integrating prior research in related contexts with original results from our own primary research. Besides advancing our academic understanding of the dynamically evolving field and service offerings, the results help organizations in practice by providing specific guidance on how to compare and select service providers from the vast amount of potential suppliers.

Literature Review

Artificial Intelligence and Machine Learning

For the term AI, various definitions can be found. For example, Chowdhary (2020, p 1) defines AI as a technology of Computer Science “which is mainly concerned with automation of intelligent behaviour”. Intelligence itself can be defined as perceiving information, analysing information and reacting to this information (Chowdhary 2020, p 1). ML is commonly categorized as a sub-area of AI and seen as a key technology of AI (Döbel et al. 2018, p 4). According to Russel and Norvig (1999, p 5), ML is a machine’s ability to derive knowledge from data. Data represents the experience of the machine, which is used to apply the knowledge to new and unknown situations. In this paper, the terms AI and ML are used interchangeably.

ML can be used for different applications and use cases. A common and generally valid classification of the use cases into specific sub-areas is not available in the literature. Typical

applications of the technology that can be found in the literature (Chowdhary 2020; Döbel et al. 2018) include clustering, classification, speech recognition, natural language processing, computer vision, robotics, expert systems, prediction and planning.

Cloud Computing

According to the National Institute of Standards and Technology, cloud computing is a "model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources" (Mell & Grance 2011, p 2). The technology behind cloud computing is called virtualisation. Based on complex mathematical calculations, virtual resources can be abstracted from physical resources, which are often located in data centres. Cloud computing is the modern alternative to the on-premises solution, which means owning and managing physical computing resources. This abstraction allows physical computing power to be shared and enables multi-tenancy (Xing & Zhan 2012, p 308). Essential characteristics of cloud computing are on-demand self-service, broad network access, resource pooling, elasticity and measured services (Mell & Grance 2011, p 2).

There are different cloud service models, and the service required depends on the goal the customer is pursuing. Each type of cloud service model is characterised by the type of control, management overhead and flexibility. The following variants are commonly differentiated between: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). IaaS is the provision of virtual infrastructure in the cloud. Compared to the other service models, it is the service with the most management and customisation options, as, from the level of the operating system onwards, management lies with the user. With PaaS services, more of the administrative overhead stays with the cloud service provider. The platform includes "all the systems and environments comprising the end-to end life cycle of developing, testing, deploying, and hosting of sophisticated web applications" (Rimal & Lumb 2017, p 5). The main target group of PaaS Services are developers or more experienced users who can fully build applications on the given platform. SaaS applications are those that do not need to be installed locally but are accessible via the internet. The entire service is managed by the provider and does not require any administration by the user (Rimal & Lumb 2017, p 5).

Cloud-based Machine Learning Services

In the literature and in practice, cloud-based machine learning services can appear under different names, such as Machine-learning-as-a-Service (MLaaS) or AI-as-a-Service (AIaaS). The term AIaaS is used less frequently, and can be equated with MLaaS due to the general synonymous use of ML and AI (Roldós 2020). According to Wolhuter (2021), MLaaS refers to "a number of services which offer machine learning tools as a component of cloud computing services". In this paper, the term MLaaS is used as a synonym of cloud-based machine learning services.

Although the wording "as-a-service" appears is part of the term MLaaS, it should not be misinterpreted as one type of cloud service model, comparable to IaaS, PaaS or SaaS. In fact, cloud-based machine learning services can be both, SaaS and PaaS. SaaS ML services are characterised by the fact that there is a graphical user interface or an application in the browser that is equivalent to software. PaaS ML services are intended for users who have developer skills, since complex and complete ML applications can be developed by the user (Vomero 2020). Hence, it can be summarized that MLaaS is an umbrella term for different ML services provided and maintained by providers (Onose 2021).

MLaaS uses the characteristics of cloud computing to simplify the otherwise complex technology. Hosted in the cloud and mostly accessible via APIs, the services allow complex AI

use cases such as image recognition or predictive analytics to be realised. An advantage of this technology is that it requires considerably less time for organizations to benefit from ML. The setup otherwise required for ML applications is replaced by a few clicks in a graphical user interface in the browser. In a short time, different types of ML algorithms can be trained and used. Companies do not have to make large investments, build up their own expertise or invest time and in case of increased or decreased demand, the cloud service automatically scales up or down and thus makes it possible to be prepared for different needs (Wolhuter 2021).

Related Studies and Research Gap

In the literature, a number of studies that are relevant for our research can be found. These include criteria frameworks from related contexts, especially cloud and web services (Bardsiri & Hashemi 2014; Ran 2003; Zeng et al. 2003; Franca & Werner 2019; Kalepu, Krishnaswamy & Loke 2003), but also decision-making models for cloud adoption (Yoo & Kim 2018), and, a framework to evaluate cloud service architectures (Wang & Liu 2013).

The work by Bardsiri et al. (2014, 28ff) introduces a framework and metrics for the evaluation of cloud computing services. The authors see the rapid growth and heterogeneity of the cloud service market, as well as the growing potential for users, as an important reason for developing an evaluation framework. The framework they present is divided into 4 categories: performance, economic, security and general. According to the framework by Ran (2003, p 1), which also deals with the selection of cloud services, the need for a selection tool is justified by the fact that the quality of web services can vary, and these must be checked by QoS criteria. The framework is structured into four categories: runtime related QoS, transaction support related QoS, configuration management & cost related QoS and security related QoS. According to the authors, not all criteria are mandatory or required. Another comparably old paper (Zeng et al. 2003, p 411), which provides a framework for the selection of web services, deals with the composition of services, i.e. the selection of components of a service. Again, various QoS metrics are used for evaluation, such as execution price, execution duration, reputation, reliability, availability. Franca and Werner (2019, p 47) present a cloud microservice selection tool based on technical, social and semantic aspects. With the help of the tool, users should be able to select the best cloud service from hundreds. From a technical perspective, the categories agility, assurance, financial, performance, security & privacy and usability are presented, each with underlying attributes. The semantic perspective is illuminated by the semantic analysis of free texts written by users. The framework differs from the classical QoS frameworks in the sense that for the first time it also includes social and semantic factors. Kalepu et al. (2003, 3ff) further extend the classical QoS attributes. The framework they propose for evaluating web services mostly includes classical attributes such as availability, price, throughput, response time, latency, performance. In total, there are 15 criteria that can be applied. In contrast to the previous frameworks, there are no superordinate categories that help cluster the large amount of attributes. In addition, they introduce the metric verity, which is can be used to determine the reputation and credibility of a provider

The paper by Yoo and Kim (2018) has a different focus than our research, developing a decision-making model for the topic of cloud adoption. It also deals with a decision making process from an organisational perspective. Nevertheless, it can provide criteria for this research. The authors discuss technological criteria such as efficiency or manageability, as well as organisational criteria related to companies going through the cloud adoption process. Top categories for the selection of services that are organisation-independent are: related advantage, compatibility, government regulation, technology support infrastructure.

Another framework (Wang & Liu 2013, 4f) has been developed for the evaluation of cloud architectures using QoS metrics. In that paper, distinctions are made between SaaS, PaaS and IaaS cloud service levels. The top level of the criteria model hierarchy starts with the distinction between IaaS, PaaS and SaaS metrics. Metrics of the PaaS layer are e.g. extensibility, request error rate, request throughput, delivery stability, environment convenience and deployment efficiency. For the SaaS layer, the following criteria are suggested: response time, costs, availability, reliability, credibility.

It can be summarized that there are a large number of studies to evaluate cloud and web services in general, and this topic has been extensively discussed. However, with regard to the aim of this study, a substantial research gap remains, as we were not able to identify studies that focus on evaluating cloud-based ML services. Due to the specific nature of MLaaS that can vary greatly in the form of delivery, and, is also substantially different from other cloud offerings, more research has clearly been necessary. Given the growing number of ML services, the expected economic potential and the complexity of the services, methods and tools for comparing the services may prove highly useful to organizations.

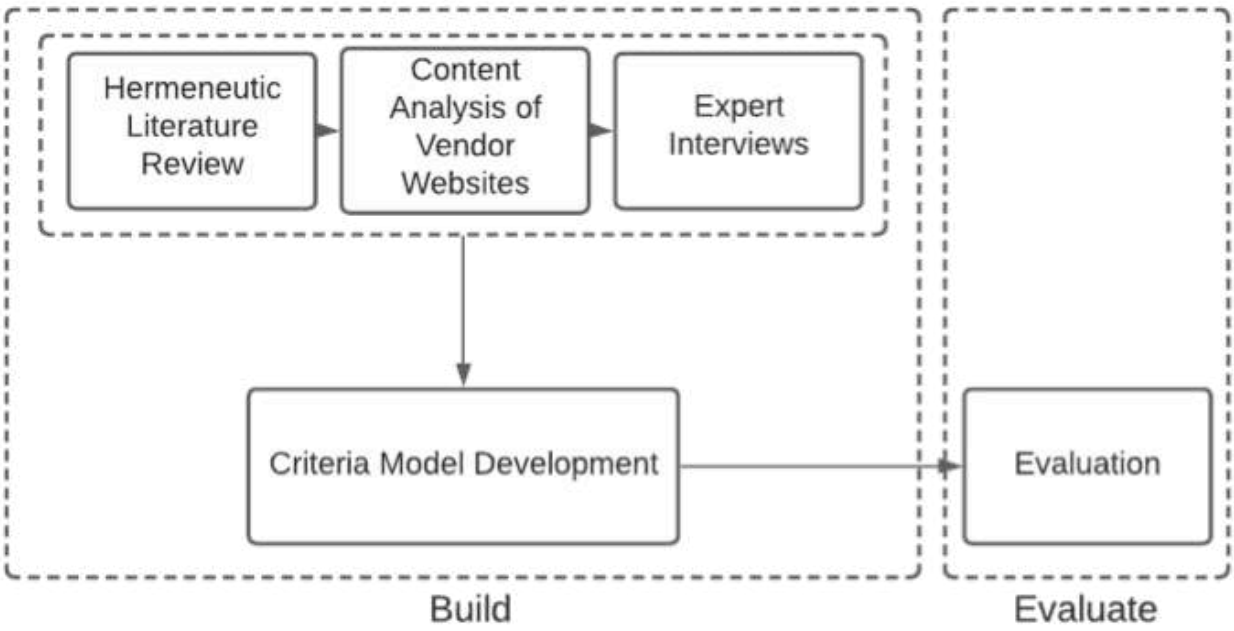
Research Methodology and Methods

Methodology and Overall Research Design

We adopt the Design Science Research (DSR) methodology for our research which can be used to create and evaluate artefacts to address relevant organizational problems, rather than describing and analysing reality as typically done with traditional methods from the social sciences (Hevner et al. 2004; Peffers et al. 2007). The aim of this work is to create a criteria framework. The DSR methodology is suitable for this goal, as it can be applied to develop an artefact, which can be a model, a method, or a product. In addition, it is helpful to generate new and innovate insights, which is necessary for this research, as the field of MLaaS services is very opaque, heterogeneous and rapidly changing.

March and Smith (1995) as well as Hevner et al. (2004) agree that the process is divided into two phases: build and evaluate. In the first phase, the build phase, artefacts are developed. In this research we use a combination of a hermeneutic literature review, content analysis of vendor websites and expert interviews to develop our criteria framework, as outlined in Figure 1. The arguments produced in the three parts are merging into the development of an overall system, the criteria model. In the evaluate phase, the artefact is then evaluated because it is a "widespread agreement that evaluation is a central and essential activity in conducting rigorous Design Science Research (DSR)" (Venable, Pries-Heje & Baskerville 2012, p 425). The evaluation process provides insights about the utility of the artefact and recommends if further build and evaluate loops are needed. The evaluation in this work is carried out on the basis of the attributes completeness and utility (Hevner et al. 2004, p 85), by conducting experimental testing of MLaaS services. In doing so, manually chosen MLaaS services are used to apply a documented simulation that includes a binary classification ML problem.

Figure 1: Details of DSR methodology and research design



Literature Review

The literature review was be conducted according to the hermeneutic principles of a review (Boell & Cecez-Kecmanovic 2011; Boell & Cecez-Kecmanovic 2014). Because of the complex technological field, it is recommended to use a hermeneutic process, rather than a systematic review, to gain further understanding of the field and to utilise most of the available resources. In hermeneutics, researchers start searching and reading papers based on a general and initial search query. By gaining further knowledge, the researcher can identify important papers and adapt his search. Through iterative reading and searching through the existing literature, horizons can be broadened, and initial thoughts can be questioned (Boell & Cecez-Kecmanovic 2014, p 262).

In the initial search, the following databases were searched using an initial search term: Web of Science, Business Source Ultimatum, IEEE Xplore, ACM Digital Library, AISel, and Google Scholar. The search term used was: "artificial intelligence" AND cloud AND (assessment OR evaluation). The hermeneutic circle was carried out several times, adapting the initial search, as aspects that could be further researched came up during the reading. The focus in the iteration stages was placed on the terms quality of Service (QoS), commercial cloud services and MLaaS. Finally, 18 highly relevant contributions could be identified. These 18 papers include related studies from different contexts, as discussed above, but also papers from the domain of machine learning that could be used to derive relevant criteria.

In the mapping and classifying step, the findings, the criteria and associated metrics for evaluating cloud or MLaaS services were summarized and aggregated using a qualitative coding system which was inductively developed from the aspects that emerged in the literature. Additionally, some categories from prior related frameworks were integrated in a deductive manner. This coding system was further refined and extended by the subsequently applied research methods.

Content Analysis of Vendor Websites

A qualitative content analysis (Mayring & Fenzl 2019, pp 634–644) of current product information on MLaaS vendor websites is used to improve and extend the initially developed coding system by providing novel and up-to-date information. The content to be analysed was information in text form of the MLaaS products from the market leaders AWS Sagemaker, GCP AI and Microsoft Azure Machine Learning.

Given that the goal was to extend the criteria model, the criteria obtained from the literature are used as a category system in the deductive approach of the method. On the basis of this deductive category application, a coding guideline is created in which the categories are defined and delimited from each other by descriptions and anchor examples. With this knowledge and the coding structure, the content of the websites was analysed, and suitable statements were assigned to the categories. At the same time, as an inductive approach, previous categories were amended by an additional category, if new aspects emerged.

Expert Interviews

Subsequently, we have conducted expert interviews which are one of the most common and important methods for data gathering in Information Systems research (Myers & Newman 2007, p 3). The interviews were conducted using a semi-structured interview guide (Myers & Newman 2007) that included questions about different aspects such as prior experience with MLaaS platforms, differentiation criteria of providers, metrics to evaluate services, as well as, problems and challenges when using the services. With the help of these questions, the results from the literature review and content analysis of vendor websites were corroborated, in order to evaluate whether the previously collected criteria were indeed relevant for MLaaS. Microsoft Teams was used as a video conferencing tool. With the consent of the experts, the interviews were recorded and transcribed. The analysis was done according to the same approach and coding system as in the content analysis of vendor websites.

The interview experts were selected according to previously defined criteria. A suitable interview partner is someone who has already gained experience specifically with MLaaS. Practical experience is a prerequisite for participating. Services from several providers should have been used, as knowledge is necessary to identify differences. Potential experts were searched and contacted on social media platforms such as LinkedIn or XING, as well as, using the authors' personal network. Details about the interviewees can be found in Table 1.

Table 1: Interviewee description

Interviewee	Characteristics
I. 1	Freelancer in the field of machine learning with previous industrial experience and management of a data science department.
I. 2	Computer scientist with practical experience in MLaaS and professional experience in explainable AI.
I. 3	Research associate at an Institute with practical and technical experience in machine learning applications and evaluations.
I. 4	CEO of a consulting firm specialised in the use of artificial intelligence in the industry.
I. 5	Employee in the cloud and AI department of one of the largest providers of these services with professional and practical experience in MLaaS.

Results

Overview

Based on the research conducted as discussed above, our framework for the evaluation MLaaS has been designed. The framework consists of six categories: Performance, Economics, Provider, Service, Security and Support. The 22 criteria collected and elaborated through this work have been assigned to these categories, and, operationalized with the help of various metrics to make them measurable.

The first category to be evaluated is performance. Performance is a versatile term, in this case it is defined by the criteria of accuracy, throughput and time-related aspects of an ML service. The second category, economics, includes criteria such as cost, efficiency or sustainability. The category provider includes criteria needed to evaluate the characteristics of the cloud service provider, such as trustworthiness or compliance with regulations. In the category service, criteria with regard to the properties of the service that is the subject of the evaluation are summarised. The latter categories, security and support, describe security-related aspects of a service and criteria regarding technical support by the provider or the availability of community support.

Another important part of the criteria framework are the metrics that enable the execution of the criteria. The metrics can have different degrees of specification: quantitative, qualitative subjective and qualitative objective. Quantitative metrics are, for example, the number of followers on social media or the response time of a server in seconds. Qualitative subjective metrics can be e.g., user friendliness or the reputation of the service or provider. Qualitative objective metrics are researchable aspects such as whether a certain functionality is available or not.

Performance Criteria

The way of measuring the accuracy of an AI algorithm depends on which type of discipline the algorithm is trying to master. In general terms, accuracy is defined by the error rate a webservice produces when providing the service (Ran 2003, p 8). In the work by Liang et al. (2020), Flach (2019) and Yao et al. (2017) the accuracy is calculated and presented with the parameters F-Score, Recall and Precision. Other metrics for accuracy are presented by Anda et al. (2020) and Ribeiro et al. (2015).

Throughput alongside accuracy is an important measure for performance. It is defined by the “number of completed service requests over a time period” (Ran 2003, p 7). Throughput is a measure related to the response time of a service. The higher the throughput and the lower the response time, the better the performance. The applicable metric for throughput is the number of processed requests per unit of time (Kalepu, Krishnaswamy & Loke 2003, p 132; Wang & Liu 2013, p 5).

The broad term time consists of more than one metric related to performance. Besides the more known time-based metrics, the time a user needs to complete a cloud service process while maintaining quality is an important economic success factor (Bardsiri & Hashemi 2014, p 30). When the process is complete and the system is ready for production, additional time-based metrics are used to evaluate performance. One of the most present is the response time, which is the time between the service request and a response to this request (Wang & Liu 2013, p 5). The literature provides further mentions (Liang, O'Keeffe & Sastry 2020; Yan et al. 2016; Ran 2003; Zeng et al. 2003; Chahal et al. 2020; Kalepu, Krishnaswamy & Loke 2003). The vendor analysis was able to contribute further aspects, such as time required for different ML steps, latency time or bug fixing time. [AWS, AZURE, GCP]

Table 2: Performance criteria and metrics

Criteria	Metric
Accuracy	MAE, MSE, Log-loss, Precision, Recall, F1-Score, AUROC, Brier-Score
Throughput	Number of processed requests over a period of time
Time	Response time, Latency, Latency Cold Start, Deployment time, Time to market, Pre-built solutions functionality, Time needed per step of ML-Pipeline, Number of clicks, Debug time, Latency with SSL, Distributed training functionality, Time between the service request and the service response.

Economics Criteria

A distinction is made between different types and dimensions of costs in connection with cloud services, also caused by a "variety of options" (Bardsiri & Hashemi 2014, p 30) that service providers offer. Yoo & Kim (2018) suggest three kinds of costs: investments, administrative and operational costs. The literature (Bardsiri & Hashemi 2014; Ran 2003; Zeng et al. 2003; Franca & Werner 2019; Chahal et al. 2020; Kalepu, Krishnaswamy & Loke 2003; Wang & Liu 2013) mentions many different types of costs. By analysing the providers and their product presentations, it was possible to gather further aspects on the topic of costs, such as the use of cost calculation tools [GCP], pay per use models [Azure] or maintenance costs [AWS]. According to the experts interviewed, other important considerations are price transparency [I. 3], notification services in the event of cost overruns [I. 1, 4] or the use of discounts [I. 3].

Scalability can be measured as the ratio of assigned resources to requested resources or simply by the option of changing the current plan to a bigger one, which provides more resources or higher transaction limits (Ran 2003, p 7; Bardsiri & Hashemi 2014, p 31; Franca & Werner 2019, p 52) . Furthermore, the scalability of a service can be measured not only in terms of computing power but also in terms of possible prediction endpoint calls or the highest possible input data volume [AWS]. For activities in a team or in larger departments, it can be advantageous to distribute the computing resources within a workspace [Azure].

Sustainability is also an important issue in the area of IT. From an ecological point of view, computing resources consume natural resources and must be used responsibly. Also, related scientific papers suggest observing the aspect of sustainability in an evaluation of a service (Bardsiri & Hashemi 2014, p 31). The task is to determine the energy consumption of the platforms used, if possible, depending on the training of a specific AI model. Possible metrics are the carbon footprint, the Data Centre Performance per Energy factor (DPPE), the Power Usage Efficiency/Energy per accuracy (F1 score).

Efficiency describes or measures how well a service uses the available computing resources and is closely connected to the aspect of sustainability. Therefore, the fewer resources are employed for a requested operation the better the efficiency of a cloud service. Cloud computing has always been marketed as a solution that reduces costs through economies of scale and reduces environmental impact through increased efficiency (Venters & Whitley 2012, p 190). Metrics for efficiency are among others: utilisation of resources and ratio of waiting time (Bardsiri & Hashemi 2014, pp 30–31; Yoo & Kim 2018, p 6). The ability to share services can improve team efficiency by providing the ability to share data sets, dashboards, notebooks or models. [Azure]

Table 3: Economics criteria and metrics

Criteria	Metric
Cost	Total cost of ownership (TCO), Data labelling costs, On-going costs, Cost per inference, Cost per data size, Training cost, Cost over a fixed period of time, Discount options, Supported users on a budget, Cost control functionality
Scalability	Ratio of assigned resources to requested resources, Upgrade of plan, Scalability of prediction endpoints and requests, Functionality for sharing and scaling resources in team environments, Training on multiple machines, Input dataset size, Optional TPU compute resources
Sustainability	Energy efficiency in datacentre, Power usage efficiency, Energy usage per prediction, Energy consumption per accuracy, Energy saving modes functionality
Efficiency	Sharing of datasets functionality, models, features and dashboards, Time efficiency, Utilisation of compute resources, Registry functionality for data and models, Model re-use functionality, Versioning functionality

Provider criteria

If a user's personal evaluation depends on the published facts of a service provider, there must be a measure of how trustworthy and honest a provider is with these characteristics. It can be measured by comparing the service-level Agreement (SLA) stated by the company with the result after using the service or with user ratings and other customer evaluation methods. Further trust related criteria can be referenced from Ran (2003), Zeng et al. (2003), Kalepu et al. (2003) and Wang an Liu (2013). The opinion of one of the interviewees is that companies must show a sense of responsibility and maintain a good reputation [I. 5].

Compliance is a criterion that could be developed by conducting vendor analysis. It includes adherence to legal requirements. The quality and adherence to these requirements are ensured by the companies through compliance programs. There are a variety of programs and certifications (FedRAMP, ISO) that can be checked, and their applicability depends on the company, country and law [Azure, AWS]. Interviewees mentioned compliance with the European GDPR as essential. [I 3, 4].

Ethics, as well as compliance, also emerged by conducting the vendor analysis. Ethics refers to the equality of decisions made by a DL model. As ML is the learning of data, biased decisions can also be made through so-called biased data, not least to the disadvantage of certain groups of people. In this case, the service provider should offer functionalities for the interpretability of the model decisions, or the possibility to recognise and correct bias. The object of these functions could be a feature importance graph, a fairness report or other disparity metrics. [AWS, AZURE, GCP]

Table 4: Provider criteria and metrics

Criteria	Metric
Trustworthiness	User ranking, Comparison of services provided to services advertised, Trust-building measures, Reputation, Employee satisfaction
Compliance	Number of compliance programs, Types of compliance programs and certifications, Transparency in compliance, GDPR conformity, Historical privacy violations, Documentation of data security
Ethics	Bias detection functionality, Model interpretability

Service Criteria

Ran describes availability in a traditional way as the probability with which a system is available, i.e., the up time (Ran 2003, p 8). The literature (Ismail et al. 2019; Zeng et al. 2003; Cabezas & Palacios 2020; Wang & Liu 2013) mentions many different types of availability. Through the vendor analysis, regional availability can be added. Depending on the countries or regions in which a service is available, access times or user compliance requirements may be affected. [Azure]. An interviewee suggests a more practical solution to evaluate the availability of a service. Instead of relying on the availability measures in the SLA, one could check and analyse the last downtimes of a [I. 1]

Reliability is service-related criteria in the model. Like availability, the consistency of the service should be ensured. Bardsiri and Hashemi (2014) define reliability as the ability of a service to remain functional without producing any kind of error. Metrics, that define reliability can be found in the work by Ran (2003), Zeng et al. (2003), Todd et al. (2018) and Wang and Liu (2013). In contrast to the factors mentioned in the literature, the focus is on the reliability of model performance and model accuracy [Azure].

The criteria modifiability, which has several occurrences in literature (Llewellynn et al. 2017; Ran 2003; Yoo & Kim 2018; Yao et al. 2017), is the “capability to make modifications” (Bardsiri & Hashemi 2014, p 31), especially when considering the costs incurred, be they monetary or time intensive. In AI related services such as ML modelling, a higher level of control can help build better ML models, because “feature, model, and parameters selection can have significant impact on the performance” (Yao et al. 2017, p 385). The range and characteristics of modifiability are one of the factors that can be expanded the most with the help of vendor analysis. One example is the level of modifiability of the different ML-Steps [AWS, AZURE, GCP].

Usability is the "quantity to which a service could be used" (Bardsiri & Hashemi 2014, p 31) by the consumer to fulfil their needs or to solve a task. It can be improved by simplifying the management of these services, for example through self-service or automation possibilities (Yoo & Kim 2018, p 6). Similar criteria are used by Ismail et al. (2019), Todd et al. (2018) and Yao et al. (2017). Since the development process involves several steps in the form of an ML pipeline, this workflow across all steps should be manageable and available in one place (AWS). All sources of the vendor analysis contain information about the usability of a service.

Depending on which system a cloud AI service is embedded in, its interoperability between other modules of the architecture is crucial. To measure the interoperability or the portability, one could quantify the dependencies and modularity of cloud services (Franca & Werner 2019, p 52) or check for applicable standards. In the literature (Bardsiri & Hashemi 2014; Llewellynn et al. 2017; Ran 2003; Cabezas & Palacios 2020; Todd, Vazquez Pena & and

Srinivas 2018) interoperability is a part of the evaluation process of these services. Based on the vendor analysis, it is possible to say that the development of the algorithm frameworks also depends on the development environment. [AWS, Azure, GCP].

Adaptability is the “level of efficiency in adjusting the solution” (Bardsiri & Hashemi 2014, p 31). It depends on how flexibly the service adapts to changing conditions or how quickly developers adapt bugs and other things. Adaptability or similar terms are mentioned by Bardsiri and Hashemi (2014), Franca and Werner (2019) and Ran (2003). In terms of adaptability, the vendor analysis brings out the metric of the number of capabilities added over a period of time, e.g., since product launch, as a metric for service adaptability [AWS].

Table 5: Service criteria and metrics

Criteria	Metric
Availability	Up-time, Ratio of successful services to total services, Access options, Fault detection and notification functionality, Regional availability, Recent downtimes, Vendor Lock-in risk
Reliability	Ratio of successful execution times to total execution times, Frequency of new releases, Maintenance functionality for model accuracy, Robustness with input parameters, Measurement of reliability under stated conditions (MTF, MTBF, MTTT), Processing time changes under normal use
Modifiability	ML Learning pipelining functionality, Time needed for any kind of change, Mean time to change, Usage of own code, Application specific models, Number of features available, Support of multiple types of deep neural networks
Usability	Trackability and monitoring of model, Functionality to change between code-based and no-code based tools, Functionality for managing the ML pipeline, models and workflows, Built-in tools for data labelling, Built in algorithms and frameworks and languages, Functionality for customisable visual user interface, Debug and profile runs functionality, Data management functionality, Local machine test environment, Kernel switching, Model sharing and restriction
Interoperability	Amount of dependencies, Transaction and connection standards, Frameworks for building images or container, Custom model migration, Connectivity with other vendor owned services and tools, Support for on-premises, multi cloud or edge
Adaptability	Coverage of Variability, Time passed to the last update, Number of added capabilities in a defined period of time

Security Criteria

According to Bardsiri & Hashemi, data security "represents a vast group of plans, systems and also equipment" (Bardsiri & Hashemi 2014, p 31) that is dedicated to guard the cloud infrastructure. Applicable metrics are the presence and availability of a SSL certificate for encrypted transfers and data (Kalepu, Krishnaswamy & Loke 2003, p 133). The security criteria is also component in the work of Ran (2003), Cabezas and Palacios (2020) and Yoo and Kim (2018). According to the providers, security can be increased through private network connectivity or differential privacy techniques [AWS, Azure]. One interviewee claimed that attention must be paid to the further use of customer training data by the provider in the case of ready-to-use AI services [I. 1].

Authentication is the determination of "whether or not somebody or something is [..] who or what it's declared to be" (Bardsiri & Hashemi 2014, p 31). To ensure safety, there should be "no access without rights" (Cabezas & Palacios 2020, p 485), and the ability to manage users' privileges and rights (Franca & Werner 2019, p 52). Further mentioning occurs in the literature (Ran 2003). The vendor analysis showed that it must be possible to create role-based access in the cloud ecosystems [AWS, Azure, GCP]. For the interviewees, it's also important to facilitate and improve this kind of authentication trough single sign-on possibilities. [I. 2].

Table 6: Security criteria and metrics

Criteria	Metric
Data and process security	Applicable SSL, Private network connectivity, Confidential computing, Differential privacy techniques, Differential privacy techniques, Further use of customer data and traceability
Authentication	Privilege management, Machine Learning roles, Managed identity for computing resources, Single sign-on

Support Criteria

Complex and large projects in the field of AI can sometimes cause problems. Therefore, users should ensure the technical expertise, accessibility and availability of the service of this provider (Yoo & Kim 2018, p 6). The providers themselves define their expertise by measuring the number of years of experience they've had. In addition, different providers are more experienced and specialised in certain areas, such as personal assistants or robotics [AWS].

The provider should offer adequate user and service support. Technical support is an aspect that came up mainly in the interviews. The focus here is on the existence of clear, up-to-date, and easily accessible documentation that can be called up in the event of problems (I. 2, 3, 5). Furthermore, the support can be defined by different support levels or offered response and service times (I. 3].

For larger companies, the question is whether some form of partnership between provider and user is possible. (Yoo & Kim 2018, p 6). Also, companies should check whether there is already an existing relationship with the provider going on, e.g. due to the use of other services [Azure].

Franca & Werner (2019, pp 52–54) extend the generic frameworks by the factor community. They hypothesise that the more questions asked on online portals about a particular service or provider, and the larger the user base, the lower the risk of not getting sufficient community support. A provider's community can either be described by its number of users or by the different industries that these users represent (AWS). According to the experts, it is important that many articles, instructions, questions and solutions to problems are posted online so that one is not left to one's own problem-solving abilities [I. 2, 4]

Table 7: Support criteria and metrics

Criteria	Metric
Expertise	Years of experience, Areas of expertise
Technical support	Technical documentation, Support levels
Relationship	Partnership possibility, Existing relationship or usage, Personal contact possibility
Community	Number of users, Variety of community members, Amount of hits in a forum, Availability of tutorials and case studies, Followers on social media, Number of experts in the community, Sentiment analysis

Discussion

The objective of this work was to develop a criteria model for the evaluation of cloud-based machine learning services. As previously mentioned, previous studies that had developed evaluation frameworks for cloud and web services were identified (Bardsiri & Hashemi 2014; Ran 2003; Zeng et al. 2003; Franca & Werner 2019; Yoo & Kim 2018; Kalepu, Krishnaswamy & Loke 2003; Wang & Liu 2013). Due to the different contexts of these frameworks, it was unclear whether they could be used in the context of cloud-based machine learning services, as well. Based on our research, it can be concluded that all the criteria from the previous studies could be adopted in the new criteria framework. Due to the fact that the criteria also occurred in our own primary research methods, we were able to confirm their suitability for MLaaS. This is not surprising, since ML services running in the cloud share properties with other cloud services. Criteria, such as interoperability, availability or cost can be applied to other cloud services, in the form of data storage services, as well as, ML services. We were also able to build on the seminal work of prior studies by adopting some of the categories from different papers and combining them in our framework to cluster the criteria, inductively confirmed and strengthened by our own primary research. Previously used categories include performance (Bardsiri & Hashemi 2014; Ran 2003; Franca & Werner 2019), economics (Bardsiri & Hashemi 2014), security (Bardsiri & Hashemi 2014; Ran 2003; Franca & Werner 2019), and support (Yoo & Kim 2018).

However, it also turned out that prior frameworks from the domain of cloud services were not able to cover all necessary aspects to evaluate MLaaS. Therefore, new criteria were integrated into the framework based on our research. For example, the algorithm accuracy criterion was missing in previous studies. Due to the fact that accuracy is a specific ML property, it could be derived from studies from the domain of ML (Ribeiro, Grolinger & Capretz 2015) that compared the accuracy of ML models in experiments, and also identified and confirmed by the vendor analysis and expert interviews.

Another criterion that was missing in the previous study is ethics. This concept is becoming increasingly important with the growing field of ML, as the technology, which has so far been little regulated, can make decisions to the disadvantage of certain groups of people. If algorithms or training data are not monitored and analysed, algorithms can learn from structural inequalities (Leslie et al. 2021). The topic is further strengthened by the continued growth of services, users, but also by new data protection laws and security concerns. The user data, which can be collected in various situations, can be used as training data for the development and improvement of ML algorithms. However, bias, discrimination and disadvantage are inherited from reality, if companies do not fulfil their duty to prevent biased data and predictions.

To summarize, it can be stated that the results of this work are in line with those of previous studies but at the same time combine both topics. The already existing QoS criteria provided a good basis for setting up the framework. The vendor analysis and the expert interviews were able to extend the usefulness of the criteria and the framework with innovative metrics that were not known in the literature before.

Conclusion

Contribution to Knowledge and Implications

The aim of this work was to create a novel framework for the evaluation of MLaaS solutions. Based on a rigorous research design embedded in the DSR methodology, were able to present a framework with 22 criteria in 6 categories. A total of 116 metrics identified in the research process could be assigned to these 22 criteria.

This research has underlined the importance of updating existing frameworks with ML specific criteria in order to provide a complete picture when evaluation cloud-based ML services. Our novel framework contributes to knowledge by providing, to the best of our knowledge, the first comprehensive set of criteria and metrics to evaluate cloud-based ML services. Taking into account both, prior academic knowledge, and, insights from practice based on collecting data from vendor websites and ML practitioners, we are convinced that all necessary aspects are covered. Additionally, we were able to specify the criteria on a high level of details, suggesting various metrics associated to the criteria. Where previous research has often provided only vague definitions, this framework was able to operationalize the criteria.

We hope that our framework helps organizations to make better decisions regarding the adoption of MLaaS and to select suitable services and providers. The criteria can be used to evaluate and describe cloud-based ML services, as well as to highlight differences between providers. By consequently applying the framework and trying to measure the metrics for different services, users will be able to increase their knowledge about the corresponding services and their characteristics, preparing them to make better decisions.

Limitations and Future Research

We are aware that our research may have some limitations. Trying to develop a holistic framework for the plethora of cloud-based ML services requires accepting a few limitations. This is due to the dynamic nature and variability of MLaaS products and the general heterogeneity of the market, which makes it very difficult to develop a universal framework. The many different problem types that ML can handle cannot always be mapped in the same depth by the framework. In addition, the services, which vary from fully automated to individual programming, are constantly changing. Nevertheless, we hope that our generic framework is helpful to evaluate all types of MLaaS, providing a basis that can, if necessary, be amended with specific criteria for particular services.

Of course, the choice of research methods for developing the artefact may always be a source of bias. Expert interviews are a good way to gain insight into the practice. However, there is always the possibility that the interviewer as well as the interviewee may be biased due to past experiences or general attitudes towards the topic. It is also not entirely possible to verify the knowledge or experience of the interviewees. In order to mitigate bias and reduce subjectivity, we have taken different measures, such as critically reflecting results within the team of authors.

Future research can further validate and extend our framework. The evaluation of the framework as part of the DSR research design was based on one ML problem type, the binary classification. By applying it to other problem types and services, the framework can be

further validated. If necessary, the framework might be further extended by adding new criteria, making existing criteria more granular, or adding metrics to the criteria, whether quantifiable or not. In addition, there is great potential for research diving into individual criteria of the framework. For example, energy consumption and sustainability in data centres with regard to MLaaS could be further analysed.

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The impact of the COVID-19 pandemic on students' learning at the Institute of Tourism Studies (Malta)

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Abstract

This paper discusses the impact of the COVID-19 pandemic on the learning experience of students at a VET (Vocational Educational Training) Higher Education Institution in tourism education, namely the Institute of Tourism Studies (ITS) in Malta (EU).

A sample of students who attended ITS between March 2020 and January 2022 generated the primary data. This revealed the students' experience in terms of their academic performance (both theoretical knowledge and practical skills), their personal well-being, and their perceived evaluation of the educational institution during the emergency caused by COVID-19. There is particular emphasis on e-learning / remote learning and the challenges of conducting school-related practical work, going on work placement or work in the tourism industry (both part-time and full-time) apart from their studies.

The data analysis revealed that the student experience at ITS was, in many aspects, similar to international trends. This was seen in terms of the impact of the pandemic's restrictions on face-to-face learning and the sudden shift to pure e-learning in all courses. Students confirmed that since ITS had, in previous years, invested in the e-learning infrastructure, e-learning systems in place proved extremely effective when they were needed most. However, not all subjects were considered suitable for delivering online. In fact, students stated that most practical subjects and certain theoretical subjects are better delivered face-to-face. The way forward recommended by students is a blended system where the courses have both a face-to-face component and an online component. The latter not only provides more flexibility in learning, which is especially sought by mature and part-time students, but also reduces time wasted in travel to and from campus.

Although research on the impact of the COVID-19 pandemic on education is widely available, little research focused on VET and Higher Education in Tourism, especially through the experience of learners. For this reason, this paper seeks to address this gap in knowledge. The major limitation of this research is that it was conducted in a volatile situation with ever-changing COVID-19 conditions, restrictions and challenges that had a direct impact on education.

Keywords: COVID-19, post-pandemic, higher education, e-learning, tourism education

Literature Review

The effect of the pandemic on higher and VET education

The COVID-19 pandemic shook the educational world to its core and according to the United Nations (2020, p 2) it 'has created the largest disruption of education systems in history, affecting nearly 1.6 billion learners in more than 190 countries and in all continents. Closures of schools and other learning spaces have impacted 94% of the world's student population and up to 99% in low and lower-middle income countries.

The most common reaction to the COVID-19 pandemic was the closure of educational institutions and the suspension and/or cancellation of physical classes (Auger et al, 2020, Sahu, 2020 and Viner et al, 2020). Many institutions authorised lecturers to start working from home and began disinfecting premises, particularly those that had recorded students and staff positive to the virus. While remote learning with digital technologies was quickly implemented or expanded to make up for the loss of face-to-face classes in many countries around the world (Amemado, 2020), the quality of e-learning has been questioned and school closures are common two years from the start of the pandemic (Azevedo, et al, 2021, p 5). Remote emergency learning was not quality online learning (National Council for Online Education of North America, 2022), however it could be as effective as face-to-face learning if done correctly (ibid.). Bozkurt et al, (2020, p 1) discovered that emergency remote learning is different from well-planned e-learning: 'in terms of educational processes, the interruption of education signifies the importance of openness in education and highlights issues that should be taken into consideration such as using alternative assessment and evaluation methods as well as concerns about surveillance, ethics, and data privacy resulting from nearly exclusive dependency on online solutions'.

Irish observers have described this overnight switch to e-learning as the 'great onlining of higher education' (European Distance and e-Learning Network, 2021). However, others started to ask why it had to be a crisis on such a scale to provide the catalyst for digital transformation of higher education (Brown & Keogh, 2021). The need for education reform has already been felt before the pandemic but there was resistance to change and rather prophetically, the OECD (Organisation for Economic for Co-operation and Development) had warned that 'reform is more easily undertaken in 'crisis' conditions, although the meaning of 'crisis' might be somewhat different in education. The shock involved is likely to be something that alters perceptions of the education system rather than an event that suddenly affects its ability to function' (Schleicher, 2018, p 208). This shock came two years later with the COVID-19 pandemic.

The success or otherwise of the sudden transition to e-learning depended on how fast the educational institutions adapted to the new circumstances and how amenable the authorities were to such a change. This depended on a variety of factors including academics' and students' problems of adjustment, connectivity, network, internet and bandwidth issues, lack of space and/or environment, lack of basic needs, mental health related issues, and lack of teaching and internet resources (Mseleku, 2020; Barbaro, 2021).

In the case of academics, some did not have the requisite knowledge to adapt to a sudden shift to online learning (Barbaro, 2021), while others had problems with adapting, carrying out and monitoring online lectures. Some of these problems were due to the lack of effective planning and enough professional development to bring the lecturers up to speed with the e-learning systems (Almahasees et al, 2021; Hickling et al, 2021; Korkmaz et al, 2021).

Vision, planning and investment in both human and technical resources are essential to deliver proper e-learning (Debattista, 2018, National Council for Online Education; 2022), and the sudden onset of the pandemic did not favour such a disposition. Furthermore, the sudden transition to online learning attracted the attention of the mass media and such terms as 'remote learning' and 'hybrid learning' were widely adopted. However, historically there is no consensus on the definition of terms related to e-learning (Debattista, 2018) and this was also the case with 'hybrid learning' when it was referring to the by-then established 'blended learning' but with a new name (Fullan et al, 2020; Microsoft Education, 2020).

In the case of the ITS, most of the e-learning infrastructure had already been implemented, with online and blended learning available in some of the programmes. The Institute was among the first higher eduation institutions in Malta to bridge the gap between face-to-face lectures and online education activities, namely by introducting a virtual learning environment as easly as 2005 and a full productivity suite for all faculty and student in 2015 (Times of Malta, 2005). This proved invaluable in March 2020, when the Maltese Government announced a national lockdown in education (Azzopardi, 2020; MaltaToday, 2020) mainly because all lectures were transferred online.

In the rest of Malta the transition to online learning was done with varying degrees of success, especially in compulsory education, due to the decrease in teacher contact hours that are so important to primary and secondary students (Busuttil & Farrugia, 2020).

The pandemic's effect on students

The change from class to online learning is a complex one that has had a multitude of effects on students. Contrary to the popular perception, young learners of Generation Z do not have innate digital competences and underachievement in the application of digital skills is still widespread in the EU (Pedone, 2021).

The first scholarly research on the impact of the pandemic on education suggested that students still prefer face-to-face instruction over e-learning (Kemp & Grieve, 2014; Amir et al, 2020; Chakraborty et al, 2021; Costado Dios & Piñero Charlo, 2021; Adams et al, 2021). This can be attributed to many reasons that seem to depend on numerous factors including availability of computing devices, the availability, quality and cost of Internet access, technical constraints, lecturer availability, presence of social cues and motivational signals and social connection (Unger & Meiran, 2020; Dick et al, 2020; Murdaugh et al, 2020; Felson & Adamczyk, 2021; Szabo, 2021).

Moreover, with the transition to full e-learning, student motivation fell drastically (Wang et al, 2019). In fact, certain learners reported challenging home environments

which led them to prefer the on-campus experience (Matarirano et al, 2021) whilst others felt the loss of the communal student life on campus and lost the drive to continue their learning programme (Gocheva et al, 2021). Additionally, certain students further noted the need for more face-to-face contact which would remind them to do and hand in assignments (Tichavsky et al, 2015).

Not having the right e-learning environment, educational tools and platforms was an even bigger challenge for less developed countries, but the demand or usage of more online and technological tools after and during the lockdown did not necessarily mean better education as it depended on the skills of the students using the system. The speed of the change-over in many institutions was so fast that students had little time to prepare for the change and this may have affected their self-confidence (Almaiah et al, 2020; Khan et al, 2021; Lukas & Yunus, 2021.)

The issue of self-confidence is tied to that of self-efficacy and perceived personal strengths and weaknesses at doing something (Bandura, 1977). This also covers student behaviour such as effort, determination, flexibility, toughness and task choice - all of which are essential in the realisation of academic expectations and performance (Alghamdi et al, 2020; Hamdan et al, 2021). Therefore, since e-learning is often seen less challenging than traditional learning due to certain advantages such as lecture recording, online tests and less written assignments, online learning must be planned in a way that elicits the same academic effort from the student that was displayed before the onset of the COVID-19 pandemic. This may also lead to a decrease in effort from the student that can affect the choice of task and lower academic performance (Lau & Sim, 2020; Mustakim et al, 2021; Nasution et al, 2021; Sakkir et al, 2021).

Moreover, Fullan et al (2020) note that students want personalised learning more than automation in their learning experience. Therefore, a balance with more social interaction on campus and e-learning still playing an important role seems to be the future of post-pandemic education (Barbaro 2021). In fact, higher education students have put forward the following recommendations for their post-pandemic learning (JISC 2021, p 19):

- Acknowledge that online learning is different and design accordingly
- Ensure students can access the technologies they need
- Improve group and class interactions
- Make online platforms more user-friendly
- Improve group and class interactions
- Improve access to support and online materials
- Record lectures (even of live lessons)
- Communicate and provide constructive feedback

Indeed, the future is clear: blended learning, or a mix of on campus and online classes in the courses. However, this brings us back to the issue of remote emergency learning not being well-prepared and well-though-out online learning. For blended learning to work, ‘there must be a pedagogical shift to design more intentional learning relationships as the foundation for engagement in content, problem-solving, and skills development’ Microsoft Education (2020, p 8).

The effect of the pandemic on practical subjects

It has been established that the sudden switch from face-to-face to pure online learning in an emergency situation was challenging for both learners and educators, with some managing to adapt despite the exceptional situation (Sahu, 2019; Hjelsvold et al, 2020; Almendingen, 2021). However, notwithstanding that online learning proved to be successful for theoretical subjects, other studies have suggested that practical subjects were not as successful online (Mahdy, 2020; Chadwick et al, 2021; Dorn, 2021).

Indeed, the difficulty associated with teaching practical subjects online has been regarded as a common issue amongst the limited studies that explore practical subjects delivered online during the COVID-19 pandemic. This difficulty is not only due to the ample preparation and situation-specific adaptation required (Pelikan, 2021) but mainly because such subjects have been built with the intention to be taught in physical classrooms where experimental and hands-on operations are the norm (Priyadarshani, 2021). In fact, Ghaemi and Potvin (2021) state that the change in the method of learning has left students following practical subjects with more difficulties during the COVID-19 pandemic, given that the closure of schools, and consequently the decrease in facilitation of practical activities, meant students were unable to carry out hands-on activities. On the other hand, however, Burford and Gregory (2002) have previously argued that it is possible to follow practical modules online as well.

In effect, various educational institutions have ensured the continuation of delivering practical subjects, despite evident constraints. During this time, various alternatives were sought, including: the postponement of practicals to when the students were back on campus (UNESCO, 2021); the rise of recovery curriculum required to successfully transition students back to school (Moss, 2021); the earlier reopening of educational institutions solely for students following practical subjects (Centre for Global Development, 2020; Department for Education, 2022); the encouragement of ‘take home labs’ were students use artifacts to engage with the required learning outcomes (Patterson, 2019) and the use of artificial intelligence and augmented reality (Nesenbergs, 2020) to compensate for the lack of physical practical tasks.

Evidently, this pandemic has, and in certain contexts, continues to cause unprecedented disruption to education and training provisions. However, research has shown that the access to theoretical skill development has been maintained through the rapid shift to distance learning (Trucco & Palma, 2020). In contrast, Schleicher (2020) argues that whilst distance learning has provided educational continuity to theory-based subjects, vocational education and training (VET) programmes have suffered a double disadvantage. This is mainly because practical and work-based learning is difficult or impossible to conduct due to imposed social distancing requirements and the closure of practical establishments (UNESCO, 2020).

The impact on students’ practical skills

A study carried out by the International Labour Organisation (2021) notes that since practical-based components account for more than 60% of the total learning time of these programmes, the increase in distance learning in VET programmes has limited

the acquisition of practical skills and organisation of work-based learning. Similarly, Gillis and Krull (2020) add that these latter components are essential for the success of VET programmes and so, in situations where practical sessions were simulated remotely, the learning experience was extremely limited.

Adjusting to distance learning has not been the only factor impacting the continuous development of students' practical skills. VET programmes that rely heavily on practical training such as hospitality, usually also include apprenticeship training and industry placements that further enhance students' experiences within the industry. Since employers have historically cut back on such programmes during economic recessions and global downturn, this concern added a further burden on VET programmes (OECD, 2020). In fact, Muehlemann (2021) notes how the pandemic strongly affected apprenticeship training because workplace training often became more difficult, or stopped completely, due to social distancing rules and closure of establishments for extended periods. This, in turn, has negatively influenced the practical skills development process of students following VET programmes.

VET institutions implemented distinct efforts to keep up the delivery of practical skill training during the pandemic and, to continue to do so efficiently, further support measures must be considered. These initiatives must aim not only to help institutions concerned to respond to current challenges but also to adapt to possible changes in labour market requirements. In fact, various countries are investing in VET and building skills to mitigate future skills shortages and minimise the pandemic's aftermath in this regard. In Sweden, for example, the government has put together a crisis package for jobs and transition by increasing funding and giving additional support to VET including distance learning providers in higher VET (OECD, 2020). In the United States, Youth Apprenticeship Readiness grants are supporting the enrolment of in-school or out-of-school youths into new or existing apprenticeship programmes (US Department of Education, 2020).

In Malta, the Ministry for Tourism in collaboration with the Malta Tourism Authority (MTA) offered a top-level training platform to thousands of workers in the tourism sector whereby the courses offered under this scheme were free of charge to participants being wholly financed by the MTA. These online training courses addressed a wide range of skills that are required in the tourism industry (Malta Tourism Authority, 2020).

Cedefop (2021, pp 6-7) recognised that 'In Malta, there is a general effort to continue with lessons via distance learning at all levels. It is still very early to say how effective it is, but at least the effort is there by all parties concerned and the technological/ infrastructural setup is proving to be up to the standard required.'

VET students' perception of e-learning

Studies focusing on the students' perception towards their satisfaction with online learning during this pandemic have established mixed outcomes (Demuyakor, 2020; Hodges et al, 2020). In Indonesia for example, mechanical engineering students felt that online learning did not allow them to master their competencies and that although they had ease of access to resources, they were still reluctant about using them sustainably in the future (Syauqi, 2020). Similar results were noted in Norway: when VET students were asked to rate the quality of online education during the

pandemic, most students described online teaching as being unmotivating, whilst some also noted how teaching was reduced or that they did not receive any teaching at all (Cedefop, 2021). In the United Kingdom, higher education (HE) students made both positive and negative statements. Flexible assessments and digital content were rated as the most significant positives whilst the lack of interaction and lack of support from teaching staff during lockdown were earmarked as the most significant drawbacks (Khan, 2021). In contrast, data collected from hospitality students in Korea and Malaysia showed a greater level of satisfaction with the availability of more than one mode of class delivery method being the greatest reason for their overall satisfaction (Choi, 2021).

Changes in assessment patterns

Monitoring of learning, assessment and the provision of feedback are important to understand students' learning progress because these allow educators to implement appropriate pedological actions that will help improve students' learning outcomes (OECD, 2013). Therefore, it is to no surprise that around 80% of the European HE institutions planned to continue with regular examinations, including online examinations during the pandemic (James, 2020; Marinoni et al, 2020). Other studies show how the COVID-19 pandemic has played an important role in the growth of continuous assessments because educational systems worldwide transformed existing assessment systems and/or developed new practises to maintain quality throughout (UNICEF, 2020; Verillaud, 2020).

Since the assessment of skills in VET programmes is usually based on a demonstration of competences in a real working environment, pandemic restrictions and closure of practical establishments led to the disruption of assessments and certification of examinations in such programmes. Nonetheless, it has been reported that many VET providers have continued their efforts to ensure continued assessments even during the pandemic (European Commission, 2020). Indeed, the effects and severity of the pandemic varies in each country, with no one-size-fits-all approach being implemented and so, rapid, and innovative responses are specific to local needs. Countries reporting low COVID-19 spread and decreased containment measures continue with in-person assessments by implementing precautionary measures and limiting the number of students present at the same time (International Labour Organisation, 2021). In other countries, alternative methods are implemented to assess practical knowledge and skills, often through virtual platforms. For example, in Ecuador and Finland, students are reported to be carrying out practical tasks at home and uploading them onto platforms or sending videos and photos of completed work to their teachers for evaluation (Cedefop, 2020).

Various concerns on the assessment process of practical skills in VET and HE were raised well before the COVID-19 pandemic. In fact, Harden and Cairncross (2006) note that the assessment of such skills is often neglected with unsatisfactory assessment instruments being the contributing factor. This pandemic has continued to trigger wider discussions about the validity and alignment of the examination processes and their benefits within certain areas such as VET and HE (EUA, 2020). Consequently, debates surrounding the need to make such assessments more authentic, including the consideration of 'open-book' exams or allowing more teamwork and presentations, are imminent (Times Higher Education, 2020).

The adoption of relatively new education technologies is also being considered. Pedone (2021, p 5) suggests that advanced digital technologies like augmented (AR) reality and artificial intelligence (AI) can support remote work-based learning.

Conclusion of literature review

The onset of the COVID-19 pandemic was one of the most disruptive factors on society in general in the 21st century, and had a profound effect on education. The institutions that already had a suitable information and comunication technology infrastructure and had previously invested in online learning were the ones to adapt first to the change.

The effect of this change was a complex one that depended on many factors. The most important factor was the gap between the developed and developing countries, but as has been shown, the technological and pedagogical factors are also very important. Despite the efforts by the authorities and the educational institutions themselves, the pandemic left a mark on the students' educational experience. This effect varies from one country to another and from one institution to another with VET educational institutions not being an exception.

In the case of the Institute of Tourism Studies, it had the advantage of a robust and well-developed VLE with lecturers and students that were already familiar with online learning. Indeed, this helped the Institute to continue with its planned strategy even during such unprecedented times (Institute of Tourism Studies, 2021).

Data Presentation and Analysis

Methodology

A qualitative research method was chosen to gather primary data on the effects of the COVID-19 pandemic on the stundent's learning at ITS. While the literature review has revealed how the effects of the pandemic on education has been widely studied around the world, the same attention has not been directed towards VET and Malta in particular. The targeted population for this online questionnaire were all of the 1067 students attending any course, at any level (EQF Levels 1 to 7) between March 2020 and December 2021 at the ITS. When compared to standard response rates, the number of responses received, 177 students (n=177) were high.

Sample characteristics

Out of 177 respondents 35.59% (n=63) were under 18 of age and so were either in the first or second year of their educational career at the Institute. These students probably experienced the Institute in transition from the full COVID-19 experience to the eventual loosening of COVID-19 rules and regulations. 31.07% (n=55) were between the ages of 18 and 24 and 33.06% (n=59) were 25 and over. The latter were mostly undergraduate bachelor student and master students. At 57.63% (n=102), more female students answered the survey than males, 41.24% (n=73). Two students (1.12%) prefered not to register the gender or chose the other option.

ITS is renowned for its multicultural environment with student enrollment from around the world. This is reflected in the survey. Although 85.88% (n=152) of the

respondents where Maltese, 14.12% (n=25) constituted 14 different student nationalities. 7.91% (n=14) came from EU member countries, while 6.21% (n=11) came from non-EU countries showing that there is no great difference from where the students originate. The top three in terms of numbers were Italian, Serbian, and Russian, but the group also included students from Brazil, Hungary, Greece, and South Korea.

Participants were asked to name the course they were attending during the pandemic. 11% were attending the basic foundation course in tourism; 27% were in culinary arts; 16% in events, travel and tourism; 15% in culture and heritage; 28% in tourism management; and 3% in other courses. It needs to be reported that the percentage of culinary arts students should have been higher since there were students who are at ITS during the pandemic but were having their internship abroad at the time of the data collection. However, this data also shows that ITS has moved away from the predominance of culinary arts courses and diversified to cover the whole range of fields related to travel, tourism, culture and hospitality.

Although the availability of work during the pandemic fell quite drastically, 32.05% (n=50) still managed to continue working full-time and 31.41% (n=49) worked part-time. Analysing these figures depended on what type of work these students had. In the case of those working in the tourism and hospitality sectors, many had their salaries guaranteed by the Government's wage supplement, particularly in the tourism sector which suffered a lot during the lockdown.

It is interesting to note that 25.00% (n=39) choose not to work to concentrate on their studies, while another 11.54% (n=18) expressed a wish to work because they were unemployed. It is important to add that in Malta, every student is given a stipend to study and so, all students do earn a small pay packet. A few students wrote further comments concerning their employment situation.These findings all tie to the tendency of older students in joining courses such as the HND in Tour Guiding and the Master of Arts in Heritage Interpretation who either have more time to dedicate to lifelong learning or prefer to work less and study.

The majority of students (82.86%, n=87) replied that they work in the hospitality sector, while 7.62% (n=8) work in the travel sector and 6.67% (n=7) in the culture and heritage sectors. At 2.85%, a small percentage of the students indicated other industrial sectors which probably included students that either want a change of career or want to supplement their earnings by acquiring a new qualification.

When asked why they were made redundant, 61.84% (n=47) answered that they lost their job because they were employed in the hospitality, travel, tourism, and culture sectors which were all very badly hit by the pandemic. Only 6 respondents (7.89%) stated they were made redundant from jobs which were not related to the aforementioned sectors. Moreover, 23.68% (n=18) stated that they wanted to work in the hospitality sector but were not offered good salaries or good conditions of work. Another 14.47% (n=11) said they could not find a job in this sector.

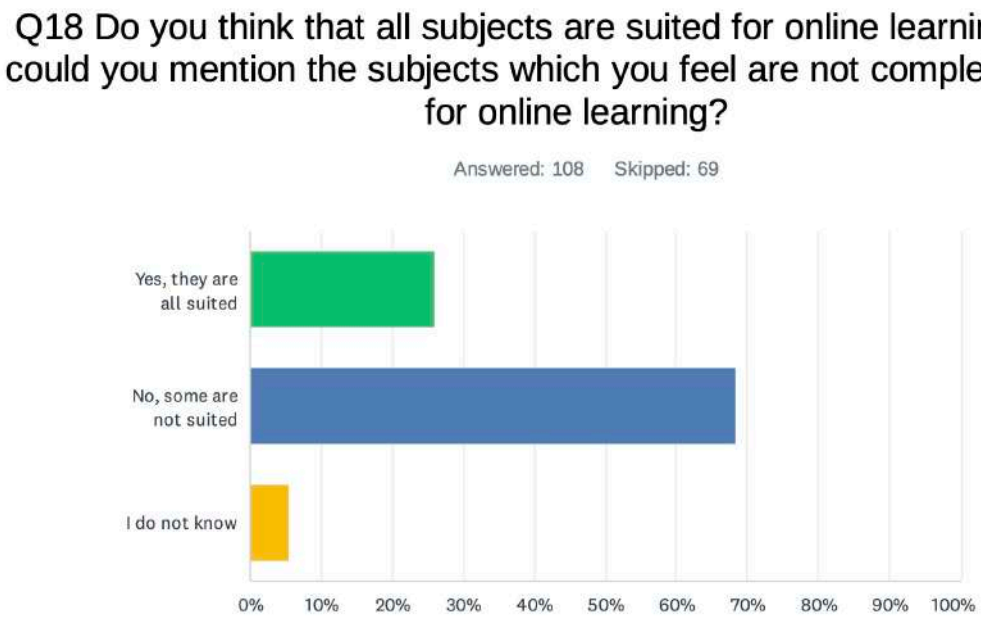
The Effect on Practical Subjects

The COVID-19 pandemic forced higher education institutions and universities to adapt to the rapidly changing situation. The mandatory social distancing

requirements were difficult to meet in a research setting particularly in the areas requiring bench work and human subjects, as well as fieldwork, were causing significant losses to research studies. (Schleicher, 2020; Ghaemi & Potvin, 2021).

The collected primary data from ITS students is aligned with such studies: At 68%, the absolute majority of respondents who follow practical courses at ITS, note that not all subjects are suited for online learning. In contrast, the views of students following purely theoretical subjects were not as distinct. In fact, 59% of these students agreed that some subjects are appropriate for online learning whilst 41% stated that all subjects were suitable (see Figure 1).

Figure 1. The subjects at ITS considered suited for online learning by the Institute's students



ANSWER CHOICES	RESPONSES	
Yes, they are all suited	25.93%	28
No, some are not suited	68.52%	74
I do not know	5.56%	6

When prompted to identify which subjects were not suitable for online learning, both theoretical and practical students identified similar ones. The absolute majority mentioned traditional practical subjects such as food and beverage service, food preparation, housekeeping, and barista techniques. However, in both groups, students also listed other subjects generally regarded as theoretical subjects such as bookkeeping, languages, research methods and statistics. This marks an evident contrast between literature that states how the access to theoretical knowledge has been maintained through the rapid shift to online learning (Trucco & Palma, 2020).

Although the majority of both practical and theoretical students agreed that practical subjects are not suitable for online learning, the discrepancy between these two

cohorts in stating how the pandemic made it harder for them to learn, is minimal. Nonetheless, it is interesting to note that the percentage appears higher amongst students following theoretical subjects. Indeed, in comparison to the 40% of practical students who confirmed the pandemic made it harder for them to learn at 47%, more theoretical students appear to have had a harder time at learning during this pandemic.

Current literature shows that practical-based components account for more than 60% of the total learning time of VET programmes, therefore, the increase in online learning implemented in such instances appears to have reduced the overall acquisition of student's practical skills (International Labour Organisation, 2021). This phenomenon was also observed by students following practical courses at ITS. Below shows how 24% of these students could not practice their practical skills during special events due to COVID-19 restrictions, 23% had their number of practical hours reduced and another 20% noted that social distancing and other health-related limitations did not allow them to practice their skills as per usual routines.

Further research also shows how VET institutions implemented distinct efforts to keep up the delivery of practical skill training during the pandemic (OECD, 2020). Incidentally, this was also brought to light by the respondents that certain measures, including block recovery practical sessions ensured that the effect of the pandemic on their practical skills was kept to a minimum. Such initiatives were essential not only to help institutions respond to challenges posed by the pandemic but also to adapt to possible changes in labour market requirements.

In fact, literature shows how adjusting to online learning was not the only factor impacting the continuous development of students' practical skills. During this pandemic, certain mitigating measures made workplace training more difficult, thus creating further burden on VET programmes relying heavily on practical training and industry placements (OECD, 2020; Muehlemann, 2021). However, the majority of the respondents did not convey this concern: more than 60% of the ITS students following practical courses stated that they completed their work placements without any issues. Further analysis shows how 52% of these students stated they actually learnt much more than they expected.

Further studies also noted how practical skills are vital for the success of VET programmes and that negatively influencing students' practical skills can have an impact on the students' overall development process (Gillis & Krull, 2020). Unfortunately, such research slightly collaborates with gathered respondents' data in that most ITS students following practical courses feel that, due to the pandemic, they are missing some key practical skills they need for their next studies.

Changes in Assessment Patterns

During this pandemic, not only have VET providers continued their efforts to ensure continued assessments (European Commission, 2020) but many have also provided altered assessment systems and/or developed new practises to maintain quality throughout (UNICEF, 2020; Verillaud, 2020). Research indicates how during this pandemic, around 80% of the European HE institutions continued with regular

examinations, including online exams (James, 2020; Marinoni et al, 2020). Such developments were also witnessed in feedback given by ITS students when 43% noted how more assessments were carried out online, 29% stated they witnessed fewer exams and more formative assessments spread throughout the academic year and 28% reported no major changes in assessment patterns.

Indeed, the monitoring of learning, assessment and the provision of feedback are vital in allowing educators to implement appropriate pedological actions that will help improve students' learning outcomes (OECD, 2013). Nonetheless, reviewed literature notes how various concerns on the assessment process of practical skills were raised well before this pandemic with certain studies showing how the assessment of practical skills are often neglected due to unsatisfactory assessment instruments (Harden & Cairncross, 2006). This pandemic has continued to trigger wider discussions about the validity and alignment of the examination processes and their benefits within certain areas such as VET and HE (EUA, 2020), however, it is also important to note that there is no one-size-fits-all approach and so, innovative responses should be specific to student needs.

In fact, when asked to rank their preference with regards to their ideal assessment methods for online learning, the majority of the respondents noted typed online assignments, short online tests during the semester, online presentations, online exams at the end of the semester and online oral tests. It is no surprise that students are suggesting alternative forms of assessment that were not considered before these unprecedented circumstances given their call for more authentic assessment (Times Higher Education, 2020).

The transition from face-to-face courses to pure online tuition as a result of the COVID-19 lockdowns need to be examined within the context of the students' digital skills and attitudes towards the digital lifestyle and its impact on their learning.
Participants answering the questions about their use and consumption of computing devices(n=108) were mobile learners with 94% saying they used a laptop and 42.60% mentioning their smartphone for their online learning. Desktop computers were only mentioned by 11.10% and tablets by 7.40%.

When asked about how much time they had spent, on average, each day learning online, (both synchronous lessons and independent study), responses varied across a wide range: 1.85% said less than one hour; 29.63% said 1-3 hours; 31.48% said 3-5 hours; 24.07% said 5-7 hours; 10.19% said 7-10 hours; and 2.78% said they spent more than 10 hours each day. Despite this wide range, 65.74% of respondents felt they had spent just about the right time on learning, with only 21.30% saying they had spent too much time on online learning and more learning on campus is better. On the other hand 12.96% said they had experienced very little time on online learning and would have liked more.

The respondents' comments reflected their preference for online learning despite the long hours involved: "*Too much time on online learning however, I prefer online learning, too hectic to come over to ITS from where I live with all this traffic, it is very time consuming*", "*I believe through online learning there is more concentration*", "*lectures online are too long (3hr) "*.

In terms of satisfaction with the online learning opportunities provides through the ITS virtual learning environment (Moodle) and productivity suite (Micrsoft Office 365) both provided to faculty and students alike, the respondents were overwhelmingly positive, with 49.07% saying they were very satisfied and 37.04% saying they were satisfied. However, the respondents noted discrepancies between the lecturers in their use of these online tools, without consistency among faculty in terms of how much they use and how they exploit them. This confirms that institutions who had adopted e-learning before the pandemic were in a much better position to provide meaningful e-learning and not ad hoc emergency remote teaching, which was not deemed as successful by the students due to the lack of planning, technical issues and other factors (Bozkurt et al, 2020; Almahasees et al, 2021; Barbaro, 2021; Hickling et al, 2021; Korkmaz et al, 2021).

Asked about the preferred means of communication online, the ITS email (part of the MS Office productivity suite) was first with 84.11% of preferences, followed by messages on Microsoft Teams with 70.09% and audio/video calls on Teams (43.93%). These three official institutional channels were followed by WhatsApp (36.4%) and Facebook Messenger (29.89%).

The participants were positive in terms of the support they received from ITS as an institution and from the ITS academics in terms of their online learning. At 53.27%, the absolute majority said ITS was very helpful, 22.43% moderately helptflul and 17.76% extremely helpful in offering resources to learn from home. In terms of support from academics, 52.78% said they were very helpful and 27.78% said they were extremely helpful. This comment from a respondent reflects the trend: *"Online learning was a totally new experience and different lecturers have different ways of explaining the lessons. However, the lecturers were all approachable and offered their personal advice and help through messages and emails*." Nevertheless, there were some negative comments also: "*A lecturer didn't even do the lesson and blamed us*", and "*Not many lecturers care if one of the students understood something or not, they just wanted to do what they had planned, which in my opinion was very selfish*".

In terms of the advantages of e-learning, when asked to rank a set of variables, 43.50% pointed out the fact that lessons can be followed from anywhere outside campus as the first preference and 30.60% as their second preference. In terms of learning from homes meaning less time saved from travelling to/from campus, 32.40% ranked it first and 21.3% second. The lowest ranking were given to the options related to communication between academics and students:

In terms of disadvantages, the fact that students must have self-discipline was ranked first by 26.85% and second by 10.19%. The need for better time management skills was given first prefence by 7.41% and second by 24.07%. This result mirrors literature that highlighted the issue of self-motivation and discipline in e-learning (Tichavsky et al, 2015; Wang et al, 2019; Alghamdi et al, 2020; Hamdan et al, 2021) when they can meet their tutors on campus. Only 11.11% ranked first a preference for a physical class to have physical interaction. The reduction of face-to-face contact received the second lowest ranking, while the need of electric power was the lowest.

All these positive responses to e-learning at ITS during the pandemic may give the impression that it was a remarkable experience throughout for the students. However, the relative majority of students, 37.14%, felt that that the pandemic had made it harder to learn. For 32.38% it made it easier, while it made no difference for 30.48%. These figure are for the total number of respondents. When filtered between Maltese and non-Maltese students, the percentage of non-Maltese students who felt that the pandemic made it harder to learn was higher at 58.82% while only 23.53 said it made it easier to learn. This is agrees with the international experience (Schleicher, 2020; UNESCO, 2020).

The students felt that their well-being suffered during the pandemic, the biggest factor being the fact they were worried about the future of the tourism industry (71.15%), and increased stress levels (57.14%). On the other hand, a relative majority felt that their motivation to succeed actually increased (39.05%) and for 38.10% it remained the same while it decreased for only 22.86%.

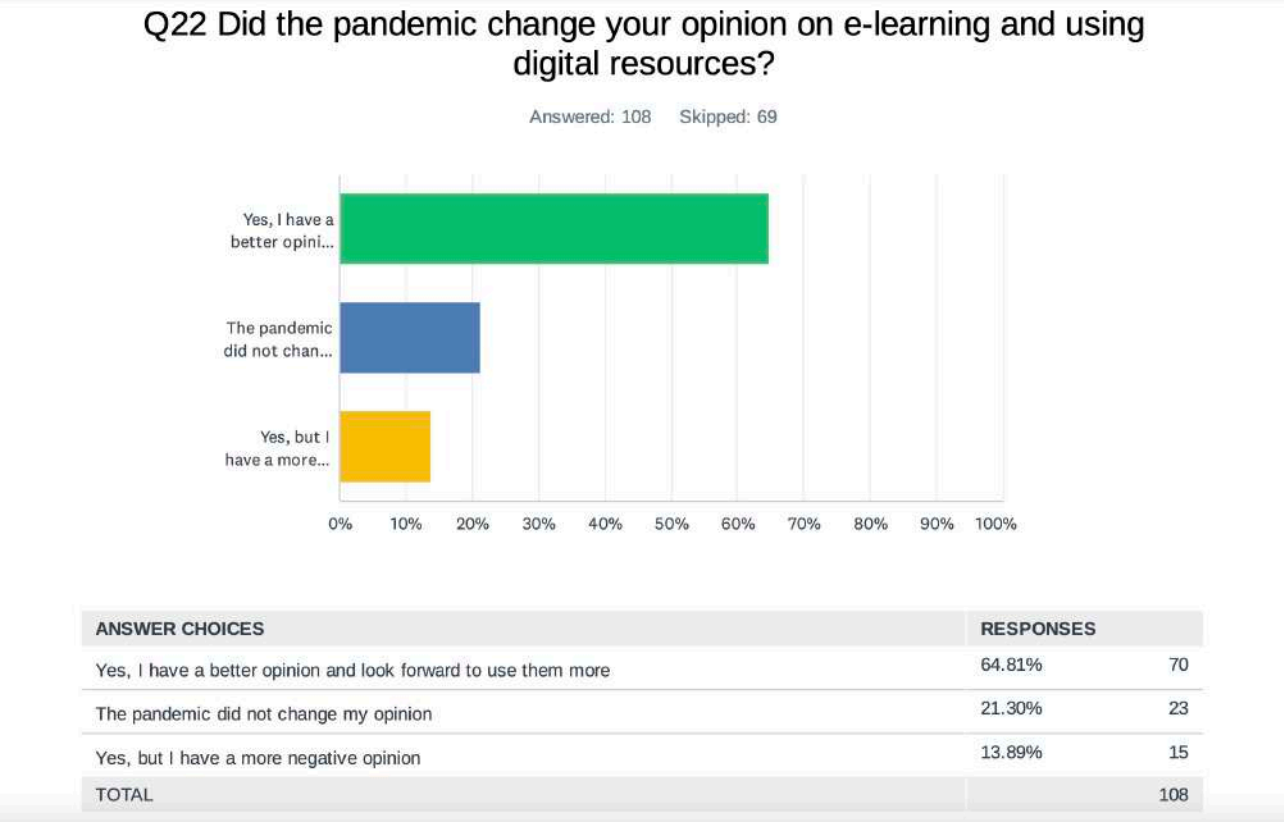
The respondents' comments are quite revealing and worth analysing:

> *"With some students being online and some in class... it takes long to start the lecture, issues with connecting. When being all online you have to rely on the internet connection and there is very little interaction between student and lecturer."*
>
> *My motivation to learn was slowly disappearing because there was no social interaction.*
>
> *"The pandemic affected me mentally not in my academic learning. Lessons kept on going as if nothing was happening so the pandemic has not affected my learning."*
>
> *"In a way, going online helped me save time on travelling to the campus. However, due to several lockdowns my 3-year-old was at home and that was very hard for me to study and take care of my child at the same time."*
>
> *"Personally I would never have found the time to travel to and from ITS and waste time between lectures . I have many work and family responsibilities. Online learning gave me the possibility to follow this course."*
>
> *"Some students didn't ask questions as they were too shy or self-conscious about their voice through the mic or wasn't available to them. Some students sleep during the lecture and the teacher would ask for then and we have to wait 3 minutes for the person to answer. For me specifically I found it difficult to stay concentrated as the lessons were boring where the teacher just talks and sometimes ask the students to participate. I prefer in class as its easier for me to participate."*

Despite all the challenges, 64.81% said they have a better opinion of e-learning, 21.30% felt no change, while only 13.89 reported a more negative opinion (see Figure 2). When all the responses were filtered by full-time and part-time programmes, the percentage of part-time students with a better opinion of e-learning

increases to 81%, a reflection of the fact these are mature students who feel they have less affinity with digital technologies that the younger students.

Figure 2. The pandemic has changed the opinion of students on e-learning at ITS in a positive way



ANSWER CHOICES	RESPONSES	
Yes, I have a better opinion and look forward to use them more	64.81%	70
The pandemic did not change my opinion	21.30%	23
Yes, but I have a more negative opinion	13.89%	15
TOTAL		108

The open-ended comments that were given as part of the response to this question are also worth noting:

> *"I have difficulty learning online because the environment at home is not the same like at school. In class physically, at school, I get more motivation and get better insights from teachers. I also capture notes quicker when I'm in class physically with students around and teachers"*
>
> *"Pandemic or not ITS should consider giving online courses, making it easier for those who want to further their studies. From my experience ITS is already equipped well for this opportunity."*
>
> *"Probably one of the better well managed institutes yet as opposed to closing its doors, it engaged students, asked what they wanted and acted accordingly with what the lecturers felt was necessary."*
>
> *Being a part-time student and the circumstances we are living in I feel certain things have to be online like for example the access to the ITS library, the ITS journal or magazine*.

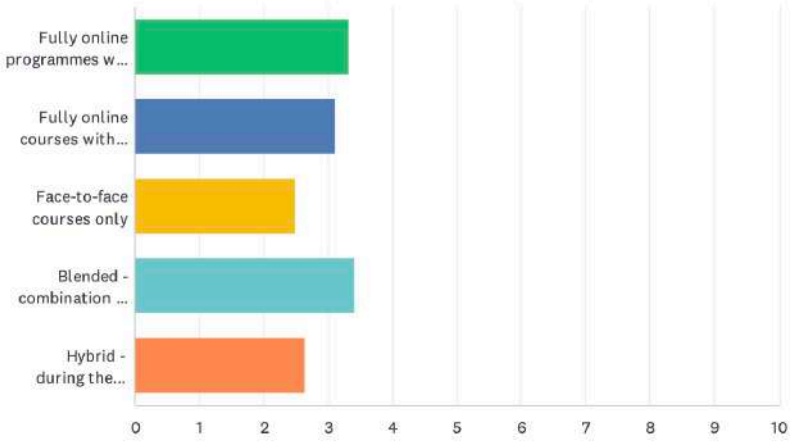
Looking forward to the post-pandemic scenario, the respondents (n=108) have a clear view of what they expected. Asked to rank the range of options from fully online

to fully face-to-face, blended learning received the highest number of first options with 32.41%, followed by pure online programmes with synchronous lesson with 25.93% and pure online programmes with asynchronous lessons with 15.74%. Only 15.74% said they would prefece only face-to-face courses and 10.19% (the lowest ranking) was given to the hybrid model (where the same class is split for the same lesson with some students in class and the rest following online at the same time). When the first and second rankings are added together, fully online synchronous (50.93%) and blended learning (50.00%) got the majority of preferences. This is in-line with the expectations of international students who also favour the blended option, exploiting both on campus and virtual learning (Fullan et al, 2020; Barbaro 2021; JISC, 2021).

Figure 3. Fully online and blended courses are the students' clear preference for post-pandemic learning

Q19 What is your personal preference for post-pandemic learning experiences? Rank these options with by moving your most important preference at the top and the least important at the bottom.

Answered: 108 Skipped: 69



	1	2	3	4	5	TOTAL	SCORE
Fully online programmes with live lessons (synchronous)	25.93% 28	25.00% 27	16.67% 18	20.37% 22	12.04% 13	108	3.32
Fully online courses with both live and recorded lessons (asynchronous)	15.74% 17	29.63% 32	20.37% 22	19.44% 21	14.81% 16	108	3.12
Face-to-face courses only	15.74% 17	12.04% 13	17.59% 19	15.74% 17	38.89% 42	108	2.50
Blended - combination of online lectures and face-to-face lectures	32.41% 35	17.59% 19	17.59% 19	23.15% 25	9.26% 10	108	3.41
Hybrid - during the lecture some of the students are in-class while the rest are present online	10.19% 11	15.74% 17	27.78% 30	21.30% 23	25.00% 27	108	2.65

Conclusion & further research

The conclusions of this research paper are quite clear and agree with most of the literature reviewed. The results obtained by the survey continue to bolster the need for blended forms of learning and a mix of online and campus classes.

The survey particularly agrees with the findings of the Student digital experience insights survey 2020/21 UK higher education survey findings (JISC, 2020) and builds upon its recommendations as follows:

--Students have realised that onine learning varies according to a host of factors, both intrinsic and extrinsic to the student, so the idea of imposing a one-size fits all should be avoided and pedagogical designs should be tailored to different categories of students ranging from VET to purely academic. For example, the survey clearly showed differences between the more mature students and the younger students, who need more guidance from the educator.

--Although the majority of students at ITS do have access to the technologies needed to follow an online lesson successfully, various factors may still interfere with this. From the Institute's side, it has made sure that having a strong a stable Internet access and readily available computers for those who may need them. But this does not deal with problems of access at the students' homes which seem to be underestimated by educational organisations.

--Due to ITS being one of the first educational institutions in Malta to integrate e-learning within its pedagogical infrastructure, VLE usage is quite mature due to the easy accessability of the online platform and generally reliable Internet access intrastructure on the campus grounds. This does not preclude certain problems such as the lack of usage by some lecturers, particularly the part-time educators and this is a *lacuna* that needs more investigation to be remedied.

--One of the major criticism against online learning is a lack of interaction with the educator. Although the survey did record some problems regarding this aspect of teaching, it is not a major concern at ITS, but needs to be addressed, particularly regarding the more practical and hands-on modules such as food and beverage and tourist guiding.

--The way the ITS VLE is structured showed that access to support and online materials was rated high by a majority of the students. Support materials are plentiful and online resources easy to access and download. This was clearly recorded in the survey.

--Most of the lecturers have opted to record lectures, particularly during the pandemic and the general response was good as it helped particularly in the more academic and complex subjects. Lecture recording does need more research due to certain GDPR and personal issues and guidelines need to be set regarding this practice, so that it is not abused by both the student and the educators.

--The survey was very important because it provided essential feedback regarding the needs and the problems of the students regarding online education at ITS. Although many students reported that communication with and accessibility of

lecturers was good, there is lack of research regarding why students do not provide enough constructive feedback to the lecturers. Communication seems to be overwhelmingly uni-directional from the lecturers to the students and this offers a new avenue of research.

Our assessment of the impact of the COVID-19 pandemic on VET and higher education will probably never be complete as scholars will continously study the impact of the pandemic well after this is officially declared over. However, the studies that have been done so far are pointing towards a watershed moment in education in terms of the use of e-learning, especially in the developed countries with an established information technology infrastructure. Blended learning, sometimes also referred-to as 'hybrid' learning, seem to be the way forward. For certain, there is no turning back to the situation where face-to-face classes were the only option.

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Holistic investment appraisal approach based on the triple bottom line

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Abstract

Until now, classic investment appraisal approaches have exclusively focused on financial success. However, with the rising interest in and need to deal with sustainability, social and ecological aspects have to be considered in investment decisions. The aim of this paper is to present a systematically developed and applicable investment appraisal model, that will not only include financial aspects, but will cover sustainability issues as well by applying the concept of the triple bottom line.

Thus, eight controlling and sustainability experts coming from backgrounds of academia and departments of small to medium sized companies in Germany were questioned in semi-structured interviews regarding their perceptions and requirements for a sustainability driven investment calculation model. As a result, there was no common consensus about how to integrate sustainability into an investment evaluation. Even though, sustainability is anchored in the strategy of many companies, clear guidance on planning and control are often missing. The interviewees expressed a need for a simple calculation model adoptable to each company's strategy making it flexible in terms of inclusion of sustainability factors and in weighing up between economic success and sustainability.

Literature review and interview results lead to a systematic four-step framework. A materiality analysis will be used to detect relevant financial, ecological, and social features addressed by a potential investment. These features will be listed, measured, and ranked. By applying this approach, a multi-dimensional investment strength profile can be created for each investment alternative. This will then be forming the base for the ability to make solid investment decisions based on the triple bottom line. This paper presents an approach that needs to undergo further testing in practice for it to be verified as a generic framework. Further research is also needed to develop instruments particularly for social features to allow a more precise measurement.

Keywords: holistic investment appraisal, corporate sustainability, triple bottom line, sustainable investment controlling, sustainability controlling

Introduction

Purpose and aim of the research paper

Up to now, classical investment controlling has focused mainly on monetary and economic-oriented objectives. However, due to the growing importance of sustainability, it seems mandatory to include sustainability aspects in an investment decision. Thus, economic as well as ecological and social aspects, also known under the concept of the triple bottom line (TBL), need to be included by decision makers. The question is how this can be done systematically. Is it possible to modify and expand existing instruments or do we need a completely new investment appraisal model? Researchers have already come up with approaches for a holistic investment calculation. Sailer (2017) for example, presents a range of possible methods and has thus advanced the topic. Nevertheless, there is no generally accepted concept, as all existing approaches have advantages and disadvantages. Moreover, in contrast to the topic of sustainability in general, little is known from practice regarding investment decisions involving sustainability aspects.

First, this paper aims to deal with the status quo of sustainability in investment controlling regarding the aspects of the TBL. In the course of a literature review, the existing theoretical concepts and ideas will be presented. To gain additional insight into the experience, requirements and needs of corporate practice, the research will be completed by an empirical study.

The aim is to create a framework respectively model to perform investment decisions on a holistic level. For this purpose, a practical evaluation model will be developed, which enables and supports decision makers to perform investment decisions based on social and ecological aspects in addition to economic criteria. The model will be developed from a user-oriented perspective, so that the holistic investment appraisal approach could potentially be used by companies.

Accordingly, it will be examined whether and to what extent companies have already integrated social and ecological factors into their investment decisions. It must be clarified what role investment appraisal currently plays in the context of the TBL.

Also, the question arises as to whether companies would use a standardized model for a holistic investment evaluation in general. Finally, it is important to examine how companies would consider such a model and what requirements would be placed on such a model from practice.

Structure of the research paper

The research paper is divided into six main sections. After the introduction deals section two with the theoretical basics of the concept of the TBL and the status quo of sustainability in investment controlling. This is followed by the methodology of the empirical study in section three. A qualitative content analysis based on semi-structured interviews with company representatives and experts was carried out. The results of the empirical study that emerged from the evaluation and analysis of the data will be presented. Finally, the insights gained are used to develop a holistic investment appraisal approach. The limitations of the proposed model are also

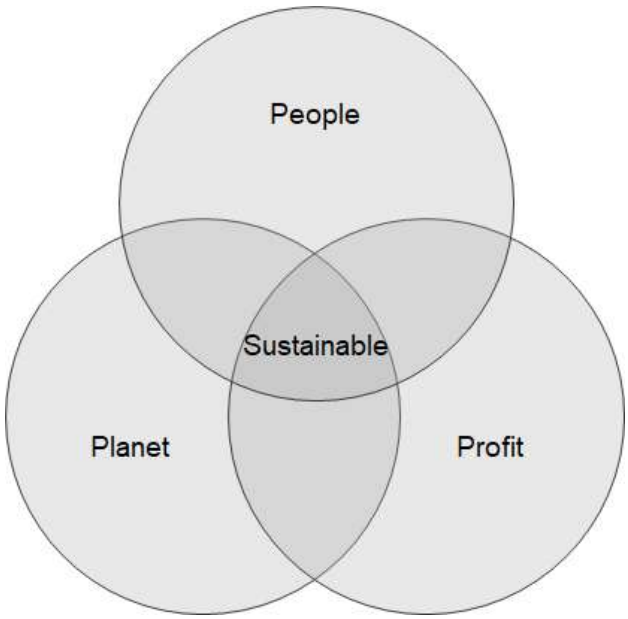
discussed. Lastly, a conclusion and an outlook on possible further research fields are provided.

Theoretical background

The triple bottom line

In traditional accounting, the word bottom line is referred to the economic success of a company, which is reported as a gain or a loss in the bottom line of an income statement. The concept of the TBL adds ecological and social objectives to the economical bottom line. The TBL, which is shown in Figure 1, therefore is based on a full cost accounting approach that tracks direct costs and allocates indirect costs (Jia, 2020). This is achieved by presenting impacts and distributing costs among all these three areas, also known as people, planet, and profit (Ludwikowski, 2010; Jia, 2020). This makes the TBL a suitable guideline for the sustainability concept of companies and was coined by John Elkington in 1997. In practice this concept sometimes is also referred to as the three-pillar model (Sailer, 2017).

Figure 1: The triple bottom line



Source: Sailer 2020, p 26

There may be overlaps between the three areas, since sustainability objectives cannot always be assigned exactly to only one area, also due to synergy effects (Ludwikowski, 2010). Synergy effects can occur, for example, when a power plant installs a new filter system that has a positive impact on the ecological sustainability goals, but also has a positive impact on the economic sustainability goals due to cost savings. This then leads to win-win solutions. The economic bottom line aims to increase the long-term financial value of the company (Elkington, 1998). Furthermore, this is the easiest to track for companies and governments, since economic goals can be measured via well-known metrics, such as return on investment, return on capital employed, cash flow and other KPIs (Conway, 2018). In addition, profit increases through a reduced use of resources or renewable resources

and advantages on the market, based on sustainable products, are targeted (Sailer, 2020). The environmental aspect includes environmental protection (Conway, 2018). Consequently, companies should review whether they are dependent on natural resources, such as water, electricity, raw materials, greenhouse gases, etc. A baseline can be established with the objective of reducing resource dependency in the future so that the natural foundations of life and the earth's ecosystem are safeguarded for future generations. Whether the company's defined goals have been achieved can be analyzed by using Global Reporting Initiative (GRI) metrics for instance, among others, or measured against the company's carbon footprint. The goals of the social perspective include fair wages, occupational safety standards, ensuring public health, promoting education, reducing poverty, etc. (Endenich and Trapp, 2019; Jia, 2020).

In theory, the economic, ecological, and social objectives of the TBL can be equally weighted (Sailer, 2020). However, according to the survey by Weber et al (2012), the focus in practice is on economic factors within the TBL. Accordingly, the social and ecological goals are subordinate to the economic goals. In order to fully consider sustainability on the basis of the TBL and the interests of the stakeholders, it is also necessary to pursue ecological and social goals, which sometimes also contradict the economic goals (Sailer, 2020).

Holistic investment controlling in literature

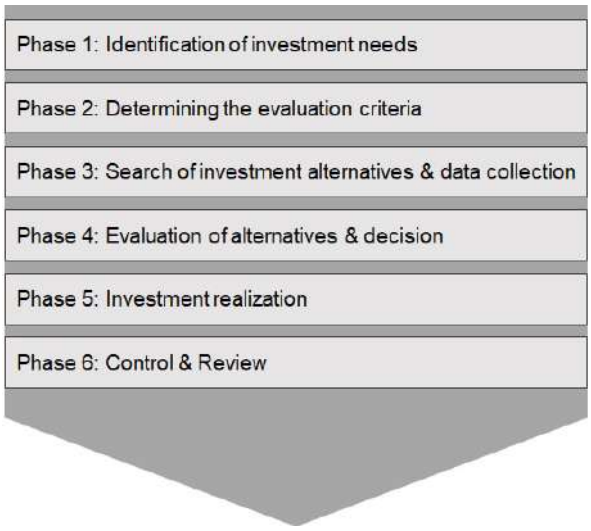
Only a limited number of books and scientific articles can be found that deal with a holistic evaluation of investments taking the TBL into account. This could be explained by the fact that it is a very specific topic which does not yet seem to be in great focus of the scientific literature. Already 20 years ago, the inclusion of ecological aspects or financial effects of ecological aspects in investment decisions was addressed by Schaltegger and Burritt (2000).

As sustainability is a very complex and multi-layered topic, recent research focuses rather on a strategic level rather than in operative controlling. Nevertheless, the following section is intended to provide an overview of the findings obtained about the systematic inclusion of social and environmental factors in investment decisions. According to Sailer (2017), the integration of sustainability into the six phases of the investment process takes place as shown in Figure 2.

First, the need for investment is systematically determined. This can be operational, for example due to an expected increase in sales, which necessitates an expansion investment to increase capacity, or strategic, due to a gap between the planned and actual situation, which can only be closed with the help of an investment. The next step is to align the corporate objectives to the investment level and to define evaluation criteria for the investment. At this point, sustainability elements can also be included. If, for example, a company has the goal of limiting its CO2 emissions, low CO2 emissions would be an important criterion when purchasing a new production machine. Once the evaluation criteria have been determined, investment alternatives are identified and the necessary data is obtained. The latter largely dependent on the character of the investment, so that no generally valid procedure can be referred to (Sailer, 2017). If during the data collection high ecological and social risks can be determined with an investment alternative, the Austrian society for environment and technology (2000) suggests excluding this alternative directly. If all necessary data is

available, the evaluation of the alternatives follows based on the best fitting calculation instrument, to clarify the advantageousness of the investment. The more an investment supports the company's goals, the more beneficial it is, and this must be measured by the appropriate instrument. Once the most beneficial alternative has been determined, the investment can be carried out and the achievement of objectives is reviewed at regular intervals.

Figure 2: Investment process



Source: Sailer 2017, p 245

It should be emphasized again at this point that an investment decision according to traditional patterns already involves many variables. With the inclusion of the two other additional sustainability dimensions, the number of parameters increases further, making it much more difficult to define a reliable investment appraisal method. To counteract this, various researchers have partially defined requirements for a concept of including environmental and social factors. In their paper on Net Present Sustainable Value (NPSV), Liesen, Figge and Hahn (2013) set four requirements for investment decision tools that should consider a company's sustainability strategy. Liesen, Figge and Hahn (2013) conclude that the instruments they considered in sustainability management, one example being a sustainable balanced score card, do not satisfy sustainable investment assessments. The requirements are the strategic orientation, defining the extent to which the investment makes strategic sense, the overall consideration of the investment period, the integrated inclusion of all three dimensions, and the comprehensible communication of the results. In contrast, the International Association of Controllers (ICV) defines five relevant requirements for sustainable investment controlling: First, the ICV (2015) considers it useful to derive the evaluation criteria for the sustainability of investments from an existing sustainability strategy of the company. Furthermore, the sustainability criteria should be integrated into existing investment controlling processes, as this is a key lever for successful sustainability performance. The third requirement is that in financial investment evaluation, the logic of the existing methods or instruments should remain in place to increase the acceptance of the added sustainability objectives among stakeholders. In addition to this, the ICV advocates a separate assessment tool for the sustainability aspects to make the impact of the economic bottom line on the social and environmental dimension as

transparent as possible. As a final requirement, a quantitative assessment is preferred. However, it is explicitly mentioned that a monetarization of physical quantities such as material and energy flows should not be carried out, especially since a conversion into euros would lead to unreliable figures and thus to a loss of transparency. However, this does not mean that quantities that are difficult to express in monetary terms can be disregarded (Austrian Society for Environment and Technology, 2006).

Despite many of the described requirements and considerations regarding the implementation of a holistic appraisal to investments, the literature emphasizes that an appropriate database is a crucial prerequisite for sustainable investment accounting. However, this is also the greatest challenge of the undertaking (ibid).

In practice, holistic investment controlling does not yet seem to be a priority, as a 2011 study of the ICV shows. Among the 295 participating ICV members, only six indicated the ecological orientation of investment accounting as a task of green controlling, which corresponds to about two percent. Higher-level issues such as ensuring the cost-effectiveness of green alignment, monitoring green achievements and transparency for green issues through metrics for planning, management and control were considered more important (ICV, 2011). In the new edition of the survey from 2016, there is a network diagram showing the consideration of ecological aspects in controlling processes. In companies that follow a holistic green strategy, this is done to a medium extent in investment controlling. If the sustainability aspect in a company only relates to green compliance, which is in the last place among the four green strategy types defined by the ICV, ecological aspects tend to be included to a lesser extent (ICV, 2016). The same picture emerges for the consideration of ecological aspects in specific investment evaluation instruments: medium level for companies with a holistic green strategy and lower level for companies with green compliance (ibid). It can be concluded from this that the topic is still relatively new in practice, missing clear and applicable guidelines.

Research design

Research gap and research question

The literature on the subject has already shown how the integration of social and environmental dimensions could take place, based on several theoretical considerations and concrete proposals in the form of instruments. However, especially when all three dimensions of the TBL have to be addressed many of these approaches still have weaknesses or inadequacies. For example, many sustainable KPIs consider almost exclusively the ecological aspect. The role of the social dimension is difficult to integrate here. In addition, it can be noted that some approaches are based on an extension of an existing controlling or investment controlling tool. Other methods, in turn, introduce a new approach. However, no established, generally preferred approach could be identified in literature. Furthermore, the various books and articles in scientific journals dealing with holistic investment appraisal are predominantly research of a purely theoretical nature.
However, the question of the extent to which these theoretical approaches and concepts prove to be feasible in practice remains largely unanswered in the course of the literature review.

This leads to the following main research question of this study:

How can investments be evaluated holistically and systematically in corporate practice, considering all dimensions of the TBL?

In order to provide such a systematic and practicable approach, several sub questions must be answered:

1. Would companies use a standardized model for holistic investment evaluation?

2. To what extend companies already integrate social and ecological factors into their investment decisions?

3. What are the requirements do practitioners place on a such a model and how should it be designed?

Aim and choice of methodology

To answer the questions above, this study is assigned to the research paradigm of interpretivism, providing the framework for the qualitative research process. This methodological point of view allows a consideration of situation-related details of social phenomena by focusing on expert knowledge combined with the understanding of subjective experience (Saunders, Lewis and Thornhill, 2009). Another purpose of applying a qualitative research approach is to differentiate existing theories with regard to human behavior (Bryman and Bell, 2015). By conducting semi-structured interviews as research method, the application of the theoretical concepts in practice is investigated and at the same time first-hand experience and impressions from practitioners regarding the implementation of the TBL in investment decisions are collected to develop a holistic investment appraisal approach.

In addition, the advantages that a qualitative approach brings, such as a better understanding of a complex issue as well as the perspective of a person involved rather than an outsider in the consideration of a social phenomenon, are considered beneficial (Vignali et al, 2011).

Moreover, a qualitative methodology is suitable for relatively new research areas - which applies to the topic under study (Basias and Pollais, 2018). Thus, the purpose of the empirical study can be assigned to the explorative field.

Selection of methods and data

In the context of the research paradigm of this study, conducting semi-structured interviews is considered as the appropriate method. The goal within the conducted interviews was to create an undisturbed flow of speech of the interviewees for a maximum gain of knowledge. Therefore, attention was paid to the use of open questions and, if necessary, targeted queries. If the interviewee steered the conversation into a different focus, the interview guide was abandoned, and further questions were asked in this corresponding direction. Saunders, Lewis and Thornhill (2012) refer to the important role played by the establishment of personal contact in semi-structured interviews. The occurrence of SARS-COV-2 prevented face-to-face

interviews from being conducted, as seen as the norm by Saunders, Lewis and Thornhill (2012). Nevertheless, a variety of videoconferencing platforms allow interviews to be conducted synchronously, with participants able to see each other online via webcam. Under the given circumstances, switching to electronically conducted interviews is considered appropriate; a total of nine interviews were conducted via video conferencing platform and one interview via telephone.

Drawing statistical conclusions about the population is not an objective of this research and thus non-probability sampling is applied (ibid). The primary focus is on the usefulness of the data for developing a holistic investment appraisal approach. The final sample includes ten interviews with a total of eleven interviewees. The sample is selected by the companies' commitment to sustainability. Small to large companies in German-speaking countries that have attracted attention due to their positive commitment in the field of sustainability are requested as interview participants. Primarily, awards and prizes are understood as conspicuously positive commitment in the sustainability area. The focus lies on the German Sustainability Award (DNP), which is considered Europe's largest award for ecological and social commitment. In addition, companies were included in the sample that had achieved top rankings in the sustainability reports published by the Institute for Ecological Economy Research (IÖW) and Future e.V. in the previous year. Since the response rate was low, the group was expanded in a second round of inquiries to include companies that are generally recognized as sustainable, for example based on an extraordinarily detailed sustainability report. A total of 49 potential participants were contacted. To change the perspective from those directly involved in practice to assessments from the viewpoint of external experts, professors who teach in the area of sustainability in controlling or who have already published in this subject area were also interviewed. This approach was intended to gather as much relevant information as possible.

Table 1: Overview of the interview partners

Interview partner	Selection criterion
Expert A	Dean controlling, publications in the field of sustainability controlling
Expert B	Focus on sustainability management, chairman sustainability board
Company C	Winner DNP 2020 (large companies)
Company D	Winner DNP 2016 (medium-sized companies)
Company E	Winner DNP 2018 (medium-sized companies)
Company F	Winner DNP 2020 (medium-sized companies)
Company G	Top 3 DNP 2020 (SMEs)
Company H	Top 5 DNP 2016 (medium-sized companies)
Company I	CSR award of the Federal Government 2017
Company J	Advertising with sustainability measures & detailed sustainability report

From corporate practice, a total of four people from the area of controlling and five people from the area of sustainability took part. In addition, two experts meeting the

requirements were interviewed. For reasons of confidentiality, Table 1 presents an anonymized overview of the individual interview partners, and the selection criterion.

Interview guideline and procedure

An interview guide was created and adapted to the respective classification of the interviewees as a company or as an expert. In general, the structure of the interview guide is based on the principle 'from the general to the specific'. Following this logic, questions were initially asked that relate to the topic of sustainability in general. This includes the definition of sustainability, the prevailing sustainability concept in the company and the current integration of sustainability in controlling. The following main part refers to investment controlling and sustainability. Here it is inquired whether sustainability aspects already find inclusion into investment decisions in the enterprises. The questionnaire is divided at this point: Companies that already include sustainability in investment decisions are asked in detail about the processes they have implemented, while companies that answer in the negative are asked in more detail about their general requirements and assessments for an applicable model. At the end, the companies had the opportunity to add individual comments. The interview guide for the experts follows a slightly different structure, as the topic area on sustainability in the corporate context is omitted. Instead, in addition to assessments of the role of sustainability in investment controlling, the focus is on questions about suitable concepts from the literature and practical experience.

After written recording permission was given prior to the interview, all interviews were recorded using a digital recording device. These recordings were used for the transcription to guarantee a higher comparability and provides the basis for an analysis of the obtained data. Transcription was carried out in an abbreviated form.

Data evaluation

To analyze the data obtained from the interviews, qualitative content analysis was selected as a method. The big advantage of this method is that it is a controlled procedure which allows to reduce large amounts of data without losing the context and core of the information. Additionally, it enables early disengagement from the original textual material (Gläser and Laudel, 2010). Table 2 illustrates the coding scheme used for the research process. The right column provides a more detailed insight into which elements have been incorporated into each subcategory.

This coding scheme was developed on the basis of the interview guide. After conducting the interviews, it was reviewed for any data-driven subcategories that may have emerged. Content from different interviewees can be combined and examined, in a relatively structured manner, for commonalities and differences. The summarized results of the study are presented in the following main section.

Limitations out of the applied methodology

Within the framework of the method applied here, it is not possible to draw conclusions about a population on a statistical basis; but this is not the aim of our study (Saunders, Lewis and Thornhill, 2012). Due to the nature of the research method, the study results are not based on pure objective evaluation. Although initially small to large companies were contacted, the majority of the sample is in the

range of small to medium-sized companies, this could distort the validity of the study results for other company sizes. Conducting the interviews online via video might had an influence on the flow of conversation on the part of the interviewees and made it more difficult to interpret non-verbal communication during the interviews. Lastly, due to the nature of the analysis of qualitative data, there may be biases on the data analysis side. As a result, the best possible standardization of data analysis was discussed and followed in the analysis. Color coding was used for the content analysis. As addressed, a conversation goes beyond the purely verbal exchange of words and these possible meanings or senses should not be lost during color coding. The explanations in Table 2 were also intended to ensure a uniform assignment of elements to a subcategory across interviews in order to counteract purely subjective assessments and thus distortions. Despite this approach, a certain bias in the analysis, due to the subjectivity of the method, might not be excluded.

Table 2: Coding scheme for interview analysis

Topic	Subcategory	Coding	Explanation
Sustainability in the companies	Subcategory 1.1	Sustainability general	TBL; Corporate strategy
	Subcategory 1.2	Sustainability in controlling general	
Investment controlling	Subcategory 2.1	Status quo	Investment model
	Subcategory 2.2	Inclusion of sustainability factors	Explanation of the current method
Model considerations	Subcategory 3.1	Selection and measurement of factors	
	Subcategory 3.2	Business requirements	Qualitative/ Quantitative; Integrated/ Separate; Weighting
	Subcategory 3.3	Meaningfulness/ acceptance of a model	Criticism; Concerns
	Subcategory 3.4	Future view	General; For companies

Interview findings

Generally, there is no uniform definition of sustainability among the companies surveyed. Nevertheless, the term 'sustainability' was frequently mentioned by the companies. Furthermore, a few companies mentioned that long-term sustainable management is their goal, so that future generations have a good basis for life and enough resources. In addition, ecological responsibility and social justice were mentioned by a few companies.

Sustainability seems to be already deeply anchored in many of the surveyed companies, due to the corporate mission statement, the corporate philosophy or the

owners of the companies who have been dealing with sustainability for a long time already. Most of the companies surveyed in the interview include the concept of the three-pillar model in the context of sustainability. It should be noted that only a few companies have heard of the concept of the TBL by name.

Nevertheless, there are only a relationship between sustainability and investment controlling so far. According to the companies, they first want to concentrate fully on a sustainable alignment of the operating business before revising the investment processes. The experts take a critical view on this, as investments represent a key lever for the sustainable alignment of the company. There is a consensus that sustainable corporate action is becoming increasingly important and the willingness to initiate measures can be classified as high. There is also a sense of increasingly relaxed budget requirements in investment controlling to pursue sustainability goals.

While some companies use classic investment calculation methods (above all the net present value method and the annuity method), the controlling departments of other companies discuss investment decisions with the respective departments without any detailed calculation of the economic advantageousness. In addition, investments were mentioned that must be carried out, regardless of economical or sustainability aspects or are made because of subjective preferences. In most cases, investments are subdivided according to the amount of capital invested. In the case of small investment volumes, the effort required to carry out investment controlling is not in proportion to the benefits. Accordingly, investment controlling plays a role in corporate practice primarily for large investments.

Most of the surveyed companies already pay attention to the selection of sustainable resources and the sustainable use of these resources in the production process. Ecological sustainability aspects dominate whereas social aspects are regarded as difficult to record and control. The most frequent point mentioned with regard to that is the commissioning of locally based suppliers. However, the transparency of supply chains is described as insufficient for adequate tracking.

The specific sustainability aspects included vary greatly from company to company and are linked to the respective business model and the individually considered investment. As already mentioned, very few companies explicitly apply the concept of the TBL. However, as the conversation progresses, it becomes clear that almost all of them have anchored the three pillars of economy, ecology and social issues in their corporate strategy or corporate practice. Experts and companies agree that ecology (especially CO2 and electricity reduction) is currently included in investment decisions more frequently and to a greater extent than social issues. This is mainly since CO2 and electricity consumption are very easy to measure and quantify. They can be integrated into existing calculations relatively easily via surcharges. Social commitment and social responsibility tend not to be considered separately for each investment project but are monitored and managed at a strategic level.

The systematic inclusion of sustainability aspects in investment decisions was denied in most cases. The companies tend to discuss the topic of sustainability individually in investment projects. The results of the discussion are not mapped using a systematic objective model. The experts see the reason for this as the lack of a scientifically proved concept that also meets the simplicity required in practice.

Furthermore, it is noted that there are different types of investments. Whether and how these can be treated in the same way has not yet been analyzed and considered in detail. All of the experts emphasize that the selection of environmental and social aspects is strongly dependent on the investment itself and on the type of company. For example, many service companies invest higher amounts in employee training than producing companies. The surveyed experts propose a theory-based approach to select relevant criteria in the form of a materiality analysis. Thus, ecological as well as social criteria could be collected and the most relevant ones for the company and its stakeholders could be determined. This is considered to be a good and pragmatic solution at this stage.

The central feature of the model to be developed is that it should be user oriented. Since there is a wide scope for design in the development of a holistic model for investment appraisal, the companies and experts were asked about the requirements and wishes they would have for such an appraisal approach.

When asked whether the companies would prefer a qualitative or a quantitative model, the picture is mixed. Companies that are in favor of a qualitative approach justify this with the fact that a calculated figure seems untrustworthy if in the end only the figure is visible without plausible justification and see a convulsive quantification of ecological and social aspects critically. The preference for information on social and ecological dimensions is in the form of a text or a ranking. In contrast, two of the eight companies are in favor of a quantitative approach because it creates transparency. According to them, all aspects that can be quantified in a comprehensible and verifiable way should be used in monetary form. Nevertheless, they agree that some qualitative information should not be forced to be quantified in any case, since this would make the evaluation no longer credible and reliable. Often a school grading system as a middle ground for this type of information is suggested. It is noticeable, that the question of assessing sustainability aspects using qualitative or quantitative data depends heavily on the preference of the respective management or decision-makers. The experts propose a semi-qualitative approach as an intermediate form.

Another interesting aspect of the model is whether a separate evaluation of the sustainability factors, which is then compared with the economic factors, is desirable or whether all three factors should be considered directly together. The majority is in favor of an integrated view. One of the experts (A) emphasizes that the three factors should never be considered separately, as there is a relationship between them. At the very latest, they must be brought together at the end. However, this does not mean that they are all condensed into one figure, but it refers to the fact that all information on the three aspects is presented together. The expert describes it as the task of the controller to collect this various information and make an overall recommendation, whereby the controller can seek help from the relevant departments for the ecological and social dimensions. In addition, he sees great potential in a visualization via dashboards, in which all information is presented in a well-prepared manner and can thus be more appealing to the decision-makers.

One question that also needed to be clarified is whether a weighting mechanism for the three factors seems to make sense. The consensus here is that this is not necessary and is rather a theoretical consideration that rarely arises in practice. Additionally, prioritization options might be already given using a materiality analysis.

According to the experts, the dimensions are to be considered equal and balanced anyways.

In general, it can be stated that the companies would like a valuation model that is comprehensible and transparent for them. In addition, the model should be a quick and easy to carry out solution for cost-benefit reasons.

Development of a holistic investment appraisal approach

General considerations

The study showed that holistic investment appraisal is relevant in practice. To date, most companies have been using simple practicable procedures to take the ecological and social dimensions into account, but standardized, systematic approaches rarely exist. The reason for this is that companies are sometimes unsure how such an approach might look like. Moreover, it is not always a priority that controlling would pursue with increased effort. Thus, it is considered quite reasonable to develop a model that companies could potentially use. At the same time, it must be noted that many of the interviewees emphasized that the model should be comprehensible and transparent to find application in practice. For these reasons, a direct extension of a common investment controlling tool was refrained from, as it is a very theoretical concept. Likewise, very complex approaches like the presented NPSV were not used, especially since the companies would probably not have the time at this stage to deal with the procedures in the depth that would be necessary. Rather, a clear guideline in the form of a step-by-step model is considered suitable to guarantee a certain degree of standardization in conjunction with a stringent system.

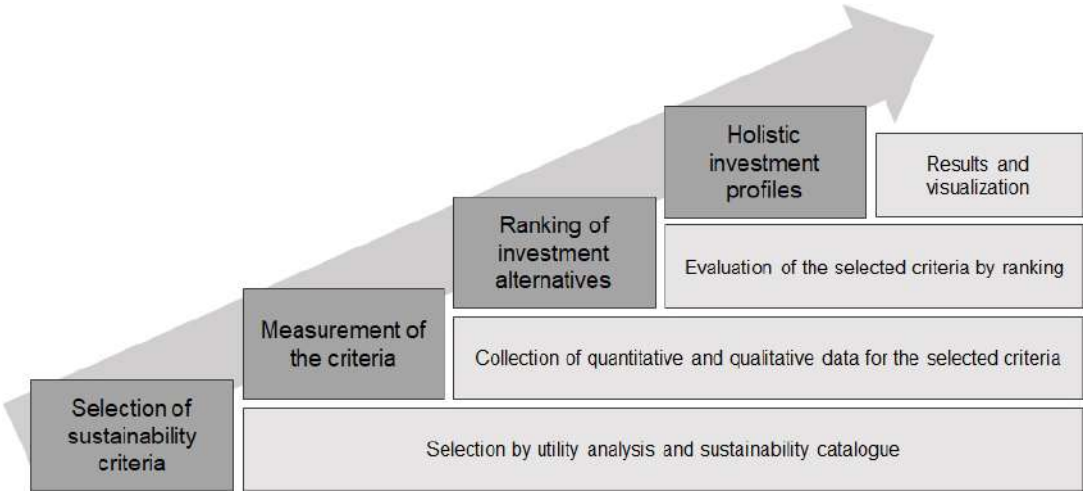
The division into four separate steps is intended to facilitate the application. In addition, the model has decision options at various points to guarantee an adaptation to the strategy of the respective company and its various investments. In individual steps, two practicable concepts of a theoretical nature were integrated. Thus, based on a practice-oriented basic framework and theoretical content, the approach is created to obtain an integration of practice and theory, which provides a systematized process for holistic investment evaluation. The used theoretical concepts are on the one hand the materiality analysis for the selection of significant criteria of the ecological and social dimensions. This concept has also been proposed by the experts and is considered a suitable method for systematizing the selection of relevant criteria. On the other hand, the four-stage model uses the utility value analysis. Utility value analysis provides an adequate middle ground in terms of data measurability. The utility value analysis makes it possible to measure the various criteria in the way that makes the most sense, whether based on monetary aspects, physical quantities, or qualitative information. A ranking is then created based on the data for each criterion, which makes the categories comparable. This semi-qualitative evaluation using a scale was also mentioned by expert B in the interview. However, it should be mentioned that in the context of the following holistic investment model approach, a modified version of the utility value analysis will be applied, since a ranking rather than a utility value is determined at the end. In addition, the economic dimension is not recoded into a rank, as it is still of great significance for the decision-makers and must not be diluted.

Certain prerequisites apply to the use of the present model. A corporate strategy that consciously addresses the topic of sustainability and incorporates this topic accordingly should be seen as an important starting point for this model. In addition, the existence of a sustainability department is advantageous as a source of information and as a support for the application of the model.

The four-stage model is primarily aimed at companies that have already integrated sustainability into their strategy and would now like to drive their investment controlling into a sustainable direction but have not yet found a suitable standardized approach for this. Thereby, the focus is on medium-sized companies since the sample consists mainly of medium-sized companies and a practicable model was developed based on their statements. Large companies might prefer more complex approaches, especially since they could invest more resources and manpower in the holistic consideration of an investment.

Now that the background and considerations regarding the model for the holistic evaluation of investments have been explained, the individual stages will be described in detail. First, Figure 3 provides an overview of the model developed.

Figure 3: Step-by-step model for holistic investment appraisal



Stage I

Materiality analysis

In the focus of a sustainability-oriented investment strategy is the identification of suitable criteria to be included in the decision-making process for them to be controlled in the operational process. In the context of sustainability management, the materiality analysis is already regularly used.

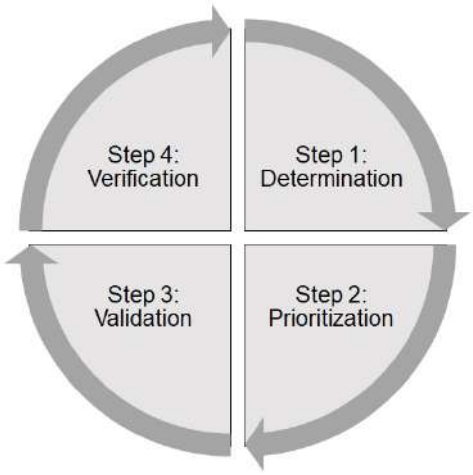
The GRI's "G4" sustainability reporting standard, published in 2013, moves away from rigid specifications regarding sustainability indicators and allows the focus to be placed on sustainability factors that are essential for the respective company individually.

Consequently, materiality analysis is becoming increasingly relevant in practice and is suitable in the context of the model for a systematized selection of relevant aspects (GRI, 2013).

Sustainability issues that are significant from both a corporate and a stakeholder perspective are considered material and thus must be included in investment decisions. A stakeholder dialog in the form of surveys and intensive discussions therefore is essential.

The GRI suggests a four-step process for identifying material sustainability fields, as seen in Figure 4 and Table 3. Even though this process is intended by the GRI for reporting in the sustainability report, steps one to three are excellent for identifying individually material sustainability aspects for investments.

Figure 4: Visualization process for identifying key sustainability fields



Source: GRI 2013, pp 40

Table 3: Explanation of the process for identifying key sustainability

Step	Description
Step 1: Determination	Collection of all sustainability issues that occur within the company and outside the company
Step 2: Prioritization	Determination of essential topics in consultation with stakeholders
Step 3: Validation	Verification of the complete coverage of all relevant topics
Step 4: Verification	Review published report to prepare next reporting period

For the identification of the factors, it is recommended to include the company's internal sustainability department, if available. It is also advisable to create a basic catalog within the company and to update it on an ongoing basis. The individually significant sustainability aspects can then be selected for each investment project with the help of the catalogue.

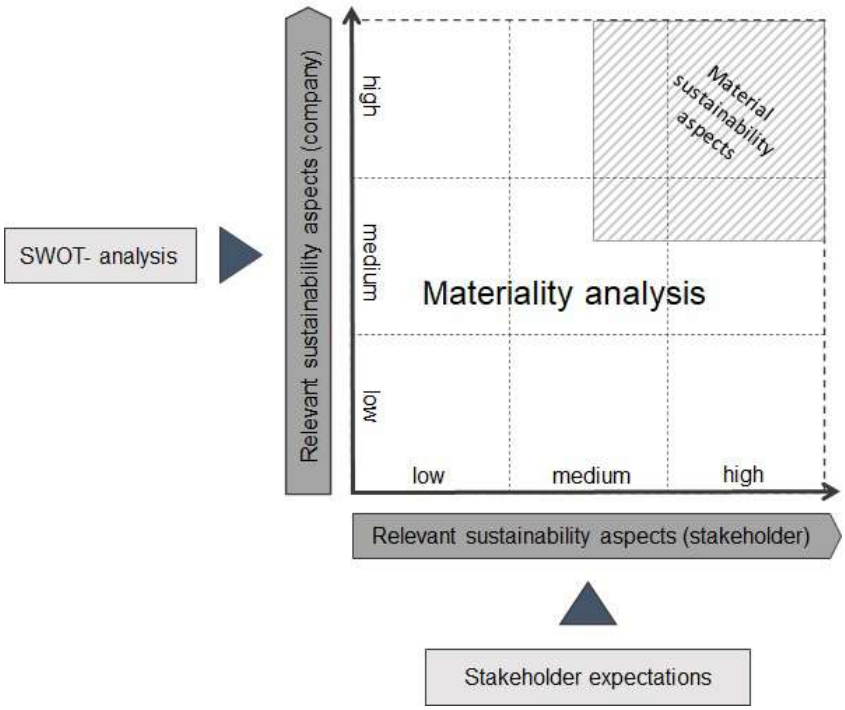
The SWOT analysis is used to prioritize the sustainability topics relevant to the company, consisting of the known components:

Environment analysis: PESTLE, opportunity-risk analysis, ...
Company analysis: analysis of strengths and weaknesses, value creation analysis, ...

The prioritization of the relevant sustainability topics of the stakeholders crystallizes from the conversation and the expectations of the stakeholders. Kaptein and Tulder (2003) recommend holding a stakeholder dialog on a regular basis for discussing sustainability issues.

From the intersection of the relevant aspects for the company and the relevant aspects for the stakeholders, a materiality matrix is formed according to the scheme shown in Figure 5.

Figure 5: Scheme of materiality matrix



Source: Sailer 2017, p 109

Knock-out criteria

In addition to identifying essential sustainability criteria, there can also be specific criteria that must be met. If an investment alternative does not meet one or more of these specific sustainability criteria, it is discarded regardless of its strength in other sustainability areas.

If, for example, a company defines fair working conditions as a high-level goal in its corporate strategy, child labor is probably a knock-out criterion. An investment alternative that is in the risk of child labor incorporation is thus eliminated regardless of other material sustainability aspects.

Stage II

After having identified the key sustainability criteria for an investment area, the next step is to measure the comparative values of these criteria in suitable units. In the ecological area, quantitative data is usually available for this purpose. For example, if a new production machine is to be purchased, the respective electricity consumption can usually be obtained directly from the manufacturer, or transport routes can be determined via delivery locations. It is more difficult in the social area, where significantly more qualitative descriptions are used in the decision-making process. Work safety or the attractiveness of the workplace can be perceived much more as "good" or "less good" instead of being measured in quantitative values. For practical purposes, it can be facilitating to assign school grades for qualitative aspects without direct metrics or to use literal gradations such as "very good," "good," "bad," and so on. In the field of economics, any classical or individualized investment calculation method can be used. If desired, it is also possible to combine several investment calculation methods. It is important for the subsequent evaluation to measure and record the expressions of the essential criteria from stage I for each investment alternative, as shown in Table 4.

Table 4: Measurement of the essential criteria

Measurement economy			
Calculation method	**Alternative I**	**Alternative II**	**Alternative III**
Calculation method I	Measurement AI	Measurement AII	Measurement AIII
Calculation method II	Measurement BI	Measurement BII	Measurement BIII
Measurement ecology			
Sustainability criterion	**Alternative I**	**Alternative II**	**Alternative III**
Ecology I	Measurement CI	Measurement CII	Measurement CIII
Ecology II	Measurement DI	Measurement DII	Measurement DIII
Ecology III	Measurement EI	Measurement EII	Measurement EIII
Measurement social			
Sustainability criterion	**Alternative I**	**Alternative II**	**Alternative III**
Social I	Measurement FI	Measurement FII	Measurement FIII
Social II	Measurement GI	Measurement GII	Measurement GIII

The model allows both quantitative and qualitative measurement results to be processed simultaneously. Thus, the user is not limited to one type of data and can create his data determination broadly.

As already discussed, obtaining data for some sustainability criteria can be a major challenge. It is therefore advisable, especially in the case of qualitative measurements, to discuss the results with the sustainability department or the sustainability officer and relevant stakeholders to create a consensus.

Stage III

After the essential criteria for the evaluation of the investment alternatives have been measured at stage II via suitable variables in each case, the evaluation of these takes place at stage III.

To realize the possibility of processing qualitative and quantitative measured variables within the same appraisal, all values are recoded into ranks. The basis for this is a ranking, which is also used in the utility value analysis. For this purpose, the measured variables of all investment alternatives within each key sustainability criterion are compared with each other. The ranks are then obtained by sorting from the best to the worst measured result. With n investment alternatives, the ranks 1 to n are assigned for each sustainability criterion. The respective character of each criterion must always be considered. For CO2 emissions, for example, the lower the measurement result, the more sustainable the investment is in this ecological criterion. If it is a question of the proportion of recyclable material in a plant, the highest measurement result is the most sustainable alternative. If all the main sustainability criteria have been evaluated according to this scheme, the arithmetic averages are then calculated for all aspects of ecology and all aspects of social responsibility. This simplifies the inclusion of the sustainability criteria by reducing many individual assessments to two average ranks as indicators for ecology and social aspects. If one or more criteria turn out to be particularly important in the materiality analysis at stage I, it is possible to separate these criteria from the respective average rank and include them in the investment profile as individual values at stage IV.

The economic results determined by investment calculations are not recoded into ranks in order not to dilute the respective monetary differences between the investment alternatives. This is also in line with the requirements of the companies from the interviews. The companies do not want to lose transparency and reliability of the economic figures by including sustainability. In practice, this means that the user is not limited to carrying out one investment calculation method but can consider any number of valuation methods.

Stage IV

At the final stage, all the results of the assessments are compiled, as shown in Table 5. The resulting decision-making basis enables the selection of an investment alternative holistically, i.e., considering economic, ecological, and social aspects. If an alternative achieves the best rank in all areas and is also relatively advantageous in all calculation procedures carried out in the economic dimension, it is to be selected. In all other cases, each investment alternative has strengths and weaknesses in different areas. An individual weighting of the factors is then necessary to make a decision. The company can weight all aspects of the TBL individually and according to the respective corporate strategy and thus arrive at a decision for an investment alternative. At this point, the dialog between controllers and decision-makers, in which the pros and cons of the investment alternatives are weighed up, also provides support.

Table 5: Formation of the decision basis

Investment profile			
	Alternative I	**Alternative II**	**Alternative III**
Calculation method I	Measurement AI	Measurement AII	Measurement AIII
Calculation method II	Measurement BI	Measurement BII	Measurement BIII
Ecology	Ø RankE I	Ø RankE II	Ø RankE III
Social	Ø RankS I	Ø RankS II	Ø RankS III
Particularly relevant criterion I	Rank AI	Rank AII	Rank AIII
Particularly relevant criterion II	Rank BI	Rank BII	Rank BIII

For further graphical illustration and analysis, the fever chart and the radar chart which are also used in classic strength-weakness analyses, are particularly suitable. This is primarily intended as a visual support and facilitation for decision-makers.

Limitation of the model

In general, it is a characteristic of models of any kind to represent the complex reality in a simplified and tangible way. Consequently, these simplifications bring certain limits with them, which are illuminated to sensitize the potential users to this. First, it should be emphasized that the created model could not yet be verified in the sense of a test application in corporate practice which has to be carried out in the future. Since the utility value analysis is a central component of the model, the same limitations as for the utility value analysis in general count for this model. Due to the application of a ranking, the specific distances between the different values of a sustainability criterion become irrelevant in the case of an investment comparison. For example, it would make no difference in the ranking if the CO2 emissions of the investment in first place were 350 tons, whether the CO2 emissions in second place were 370 tons or 500 tons. The absolute and percentage differences between the ranks become less important. At the same time, the model was developed from a sample survey in which the interview participants were mainly from medium-sized companies. This also limits the generalizability of the model. It cannot be ruled out, that the empirical investigation of a different sample, for example large international corporations, would have led to the development of a different approach.

Conclusion and outlook

The aim of this research paper was to develop a user-oriented model for the holistic evaluation of investments under consideration of the TBL. The literature review showed that the topic is a very young research topic, which is nevertheless considered relevant due to the influence of investments on the achievement of long-term corporate goals. Analogously, companies that have not yet dealt with this topic in depth have confirmed that there is interest in the topic. Even companies that have already established approaches to integrate social and environmental aspects stated that they want to continuously improve in this area. Nevertheless, there is the impression that the topic is not given the highest priority in practice.

The literature research has shown that robust data and methodological approaches are required to consider the TBL in investment appraisal. Nevertheless, there is a small range of approaches in the literature regarding a holistic evaluation of investments. When looking at the existing methods, it can be stated that each approach has shortcomings and weaknesses. Moreover, some models add only one of the two additional dimensions to investment appraisal. Especially the quantitative integration of the social aspects poses challenges to researchers. Despite the multitude of approaches, no established standard exists in the literature to date.

With the help of the empirical investigation, an attempt was made to clarify the questions that arose from the literature research. The investigation led to the conclusion that there are differences among companies in the inclusion of the ecological and social dimension in the context of an investment decision. While one company follows a systematized process, the majority does not have a set procedure. Analogous to the literature, the inclusion and measurement of the social dimension is seen as a major challenge in practice. It is controversial as to whether the model should be based on quantitative, qualitative data or a mix of both. Most of the companies emphasized the desire for the model to be a pragmatic and comprehensive and expressed a fundamental interest in such an appraisal approach. To meet the requirements of the companies, a step-by-step model was chosen. Thus, the model leaves many possibilities to adapt it to the individual needs of the respective company. To ensure systematization, two concepts from theory were incorporated: materiality analysis and utility value analysis. Due to its importance for the companies, the economic dimension is still expressed in monetary numbers rather than within a ranking. Thus, a semi-qualitative approach is taken regarding the measurement of the data. In developing the model, it was only possible to draw on existing findings from the literature as a basis. Thus, there is no monetarization of aspects in the social dimension especially since this was not a priority for the companies. Thereby, a standardization of the sustainable investment evaluation shall be guaranteed, without losing traceability. Next step is the practical testing of the model. This would allow the proposed concept to be further improved and expanded.
To further elaborate on the topic, it would make sense to conduct another survey of companies based on the results of this study to obtain well-founded results with an expanded sample. In this way, the insights gained could be deepened. These studies could also raise awareness of the importance of a holistic investment assessment. Furthermore, it should be investigated whether all aspects of the TBL can be completely quantified or monetized. That was also considered relevant in the interviews regarding the future. In addition, due to the growing significance of sustainability, it is assumed that sooner or later companies will have to address the issue and incorporate it into their strategy. Since investments have a leverage effect on corporate goals, it is highly recommended that the topic of investment controlling be addressed at an early stage, taking the TBL into account.

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Effect of Price on Customer Satisfaction Among Corporate customers of Banks in Nigeria

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Abstract

Customer satisfaction is a key variable which enhances customers loyalty. Satisfied customers will remain loyal to the firm or brand and may even introduce friends and associates. However, customers that are dissatisfied and can discourage other people from patronising the brand or firm. Variables impacting customers satisfaction included are to price, brand, product quality, service quality. This research will evaluate the impact of price being one of the variables on customer satisfaction amongst corporate customers in banks. The research further investigates which economic sector is price critical to customer satisfaction. This is in recognition of the levels of heterogeneity amongst the different sectors of the economy. Survey of 300 corporate customers undertaken administering questionnaires out of which 254 questionnaires were analysed. Corporate customers randomly selected were in the Petrochemical, Manufacturing, Agriculture, Real Estate, Construction and Mining sector. The research revealed price is critical to customer satisfaction and increases brand loyalty.

Keywords: corporate customer; price; service quality; product quality; brand; customers satisfaction

Introduction

Customer satisfaction can be defined as the consumption appraisal or evaluation of the product or service and this appraisal possesses both the cognitive and the effective elements (Szymanski and Henard, 2001). This evaluation is based on the pre–consumption expectation of the product or service and the performance at consumption (Oliver, 1997). Aslam, et al. (2018) stated that price has a significant correlation with CS.

Customers usually have a pre-purchase expectation for product price and services (Aslam, et al., 2018). Customer satisfaction plays a significant role in improving the company's image in the minds of customers (Yulisetiarini and Ade Prahasta, 2019). When the customer feels that the value received is less than the monetary compensation exchanged, then dissatisfaction sets in (Blanchard and Galloway, 1994; Heskett, et al, 1990). When a customer compares the price paid in the past for a product or service with the price currently charged by a competitor, and discovers that the current price is lower than the price offered by the new competitor, that he was made to pay more than what the competition offers, then the customer will feel cheated and that can develop into some form of dissatisfaction (Zeithaml, et al, 1990). The customer was made to pay more for the same product or service without any form of justification can result in what is described as price inequities, and price inequities can lead to customer dissatisfaction and disloyalty.

On pricing, the level of satisfaction is always high when the customer discovers that, relative to the competition, he paid the minimum price while at the same time he gets maximum service and thus profits from the relationship (Jamal and Kamal, 2003). This framework results in three outcomes when the performance of the goods /services is matched against the value or the expectation:

1.Approval- the goods/ services purchased meet the standard of expectation by the customer.
2.Positive disconfirmation- this is the outcome when the performance of the goods / services exceeds the expectation of the customer.
3.Negative disconfirmation – when the outcome of the performance of the goods / services is inferior to the satisfaction of the customer.

The terms of the financial products acquired or the services offered by the bank, fully meets or exceeds the expectation of the customer. Indeed, it leads to a mutually beneficial relationship (Cohen, et al, 2006). Furthermore, a higher degree of satisfaction also encourages banks to improve service quality, introduce innovative products and provide efficient bank management, as banks are encouraged to create more customised products for the customers (Cohen, et al, 2006 and Oke and Dada, 2017).

The customer loyalty plays an important role, which can help the banks not just to survive but also to remain profitable in an extremely hostile global market and banks needs to provide a service which enhance customer satisfaction in order to thrive in today's very challenging market (Cohen, et al, 2006; Anderson et al, 1994).

Literature Review

Evaluation of Corporate Customers

It is important to evaluate the needs of the corporate customers and further ensure that the quality of service given to the customer measures to the expectation of the customers. Therefore, a corporate customer should have quality financials, have a diversified ownership and also be seen to be a market leader in its own industry (Athanssopoulos and Labroukos, 1999). Having a good turnover alone may not qualify a company to be classified as a corporate customer if the level of corporate governance is either extremely low or non- existence in the organisation. The most important products of corporate banking customers include but are not limited to the following: loans and advances (including loan syndications), leases, cash and liquidity management, transaction banking, trade financing and commercial papers, among others. In the eighties, when there were specialised banks in the financial services sector of the economy, corporate banking was principally the business of merchant banks. These are very highly specialised services and require highly competent officers to manage the various relationships.

Banks, need to safeguard that they go beyond only retaining of corporate customers to the point of ensuring that the corporate customer maintains a highly active relationship with the bank and also try to be the lead bank for the customers to ensure they have a good slice of the customer business. For only then will the relationship be profitable to the banks (Tyler and Stanley, 1999). The bank should step up to measure the relationship with the volume or turnover of the corporate customer in order to ensure that what they are getting from the corporate customer qualifies the bank to regard the

corporate customer as such it will just amount to window dressing the customers' profile of the bank without any meaningful value addition to the bank.

The corporate banking space remains very competitive and the goal of each bank is not just to retain the corporate customers but to ensure that they earn the lead bank status for these customers in order to benefit from the volume of transactions and the collateral margins that come with it. The complexity that accompanies the businesses in this segment (Athanassapoulos and Labroukos, 1999), banks have to be able to know what the key drivers of loyalty are, for the corporate customers in their portfolios.

Tyler and Stanley (1999), Athananassapoulos and Labroukos,(1999), Gibbs and Turnbull, (1989) have come up with different outcomes of the determinants of loyalty in the corporate customers segment, it therefore becomes very imperative for banks wishing to retain corporate customers with the objective of eventually becoming their lead banks to be able to know which of these determinants will best create loyalty for their respective corporate customers and ensure they are able to meet up with the customers expectation in this regards.

Corporate Image/ Branding

Corporate image is especially most important factor for any organisations in the service industry including the banking industry (Gronroos, 1984) and the image is to a great extent determined by the customers by evaluating the quality of services they receive from the service organisation. In a study conducted by Bloemer, et. al (1998), they found out that the corporate image of a bank has a clear positive influence on service quality and also loyalty. The image of a bank is mostly linked to the credibility of the bank (name and the reputation) and the ability to satisfy the needs of the customers (Mihealis, 2001).

Banking Product and Service Features

Products and service features constitute a great deal of influence on customer satisfaction particularly in the corporate banking segment where customers are better informed and exposed. They are constantly demanding more from their banks and these features are a major determinant of customers' selection and loyalty to banks (Kamal et. al, 1997). Products in banks include the core services or products that the banks provide, in addition to the specific features that may be unique to some customers (Rust and Oliver 1994). The quality and functionality of the products further enhances customer satisfaction. Banking products consist of Loans, Overdrafts, Current and Savings accounts and other specialised products and services. The flexibility of the features of the products and services and how they are packaged/structured to meet the specific needs of the individual customers, creates a higher satisfaction index, because it will create a unique impression with customer that the bank understands their needs and are able to meet them through their ability to customise products (Zeithaml and Binter, 2003).

In other situations, if the bank participates in product bundling which can reduce the cost of acquiring the individual products, then it can be attractive to the corporate customers as against laying the generic products to the corporate customers which may after all do not seem to be cost effective. This is very crucial to customer satisfaction since the post purchase evaluation of the service is crucial to customer satisfaction

(Oliver, 1997). It is important for banks to identify the needs of the customers and ensure that they create products with modifications that will meet the needs of these customers since in reality, banks products are homogenous with extraordinarily little variations.

Pricing for Products and Services

Price, therefore, is the total evaluation of the services and products offered by the bank to the customer expressed in monetary terms (Mutengezanwa, et. al, 2011). For the corporate customer, price of services can come in different forms ranging from interest paid for loans and advances/ overdraft, fees for numerous services including bonds, IPOs, commitment fees for loans etc. For the purpose of this research, price is the rate at which banks are willing to lend money to corporate customers to do business. A customer who is not satisfied by the price that the bank is charging for the goods and services will tend to be dissatisfied and that can lead to the customer disloyalty and switch to other banks (Keaveney, 1995). Fairness in price apart from the quality of services received also relates to the value received from the services rendered by the bank.

Several factors impact customers satisfaction in the marketplace, and it is important that managers are aware of what variables impact which market to enable to align appropriate strategies to deal with how they can ensure that their customers are duly satisfied in order to ensure their continuous loyalty and retention. Here in this study, the corporate customer base has been segmented into different economic sector groups in order that the outcome of the study will not be unduly generalised.

Methodology

A questionnaire was designed for the research and distributed to 300 top executives of corporate customers of banks who were randomly selected. Responses were received from 254 of them and were validated. The questionnaire was designed using a Likert-type five-point scale (1-strongly Agree, 5- strongly Disagree). The research adopted the actual prices at which banks give loans to their different corporate customers in the different sectors of the economy. The paper adopted price, brand, product quality, and service quality in evaluating customer satisfaction amongst corporate customers.
The research is using the Spearman Correlation to evaluate the degree of relationship between the dependent and independent variable while using regression analysis to evaluate and confirm the findings for the research. The constructs adopted for the research are length of years, volume of transactions routed through the customers' bank and customers' satisfaction.

The reliability test was conducted using Cronbach Alpha method for the purpose of assessing the consistency of the entire scale. According to Pallant (2004), reliability scores which are greater than 0.70 on the scale are considered acceptable. On this test all questions on the validation reported an alpha score above standard guide of 0.70. By implication, the scales were considered suitable for the analysis with acceptable reliability. Cronbach Alpha of 0.76 was obtained for the entire scale. Table 1 shows the scores on the validation and reliability of the research instrument.

Table 1: Validation of Instruments Using Cronbach Alpha Scores

ITEM	NO	CRONBACH ALPHA SCORE
Socio- demographics	9	0.801
Loyalty Factor	5	0.726
Total	42	0.764

Source: Field Survey, 2020

Results and Discussions

Category of the Businesses of the Respondents

Table to shows results from the survey showed the following outcome; 64.2% of the respondents were engaged in the manufacturing business, 15.7% were engaged in oil and gas businesses, 15% were engaged in real estate and construction while 3% and 2% were engaged in agriculture and mining, respectively. 3 were engaged in agriculture business.

Table 2 : Category of Businesses of Respondents

Business	Frequency	Percentage
Agriculture	8	3.1
Manufacturing	163	64.2
Oil and Gas	40	15.7
Real Estate and construction	38	15
Mining and Quarrying	5	2
Total	254	100

Source: Field Survey, 2020

The low percentages of 3% and 2% for the agriculture and mining and quarrying sectors respectively may be attributable to the fact that these sectors are not as developed at the time of the study. The major reasons for their inactivity first from the agriculture sector may be because governments and private sector investments in agriculture dipped on the advent of crude oil in commercial scale in the country and secondly for the mining sector, because of the high capital requirement and the long gestation period for results, extraordinarily little investments have been made in the sector. Consequently, these sectors have remained underdeveloped.

Years of Banking Relationship of Selected Firms

The result from the field survey showed that 13.78% of the respondents have been in a banking relationship for between 1-5 years while 51.57% have been with their banks for between 6-10 years. 18.9% also have been with their banks for between 11-15 years

and 15.75% have been doing business with their banks for over 15 years. The result of the survey actually shows that the population sampled qualified for this survey, because most of the corporate customers are considered to have remained with their various banks for a prolonged period and considered as evidence of being satisfied with the relationship. This agrees with the position of Yi and Jeon (2003) in which the length or the continuity of the banking customer over a long time is a measure of how loyal the customer is to the bank.

A customer that is with a bank for an abbreviated period of time and then switches to another bank is not seen to be loyal to the bank (Median, 1996). One reason why the switch may occur might be the fact that the customer is not satisfied with the bank. The outcome detailing the number of years that the respective respondents that are being sampled have been in a banking relationship with their various banks is shown in table 3 below.

Table 3: Years of Banking Relationships by the Respondents

YEARS OF BANKING RELATIONSHIP	FREQUENCY	PERCENTAGE
1-5	35	13.78
6-10	131	51.57
11-15	48	18.9
Above 15	40	15.75
TOTAL	254	100

Source: Field Survey, 2020

Percentage of Respondents Involved in Lead Banks Selection

The table 4 shows that 95% of the respondents maintained banking relationships with more than one bank and participated in split banking. But 74% of the population sampled actually spends time making decisions on the quality requirements, which the lead bank for their businesses should pose. Others may just allow the lead bank to evolve from the relationships, which they maintain with a number of banks.

Table 4: Respondents Involvement in Split Banking and Selection of lead bank

	YES	NO
RELATIONSHIP WITH MORE THAN ONE BANK	94.8	5.2
SELECTION OF LEAD BANK	74.3	25.7

Source: Field Survey, 2020

Price as a Factor of Customer Satisfaction

There are a number of factors identified in literature that can impact customers satisfaction and these include, price, image, service quality, service product, branding amongst others.

For many corporate customers, price is one of the most important variables that is regularly measured because it is the one variable that has direct implication to both the revenue and the profitability of the firm. The lending rates offered by the banks to corporate customers vary from sector to sector. This may be attributed to a variety of reasons, including the risk factors associated with the respective sectors, and the other special conditions that may be attached to loans in the respective sectors. Results in Table 6 shows that the average lending rate offered by the banks to agricultural customers is 12.45%. The minimum price offered by the bank is 4% whilst the maximum price offered is 22%. In the case of mining and quarrying products, the average price offered by the banks is 18.29%, the minimum price is 13% and the highest is 22%.

The lending rates offered to corporate customers in the oil and gas sector stood at an average of 17.5 % with a minimum of 13%. The highest in the sector is also 22%. The average lending rates offered by Nigerian banks to corporate customers in the manufacturing sector of the economy is 16.98%, with a minimum of 4% and a maximum of 22%. In the real estate and construction sector, the average price is 17.78%, a minimum price of 13% and a maximum 28%. The graphical illustration of average prices of products offered by the Nigerian banks are presented in table 5. The product with the highest price is mining and quarrying followed by real estate & construction, oil & gas, manufacturing and agriculture respectively.

The standard deviation values show that the most stable price offered by the Nigerian banks is for the loans to customers in the real estate and construction sector, with a standard deviation value of 2.64. The least stable rate represented by the loans with the highest standard deviation value is the price of agricultural customers. The value of the standard deviation of agricultural products offered by the bank is 6.17. The range of prices of loans offered by Nigerian Banks are demonstrated and shown in table 5. The table clearly demonstrates that most of the banks for instance charge as high 13% for lending rates and banks will lend to the mining and quarrying sector at between 16-20%. The high lending rate for the mining sector may be responsible for the slow development of the sector as extremely excessive cost borrowing may not be economically beneficial to the corporate customers.

Table 5: Descriptive statistics of prices of banks' Loans

Products	Mean	Standard Deviation	Min	Max
Agriculture	12.453	6.17	4.0	22
Mining & Quarrying	18.289	2.69	13.0	22
Oil & Gas	17.513	3.15	13.0	22
Manufacturing	16.978	4.42	4.0	22
Real Estate & Construction	17.773	2.64	12	22

Source: Field Survey, 2020

Test of Normality

Prior to conducting regression analysis, tests of normality and multicollinearity were conducted. The Kolmogorov-Smirnov test was used to determine the normality of the distribution for the variables. The distributions of most of the constructs were found to be normal, being significantly indifferent from normal. Most of the constructs had p-values that were above 0.05 ($p>0.05$) as indicated in Table 6.

Table 6: Kolmogorov Test of Normality.

Construct	Statistic	P-value
Years of relationship	0.317	0.071
Volume of transaction	0.301	0.101
Customer satisfaction	0.215	0.120
Loan prices of Oil & gas	0.310	0.210
Loan prices of manufacturing	0.412	0.092
Loan prices of real estate	0.402	0.059

Source: Field Survey, 2020

Test of multicollinearity

Before taking the variables into further analysis, the study variables were evaluated to check for the existence of multicollinearity among the continuous variables and verify the degree of association among discrete variables. Variance Inflation Factor (VIF) was therefore computed (Table 7) to detect multicollinearity. VIF values of the variables are 1.56 for measure of the years of relationship; 1.44 for volume of transaction; 1.37 for customer satisfaction; 1.23 for loan prices of oil and gas and 1.34 for loan prices of manufacturing and 1.47 for loan prices of real estate. The mean VIF for all the values is 1.40, indicating that none of the variables for the study exhibits multicollinearity

problems. This indicates that the variables are suitable for further analysis and the findings emanating thereof, are relevant for policy recommendations.

Table 7: Estimated Variance Inflation Factor

Variables	VIF
Years of relationship	1.56
Volume of transaction	1.44
Customer satisfaction	1.37
Loan prices of Oil & gas	1.23
Loan prices of manufacturing	1.34
Loan prices of real estate	1.47
Mean VIF	**1.40**

Source: Field Survey, 2020

Relationship between Loan Prices and Customer Satisfaction Using Spearman Correlation

Variation in lending rates offered by banks has a significant relationship with corporate customer satisfaction, implying that price is a principal factor in customer satisfaction (Table 8). The Spearman Correlation results showed that prices at which the corporate customers are able to secure credit facilities from the banks are significantly correlated with customer satisfaction in respect of corporate customers in the manufacturing sector of the economy. Also, the correlation coefficient of price in the oil and gas sector and customer satisfaction is negative but significant, indicating that price is correlated to loyalty on this measure in the two sectors. Customer satisfaction programs in these two sectors, promoted by the banks, must have more inputs of price factors to contribute to customer satisfaction, otherwise it could lead to customers switching loyalty to competitors. This, clearly, is the result of the study on the relationship of price and the impact of price on customer satisfaction. A change, or non-competitive pricing for credit facilities in the oil and gas sector of the economy reduces the level of customer satisfaction in the sector. Similarly, customers in the manufacturing sectors may be dissatisfied with an increase in prices offered by the banks, particularly if such increases are seen not to be competitive or matched with a higher level of satisfaction. This shows that in general, of the three sectors, real estate is insensitive to price as far as the customer satisfaction index is concerned. However, on the other hand, price is significantly related to customer satisfaction in the other two sectors of the economy. This meaningful relationship affects corporate customers in the two sectors of Manufacturing and Oil and Gas. However, it should be noted that correlation does not imply causality.

Table 8. Spearman Correlations between Loan Prices and Customers Satisfaction

Satisfaction			
	Oil & Gas	Correlation Coefficient	-.466**
		Sig. (2-tailed)	0.039
	Manufacturing	Correlation Coefficient	-.472*
		Sig. (2-tailed)	0.036
	Real Estate	Correlation Coefficient	-0.337
		Sig. (2-tailed)	0.146
	Satisfaction	Correlation Coefficient	1.000
		Sig. (2-tailed)	.

Source: Field Survey, 2020

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-taied).**

Estimated regression impacts of prices of loans on customer satisfaction

Regression results in Table 9 show that the prices of loans of manufacturing and real estate sectors have a significant effect on corporate customers' satisfaction at 5% level. The p-value of loan prices in manufacturing and real estate sectors are 0.035 and 0.000, respectively. These values are less than 5% level hence the significance of the variable. This result means that the rejection of the null hypothesis of no relationship between price and customer satisfaction. The conclusion therefore is that price significantly impacts customer satisfaction in the manufacturing and real estate in the customer satisfaction index and thus supports hypothesis H1. However, brand and service quality have a significant effect on customers' satisfaction in the oil and gas sectors. No significant effect of price could be established on satisfaction of oil and gas corporate customers thus supporting hypothesis H2. Price therefore is seen to be critical to customer satisfaction in two sectors of Manufacturing and real estate. The overall result shows there is a significant impact of loan prices on customer satisfaction in the manufacturing and real estate sectors. Brand is important in the oil companies particularly the international oil companies (IOCs) because of the usual need to follow the brands adopted by the parent offices.

Table 9. Regression Estimated impacts of prices of loans on satisfaction

	Sectors		
Variables	Oil & gas	Manufacturing	Real Estate
Price	0.051(0.109) [0.470] {0.638}	0.227(0.107) [2.115] {0.035}	0.252(0.070) [3.604] {0.000}
Brand	0.333(0.080) [4.169] {0.000}	0.048(0.078) [0.617] {0.538}	0.009(0.051) [0.179] {0.858}
Service quality	0.204(0.066) [3.068] {0.002}	0.119(0.066) [1.813] {0.071}	0.011(0.043) [0.251] {0.082}
Product quality	0.106(0.078) [1.354] {0.177}	0.126(0.77) [1.636] {0.103}	0.063(0.050) [1.252] {0.212}
Constant	0.463(0.610) [0.759] {0.448}	1.411(0.598) [2.358] {0.019}	2.890(0.390) [7.408] {0.000}
R^2	0.599	0.406	0.487
F stat	9.186	3.875	4.435
P value	0.000	0.005	0.002

**, significant at 5% level of significance
The values represent coefficient, ( ) = standard error and [ ] = t values, { }=p values respectively

Managerial Implication

Customer satisfaction is seen to be critical to customer loyalty. It is also clear from the findings that it will be wrong to assume that one variable will be critical to corporate customers irrespective of the sector of the economy in which they operate. Managers of banks therefore must therefore be interested to know which variable is critical to customers of the diverse sectors in which they bank. Knowing this, therefore, will enable them to optimise their efforts in the diverse customer satisfaction programs.

For instance, from the outcome of the study, banks interested in satisfying their customers in the real estate and construction sector of the economy must ensure that they offer to these customers fair and competitive prices for the banks' products since price is critical to customer satisfaction in this sector. This position is also applicable to customers in the manufacturing sector.

However, the variable critical to customer satisfaction in the oil and gas sector is branding/ image and thus meaning that bank managers wishing to satisfy customers in this sector must ensure that their brands/ image is extraordinarily strong otherwise they will not be able to satisfy these groups of corporate customers. In addition to a strong brand, service quality is critical to corporate customers satisfaction.

Conclusion

The paper evaluates customer satisfaction using the corporate customers of banks. Large corporations, most of the time participate in split banking thus making them most times to make decisions on which of the banks will be selected as their lead banks. It is usually the lead banks that the corporate customers are loyal to (Fragata, 2009). However, customers' satisfaction is a key factor that can foster customers' loyalty (Lam and Burton, 2005). And it is the banks which the corporate customers are satisfied with, that will enjoy the status of the lead bank.

The conclusion from the paper shows that distinct factors or variables can impact customer satisfaction differently, but it is important to empirically determine these variables and the different sectors which they also differently impact. The paper showed that price impacted customer satisfaction in the manufacturing and real estate sectors while service quality and brand impact customer satisfaction in the oil and gas sectors.

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A critical presentation of the portfolio of requirements resulting from the nature of Industry 4.0 for higher academic education

Manuel Maier

Abstract

A framework to illustrate the potential demands of Industry 4.0 on academic education. Industry 4.0 is not only changing the production sector decisively, but is also placing high demands on the quality of product data, which significantly influences many areas in a company. The characteristics of this new form of industry include enormous structural complexity, a high degree of material, logical and electronic networking and a demand for collaborative and interdisciplinary work. In addition, there is high pressure to adapt, due to a generally claimed rapid technological development. After a critical examination of the latter, the question to what extent these complex demands are already reflected in academic education is explored. The study is data-based. For methodological data collection, interviews will be conducted with education experts from higher education institutions. The interviews will be analysed for their core statements. Finally, these findings will be combined with relevant literature to form a framework to be developed. Using a constructivist approach, the article aims to clarify which higher education subjects are particularly affected, which new subjects would make sense and what should be adapted in existing subjects. This topic leads to a discussion of how the necessary adaptation of the curricula should take place, both structurally and in terms of content. Against this background, the outdated "competence" concept and its necessary formal adaptation are critically examined. Finally, it is shown that Industry 4.0 demands a series of new individual competences, especially transversal ones, which, however, do not have to be taught in the conventional way from a didactic point of view, but must be stimulated in a predominantly practical way.

Keywords: Industry 4.0, higher education, internet of things, competences, digitalisation

Introduction

> "The profile of the contemporary professional requires a person with ethics, who is environmentally conscious, disciplined, willing to do things differently, knows how to lead, solve problems and conflicts, who works collaboratively, adding organizational productivity."
> (Bessa da Cruz, Jacinto, Martins, & Paraguaçu, 2020, p. 55)

Technological scientific development is the main driver of structural economic change. According to Milling (2013), this technical progress as the driving force of economic industrial processes can be defined in economic terms as:

1. The creation of new or improved products (product innovations),
2. the transition to new or improved production processes (process innovations).

The second definition of process innovation plays a particularly important role in Industry 4.0. Due to advancing technical possibilities, a pressure to change and, above all, the required speed of such change is rapidly increasing for industrial

companies and their employees. This means that there is more and more technical progress to be mastered in ever shorter time intervals.

In an article from 26 July 2014, Nina Trentmann refers to the economist Jeremy Bowles, who stated at the time that the next generation of employees must be trained in such a way that they can benefit from technological progress with their skills instead of being endangered in their professional success. These skills include, in particular, social and creative intelligence, Bowles said. To develop them, school and university curricula need to change. – To what extent has this happened since then? The answer to that question is part of this study.

It now seems to be evident from life that technological progress has at least a rapid, if not an exponentially accelerated growth. An online article by Bela Mutschler from 13 July 2018, addresses this often invoked exponentiality of technical progress: “The speed of technological progress is hardly tangible for people today. Too much is happening in too short a time in too many areas. There is much to suggest that technological progress is even exponential. This is also one of the reasons why technological progress is no longer tangible or hardly tangible for many people,” it says. This is because human perception is linear by nature and is thus not immediately able to cope with the cognitive resolution of exponential processes. The enormous acceleration in the growth of technological knowledge had already been formulated in 2001 by Ray Kurzweil, Director of Engineering at Google LLC, in his thesis that the technological progress of the entire 21st century is equivalent to the technological progress of the past 20,000 years.

In view of such a wealth of technological knowledge, it is obvious that the limited absorption and processing capacities of the individual human mind are overtaxed.

However, the myth of rapid technical progress must be critically examined, and its various aspects must be differentiated more precisely. Is it possible that the alleged exponentiality of technical progress as the driving agent of the so-called fourth industrial revolution is just a hyped generality without sufficient reference to reality?

From this critical perspective, Eva Wolfangel's article “Die Mär vom rasenden Fortschritt”, published in “Technology Review” (6/2017), a magazine of the Massachusetts Institute of Technology (MIT), sheds light on the question of whether the frequency of innovation is really as high as it is generally rumoured to be.

Wolfangel analyses various examples and comes to the conclusion that really great leaps in innovation, such as the introduction of digital photography or the iPhone, occur rather rarely. And still other aspects put the buzzword of disruptive exponentiality into perspective. For the temporal frequency of innovation-driven new discoveries and inventions is one thing; their implementation is another. The question of the speed of implementation is again divided into two parts: First, how fast is implementation in the industrial (mass) production process? And secondly, how fast is the resulting implementation in consumer use? How quickly, and to what extent, are new technologies accepted by the majority of potential consumers? In a word: When do the innovations actually reach society? It takes a while for such breakthrough new products to really arrive on the market. Economists use the time it takes for 50% of all households to be equipped with technical innovations as an indicator of the speed at which they are accepted. In this regard, Wolfangel refers to

the studies of David Moschella, among others, who determined the time periods for penetration on the US American market for the technology products television, radio, mobile phone and computer. The surprising result shows that the television took nine years, the radio eight years, the mobile phone an impressive 15 years and the computer 17 years. In these cases, which are typical of the development of the information age, there can be no talk of rapid change. On the contrary, the pace of dissemination is strikingly slow. It is also telling that the www, invented by the British computer scientist Tim Berners-Lee in 1990, needed about twenty years to have a lasting impact on everyday professional and private life. Finally, Wolfangel refers to the US economist Robert J. Gordon, who in his book “The rise and fall of American growth” comes to the data-based conclusion that technical progress has even slowed down permanently. How are these phenomena to be interpreted?

Undeniably, there are technological evolutionary leaps that, in their disruptive quality, interrupt the success series of established technologies. Every innovation initially exerts a disruptive function, structurally, organisationally and psychologically. However, this does not mean that such disruptions occur with high frequency and at the same time completely unexpectedly and abruptly. The perception of disruptive technological thrusts lies, on the one hand, in the fact that in historical retrospect the 20th century as a whole, as already mentioned above, produced an explosive increase in technological knowledge unprecedented in human history. On the other hand, it is rooted in the psychological phenomenon that the individual human being can only reactively meet the demands of the enormously increased information density to a very limited extent. The directly experienced flow of life has become denser; suddenly new things seem to be crashing down on people from everywhere. This leads to a partial distortion in the assessment of the actual technological innovation pressure. (compare this with: Ivonne Förster: „Zeiterfahrung und Ontologie. Perspektiven moderner Zeitphilosophie.“ München 2012.) Thus, viewed objectively, the disruption proves to be more of a psychological-perspective perception issue. Especially since in the concrete economic process within an economic unit only a tiny fraction of the globally rapidly increasing specialised scientific knowledge is required. De facto, the impression of hectic development and required haste is created by too little presence and attention and is ultimately due to a lack of willingness to change. To put it colloquially: Technological developments are simply slept through far too often, even though their natural pace does not actually overtake us. In order to change this, the view must be sharpened at a management level on the cognitive side and the will must be sensitised and activated on the practical side, so that we are not actually overtaken by developments out of inertia, the speed of which is actually not so murderous. This shows once again that Industry 4.0 not only places higher demands on the acquisition of “technical” factual knowledge at a management level, but above all also on the personal competences of awareness-raising in a broader sense.

For the reasons mentioned above, there is a need for special knowledge management. This must be taken into account: Technological progress not only results in a linear increase in individual facts/data, but also, and especially, in an exponential increase in the number of links between them. In a word, this means that the complexity increases enormously once again. Maisiri, Darwish, and Van Dyk (2019), point out: “The trend of job complexity has been upward through successive industrial revolutions”. This is a historical increase in complexity that has once again been massively accelerated by the fourth industrial revolution – a process that calls

for interdisciplinarity in both cognitive and practical terms. For this reason, the authors Sackey, Bester, and Adams (2020) emphasise that “the ever-increasing complexity of industrial systems makes interdisciplinary courses necessary.” There is a need for interdisciplinary thinking that, as such, once again reaches beyond itself and claims the human being as a whole.

It is therefore not only a question of quantitatively increasing the degree of networking of subject content in (academic) teaching. This task can be mapped to a high degree by electronic systems. This electronic transposition is without question an indispensable basis. But – and this raises the really important follow-up question – what comes after that? Or to put it another way: for *whom* and *to what end* must this combinatorial task be carried out? This is ultimately an anthropological issue. Because in the end, it is always and exclusively human consciousness that takes creative recourse to it. In this respect, it is ultimately about the human resources of a highly industrialised society and their formation. Accordingly, Benešová and Tupa (2017, p. 2196) say: “The role of the human factor will be necessary for the future manufacturing. The skills and qualifications of the workforce will become the key to success of a highly innovative factory. For this reason, the companies should be focused on the development of qualified workforce by the Human Resources Management. The Human Resources Management is not only focused on selection, staffing and dismissing employees but also on human resource development, i.e. education, learning and training of employees.” Therefore, the authors Santana, Afonso, Zanin, and Wernke (2017) stated as early as 2017 at the Manufacturing Engineering Society International Conference in Spain: “It makes clear that industry 4.0 is more than just technology. The human resource could probably be even more important in times of industry 4.0.”

This requires the development of special integral abilities for human use in order to bring together an abundance of individual facts. However, this cannot be achieved by one-dimensional modular thinking that merely adds together the diversity of facts in a linear manner, but only by a holistic style of thinking that anticipatively integrates the diversity of details into the targeted whole from within the system to be created. In short, a *systemic* thinking is called for that embraces in an anticipatory mind an overview of its own mental acts of analysis and synthesis of the objects of knowledge at hand – even before it finally sets them into concrete relational contexts on the object level itself. It is a thinking that is conscious of itself *as* operative thinking on a meta-level. This means that in this elevated profile of requirements, I must not only think straight, rather I must know *what* I am thinking and *how* I am thinking in order to do justice to complexity and connectivity.

Of particular importance in such complex cognitive acts is not least a permanent critical self-reflection, in order to finally realise itself meaningfully in practical action.
These structural epistemological and action-theoretical requirements define the specifications with which modern university didactics must meet the requirements of academic vocational training in the age of Industry 4.0. Such an adaptation is also demanded by Benešová and Tupa (2017, p. 2196) “For this reason the education system will be changed from Education 3.0 to Education 4.0.”

A look at the literature shows, as do conversations with experts, that a purely technical enrichment of the educational scenarios does not bring the desired performance for this transformation task. In the established, classical world of studies

of the past decades, a lack can be identified that the individual disciplines are not sufficiently linked at the subject/content level for the requirements of Industry 4.0, as Prof. Dr. Meinberg pointed out in the interview. This already indicates that thinking and acting must be trained to approach the work tasks in a more comprehensive and penetrating way. Simply increasing the degree of specialisation is not in itself effective. It is true that even and especially in highly technologized companies there is an obligatory lament about the chronic shortage of skilled experts. However, gathering highly specialised experts from different disciplines in a crowd is not the solution to the personnel requirements structures for Industry 4.0. On the contrary, a mere concentration of expertise from different disciplines is counterproductive. Such an approach falls short, if those involved lack the coping strategies for dealing with this wealth of information in an interdisciplinary manner.

Not only is an accumulation of subject-specific knowledge required, but new, different fields of competence must also be added to the educational concepts, which, with an adapted didactic set of instruments, cover the previously rather subordinate skill desiderata of the students.

In the appropriate training of progressive professionals, as elsewhere, a distinction must first be made between the professional content or subject level and the competence level that responds to it. Both must, of course, correlate as far as possible. The technical innovations generate pressure to change and adapt, which require an adaptation of the *curricula* at a *subject level* and a correlated adaptation of the *competence grids* at a *competence level*. The decisive factor here, however, is the fact that in the modern, highly technological world of work, far more competences are required than the directly cognitive skills that serve the acquisition of subject-specific knowledge as such. Such an exclusive focus on the purely technical content represents a fatal reduction of the educational process. This in itself is not a new insight, but it gains even more lasting significance through the peculiarities of the fourth industrial revolution already described. Due to the high pressure of change, complexity and connectivity, systemic thinking, personal competences and soft skills are particularly required. The purely content related-positivistic field of competence of purely factual knowledge transfer is only one of several that must be didactically configured into a comprehensive competence grid. Future “engineering training”, emphasize accordingly, Maisiri et al. (2019, p. 94), “must not focus only on specific discipline knowledge; behavioural skills must also receive significant consideration. Beyond balancing discipline knowledge and behavioural skills, interdisciplinary understanding must be developed.”

The required subject content is directly mapped by the classic forms of the curricula of the degree programmes – admittedly enriched with new, contemporary learning objectives.

Example for a curriculum

Software Engineering B.A.

1. Semester	ECTS	HWS	2. Semester	ECTS	HWS	3. Semester	ECTS	HWS	4. Semester	ECTS	HWS
Programming	10	6	Big Data & Analytics	5	3	IT Plattform	5	3	Artificial Intelligence	5	3
Computer Architekture	5	3	Backend Development	5	3	Software Engineering 2	5	3	Advanced Programming	5	3
Management Basics	5	3	Parallel Programming	5	3	Cloud Computing	5	3	IT Security	5	3
Start-Up-Management	5	3	Software Engineering 1	5	3	Operating Systems	5	3	IT Agile Development	5	3
Mathematics & Statistics	5	3	Design & Web Optimization	5	3	Software Testing	5	3	Corporate Management	5	3
Business English	5	3	Quanti. & qualit. Methods	5	3	Digital Media	5	3	Smart Systems	5	3
	30	18		30	18		30	18		30	18

120 ECTS

Mendatory faculty-wide modules
Mendatory specialization modules
Compulsory elective
modules

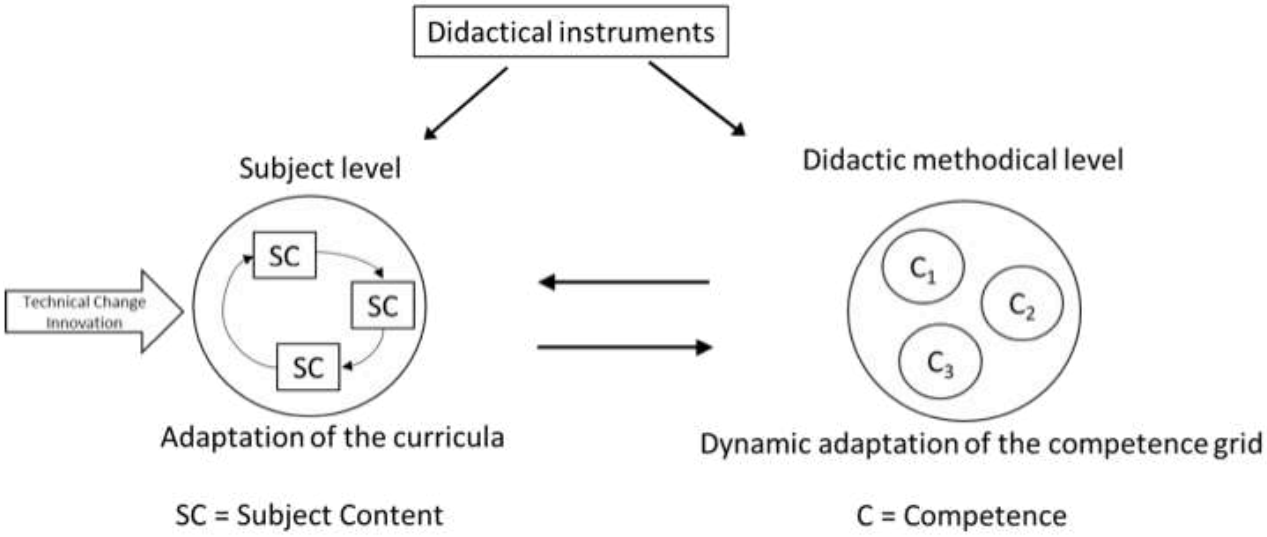
List oft abbreviations
HWS: Hours per week
ECTS: European Credit Transfer System

This addition to the content, is only the starting point for training that is appropriate for Industry 4.0. A corresponding concept that goes beyond these initial reasons and aims for a genuine overall view is still in its infancy. The interview partners included Prof. Dr. Riegler from the Bavarian Centre for Innovative Teaching (BayZiel). He is the managing director and overall scientific director at this institute. It is a joint institution of the 17 Bavarian state universities of applied sciences and technical universities (HaWs/THs). In its self-image, the activities of the BayZiel with its overarching organisational structure are geared towards a long-term institutionalised cooperation of the universities in the field of innovative teaching. This is implemented in terms of content in the three business areas: Qualification and Didactics, Teaching and Learning Research and Educational Support.

Riegler's core statement is that even in this institute, which is explicitly dedicated to modern higher education didactics, an overall view from an Industry 4.0 perspective does not (yet) take place. Indirectly and partially, the BayZiel meets the corresponding requirements in that the qualification of lecturers is “interdisciplinary and independent of content”. This is reflected, among other things, in the adequate “formulation of learning objectives, the implementation of research-based learning methods and topics such as the diagnosis of student difficulties or students’ resistance”. Riegler sees the so-called learning goal-oriented approach as an effective and potent means for Industry 4.0 didactics. – What is important here is to formulate the corresponding learning objectives in a systematic network and coordination. This is where the relevant desideratum is to be located in a more systemic way; including perspectives that are most closely associated, such as sustainability or future skills, as Riegler emphasises in his concluding statement.

These curricula, as exemplified above, must of course be subject to permanent monitoring by an expert committee and their results must be continuously adapted to technical progress. These curricula form one pillar of the training. The other pillar is the competence grid of individual competences that are not directly linked to content, which in turn can be divided into fields. These requirement profiles result predominantly from the larger work contexts in which the subject content-related factual knowledge must be applied. In the context of Industry 4.0, these contexts are

characterised by enormous complexity. The coordination between both “pillars” and the implementation by means of suitable didactic instruments determines the task to be mastered, as can be structurally outlined with the following illustration.



The left-hand side of the graphic represents the various curricula relevant to Industry 4.0 at the content level, triggered by technical progress. This subject content must of course be permanently monitored and adapted in line with the prevailing pace of development. As the interviews showed, the following faculties are particularly affected or relevant: Industrial Engineering, Mechanical Engineering, IT, Business Administration.

The right-hand side represents the competences assigned to the content, which, as shown, in addition to the pure ability to reproduce the subject content, includes an enormous amount of additional so-called soft skills, which are more background and yet of indispensable importance because they enable the application of the subject knowledge in the modern working world 4.0 in the first place. Appropriate didactic instruments are needed to coordinate the two sides (technical requirements on the one hand and assigned implementation and application skills on the other) and to advance this process until the framework curriculum is practicably broken down to the daily lesson plan and concretised in the teaching process. Admittedly, only basic requirements can be presented and discussed in this article.

Industry 4.0 is characterised, above all, by a high degree of networking that also transcends disciplinary boundaries. The universities are faced with the task of didactically reflecting this complex networking in their teaching concepts and stimulating the students intellectually as well as training them in their social interaction behaviour through sufficient cooperation skills. With regard to the status quo, it should be noted here: the interviewees repeatedly mentioned that the extremely important networking performance of the various textbooks and teaching topics, including the associated competences, for the Industry 4.0 characteristic, is only very poorly done in practice or is completely absent in individual cases. This is not a minor faux pas, but a serious deviation from the elementary didactic requirements.

As already pointed out, there is a wide gap between the requirements and the reality of Industry 4.0. The claim results from the technological nature and complexity of the matter itself and cannot be reduced arbitrarily. As Bessa da Cruz et al. (2020, p. 34) state, the following applies to university graduates:

> "As future professionals, students need technical knowledge to deal with emerging trends, such as Big Data, Internet of Things (IoT) and Robotics. In addition, social skills, such as solving complex problems, dealing with conflicts, creativity, innovation and communication leadership and collaborative work, are paramount."

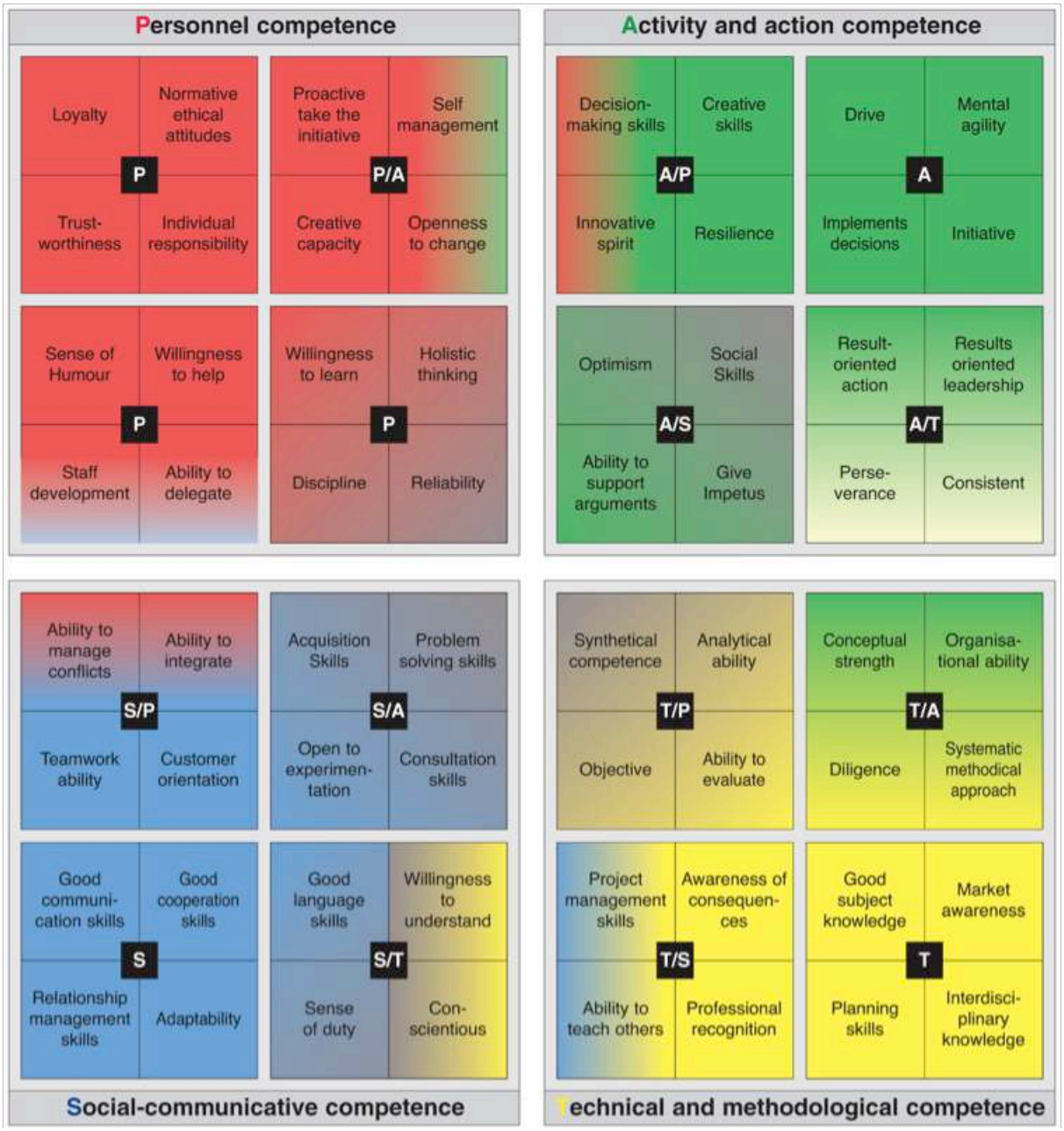
And yet the current higher education system as a whole is still rooted in and biased to the traditional education system, as Freeman et al. (2014) criticise, so that it is not sufficiently up to the task of making the industrial world more agile, economical and productive through the type of education it provides (l. c.). These discrepancies between the factually necessary demand for the training of the required skilled workers and the reality of everyday university life are considerable, as the above-mentioned study demonstrated. In its implementation, the striking fact emerged that,

> "students claim to be prepared for Industry 4.0 challenges, professors think otherwise. There seems to be a pedagogical challenge to fully achieve the requirements for the development of future I4.0 professionals, in addition this research identified that active learning methods, focused on the development of 21st century skills, are poorly applied by professors, which may indicate that students are not being exposed to real life situations necessary to better prepare themselves for the future challenges of I4.0." (Bessa da Cruz et al., 2020)

However, the universities must also take into account that in the education system of the 21st century, as Boaventura de Souza Santos (2008) points out, the university will no longer have the classic monopoly on knowledge. This circumstance, that they will only be successful in the future in close cooperation with other actors, must be integrated by the academic institutions both in their self-image and in the conceptual implementation.

As Felberbauer pointed out in the interview, a modular structure of the curriculum is necessary in order to reflect the diversity of content and the structural interconnectedness of interrelated and interdependent topics. This means that the different subject areas require the didactic use of teaching modules as (a) coherently conceived units, which (b) are coordinated and networked with each other so that they can be connected, in order to enable a continuous knowledge network with adequately formed competences for action in this planned interlinking.

The high level of coordination demanded by the Industry 4.0 requirements profile also directly entails the need for a correspondingly pronounced cooperative style of teaching, learning and working. Only if a modularly interlocked curriculum and a cooperative style of interaction go hand in hand can the complexity of interdisciplinarity be mastered and the holistic approach required from it be



guaranteed, as can be deduced from Professor Meinberg's remarks. In addition to the systematic development of networked thinking, due to the speed of technological innovation, attention must be paid to the continuous updating of teaching and the permanent adaptation of teaching material. – *Summa Summarium*, this results in very high requirements for academic training in accordance with the task portfolio of the fourth industrial revolution.

The competence grids to be didactically generated from these diverse requirements are correspondingly interwoven and variable in many ways. A competence grid is differentiated by competence fields and filled out by individual competences, – which are admittedly coordinated among themselves in different affinity levels. Of course, depending on the perspective and optional focal points, different competence grids are possible and useful. For the requirements discussed here, for example, a structuring such as the following is powerful.

Explanation of the four quadrants:

In addition to the field of (a) subject-specific competences, there is the (b) general subject and methodological competence field, the (c) personal competence field, the (d) activity and action competence field and the (e) social-communicative competence field.
“Through connectivity and communication between people, machines and products” respectively “through constant interaction with machines and assistance systems, people become part of the cyber-physical system, which fundamentally changes their requirement profile”, state Wegener et. al. (page 30 / 37) in their article on Industry 4.0 for mechanical and plant engineering. It should be emphasised, although this is only done to a rather limited extent in this publication, that this significantly changed requirements profile encompasses considerably more than just additional specialist knowledge.

> “Industry 4.0’s advanced technologies and automated systems are increasing the level of complexity of the skills required in the workforce of the future. This interaction requires strong skills, not only from technical specializations, but also from non-technical ones, such as emotional intelligence, critical thinking, creativity, innovative communication, proactivity, collaboration, and teamwork.”
> (Bessa da Cruz et al., 2020, p. 56)

These essential competences for Industry 4.0 requirements do *not* appear in the curriculum as an explicit subject matter, which the teacher lectures on in a more unified sense. This is because what is formally represented in the curriculum and timetable forms the *conditio sine quo non* in terms of subject matter, but it does *not* represent the decisive core competences for a successful professional activity in Industry 4.0. The typical core competences 4.0 must be “invisible”, i.e. immanently deeply anchored *within* the teaching of the technical-contentual contexts. This means that they are not so much explicitly *taught* in a thematic way as they are immanently *stimulated* at a deeper level by the "*how?*” of teaching/learning, because as practical skills for action they *cannot* be meaningfully conveyed as an abstract theoretical subject matter. From the very beginning, it is about doing, not about knowing. The central and typical Industry 4.0 competences are, so to speak, permanent, background “accompanying requirements” of purely technical skills, because they cannot be applied linearly as ready-made and completed content in the same mode to work situations that remain essentially unchanged.

It will therefore be important to stimulate soft skills situationally through the way in *which* the contents and results are developed. This qualitative aspect, beyond the purely factual information as such, must be adequately reflected methodically in didactics. This means that in our context it must be realised within (also electronically) networked teams and in connection with man-machine interfaces. This includes activating, challenging and promoting, shaping and linking manual, intellectual, communicative, emotional, cultural (etc.) abilities.

If machines and cyber-physical systems exchange more information, people will have to adapt their communication behaviour analogously – both in terms of the *quantity* of

communication (numbers) and the *quality* of communication (quality of content) and the *depth* of communication (location of meaning in the overall horizon). This increasingly requires social and interactive learning.

One of the preferred didactic scenarios in academic education 4.0 is project-based learning (see Maisiri et. al. 2019, page 95), in order to transform the individual components into comprehensively interlinked systemic skills. Due to its complex practical relevance, project-oriented learning has the integral function of adequately combining knowledge and action skills in a multi-layered manner, stimulating the ability to cooperate in a team and learning to (jointly) learn by calling on innovative problem-solving skills.

Dealing with the isomorphism between reality and virtual simulation, which is typical for Industry 4.0, requires a high degree of intellectual agility. Regarding this shadowy duplicate character of the real, Wegener, Kunz, Bochmann, and Bänziger (2016, p. 30) write: “A main feature of Industry 4.0 is that products, i.e. machines, vehicles, manufacturing plants, valves, etc., are equipped with a second identity on the internet, which is called a digital image, also called a virtual representation and, depending on its characteristics, a digital shadow or digital twin”. The resulting constant fluctuation between reality and virtuality requires a flexible sovereignty of consciousness and presence of mind in order not to “fall” into this process or to lose oneself in virtuality without any connection to what is real. Thus, in addition to the distinctive qualities of structural vision and structural understanding, special bilateral transfer abilities are needed so that a dynamic and logically guided pendulum movement of the mind can succeed in the work process. Last but not least, this includes the ability of critical self-reflection of the consciousness, which regularly critically questions its own space of action.

Distance learning as a constitutive component of these study programmes not only serves as an effective means of reducing the need to travel to different teaching locations or to maintain teaching in emergencies such as the Coronavirus pandemic. Above all, it serves as a practical example and practice model for lifelong networked learning and working. In an appropriate e-learning/blended learning environment, appropriate media use with modern communication and collaboration tools as well as virtual simulations and search/research skills can be trained in a playful way. Modern learning necessarily means learning and permanently internalising highly networked thinking. This is because the communicating and learning systems of the Smart Factory also require communicating and learning employees throughout in order to avoid staff-related islands of inconsistency. This cannot be achieved through knowledge aggregation, but only through the systematic development of proactive thinking, behavioural skills and learning to act that has become habitual. Accordingly, Maisiri et al. (2019, p. 92) also state “that soft skills will be as important as technical skills in the engineer of the future. The future engineer’s interaction with intelligent machines will form a symbiotic partnership that requires a firm base of soft skills, such as emotional intelligence, critical thinking, innovation, communication, collaboration, leadership, and teamwork.”

The preceding presentations have shown that training for the occupational requirements of the fourth industrial revolution has to take into account almost the entire range of human capabilities. These competence trainings and formations have to be adapted to a large number of individual cases of different curricula or their

modules. Of course, these didactic individualisation processes of certain training scenarios cannot be carried out in the present article, because it is aimed more broadly at the overall structure of the new type of requirements. The following overview, which covers the personal, social, methodological, cognitive, technological and digital-electronic dimensions, is presented as a resulting and provisionally conclusive direction for the generation of a competence compass; whereby the latter already extends a good deal into the subject-specific competence level.

Digital skills:

- IT / Data
- Cyber security
- Cloud computing
- AI skills
- Digital content creation

Cognitive-intellectual skills:

- Practical inventiveness
- Creativity
- Critical and logical thinking
- Flexibility
- Complex thinking / understanding
- Analytical thinking
- Synthetic thinking
- Interdisciplinarity

Technological skills:

- Designing ability
- Virtualization capability
- Interoperability understanding
- Troubleshooting
- Digitization skills
- Interaction with modern interfaces
- Application skills for Internet of things, robotics, 3D printing, for example

Programming competencies:

- Programming languages
- Logical thinking
- Coding
- Simulation skills
- Hardware and software skills

Personal competencies:

- Willingness to perform / motivation
- Independence
- Sense of responsibility
- Diligence
- Self-confidence
- Self-assessment competence
- Perseverance / Endurance
- Frustration tolerance / resilience
- reliability
- Flexibility
- (Self-)learning ability
- Leadership skills
- Organizational skills
- Negotiation skills
- Entrepreneurial thinking
- Decision-making ability
- Self-awareness and self-reflection

Of central importance in all this is an adequate further development of the concept of competence itself. A modernised, contemporary concept of “competence” must be both sharp and flexible in order to do justice to its multifactorial profile of requirements. The first definition of competence relevant to the world of work was provided by McClelland (1973) when he defined competence as a personal quality or set of habits that lead to better work performance. In the discussions of the following decades, this behaviourist approach proved to be too narrow, because such an understanding of competence focuses too much on the learning of isolated behaviours. Weinert (2001), for example, understands the concept of “competence” as a totality of knowledge, skills, attitudes and values in a much more comprehensive and adequate way.

Taking into account the constructivist paradigm, the importance of values, motives and beliefs for competence formation is emphasised. This leads to the inclusion of interpersonal and intrapersonal talents and abilities. Grzybowska and Łupicka (2017), for example, outline three dimensions of the competence issue, which, in addition to the didactic aspect, also include the interpersonal and intrapersonal.

In the intrapersonal meaning dimension, the question is how a subject – both learner and teacher – interprets him/herself. That is, how are one’s own attitudes managed, reflected upon and improved? What readiness relationship do the actors as self-responsible individuals place themselves into competence requirements such as communication skills, creativity, proactivity, conflict skills, autonomy, discipline, problem-solving skills, and so on?

In the interpersonal meaning dimension, on the other hand, the interaction of the subject with the other parties involved in the learning process is examined. The exploration of competences such as an ability to work in a team, collaborative skills, leadership qualities and similar moves into focus here. In a word, many of the competences required for the future world of work are no longer in the realm of knowledge and manual skills, but are behavioural, as can be seen in the list of competences in the World Economic Forum’s report entitled “The future jobs report” (WEF, 2016). Due to their immanent transversality, these behavioural competences are comparatively difficult to grasp in theoretical research and difficult to convey in didactic practice.

The so-called *transversal*, i.e. *overarching*, competences are also generally counted among the key competences. (OECD, 2005, p. 9) According to Scharnhorst (2021, p. 19), the latter can be defined “as situation-appropriate combinations of knowledge, skills and attitudes”. In this context, we also speak of life skills, essential skills or 21st century skills (“Battelle for Kids”, 2019), to which the transversals 4K: communication, creativity, critical thinking and collaboration are added.

In addition, three “transformative Competences” were identified in further research: First, the creation of new economic, social and cultural added values; second, dealing with tensions and dilemmas; and third, the willingness to assume responsibility. (OECD, 2018, p. 5 f.) According to the study, these three transformative competences in turn unfold on the foundation of transversal competences such as self-regulation, adaptability, openness, creativity, systemic thinking, etc. A gradation of personal competences is presented here.

The outstanding importance of these kinds of competences for the modern world of work is fundamentally beyond question. “Various studies show that groups of experts assess certain competences as transversal and agree that they should be taught as a priority in educational processes.” (Scharnhorst, 2021, p. 21) However, they entail the problem that their content cannot be conveyed as formal, i.e. theoretical, teaching material. Accordingly, Weinert (1999, p. 11) also pointed out that transversal key competences in their contextualised and highly complex nature cannot be taught as a separate set *en bloc*, as it were. Scharnhorst (2021) refers to a study according to which precisely these important transversal competences are those that are most difficult to initiate in the training process.

> “The assessments of importance and feasibility were correlated, which showed that the suggestions considered most important – metacognition and reflection, transfer of competences and critical thinking – were also those judged to be very difficult to implement. On the other hand, the clusters of literacy, numeracy, information handling and cooperation, which were judged to be relatively easy to teach, were also judged to be of relatively low importance.” (Scharnhorst, page 21)

She goes on to say: “Competences only become transversal when individuals can actually transfer them to other situations and use them effectively there”. (l.c.) Transversality is therefore not a training content that is objectively available and can be easily called up and transported at any time according to clearly operationalised or even operationalisable criteria, but represents an ability that must be activated flexibly, intuitively and improvisationally on a case-by-case basis and must be carried out precisely. Mastering this fundamental lack of objectifiability of transformative / transversal key competences through proactive training concepts represents a high didactic art. For the flexible, result-oriented and successful application of acquired education in an increasingly complex (working) world is “less a function of the acquired knowledge itself than of the way in which knowledge is acquired.” (Weinert, 1998, p. 116) This means that, in practice, these didactic requirements to implement transversal competence building can only succeed if higher education institutions move towards installing problem-based learning (Barrows, 1986), project-based learning (Kokotsaki, Menzies, & Wiggins, 2016) and challenge-based learning (Clegg & Diller, 2019) in their educational scenarios.
The intention of this article was to provide a problem-oriented introduction to these complex interdependencies.

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The future of travel? Understanding the factors that lead to acceptance or rejection of hyperloop technology

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Abstract

Increasing urbanization is causing many challenges for mobility today, such as traffic jams and high carbon dioxide emissions. Hyperloop is a radical mobility innovation that could offer a potential solution for these issues. Since hyperloop is currently under development, overcoming technical and economic challenges as well as increasing its acceptance in society will decide the success of this innovative mode of transport. Currently, research on hyperloop user acceptance is limited. This study aims to identify users' willingness to use the system and factors that determine support or rejection for hyperloop. Therefore, an acceptance model was proposed and then tested in an empirical study based on a sample consisting of N = 387 participants in the Netherlands. The results indicate that performance expectations (e.g., high speed, comfort, environmental advantages) support the acceptance of hyperloop, while safety concerns (e.g., technology failure, low-pressure environment) were identified as a rejection factor. Based on the results, interested stakeholders should consider the benefits as well as possible fears and concerns regarding hyperloop in their communication. Future research should include experience opportunities with hyperloop to obtain even more valid results.

Key words: hyperloop, acceptance, performance expectations, perceived danger, knowledge

Introduction

Existing transport systems and mobility concepts are reaching their infrastructural and ecological limits in metropolitan areas around the world (Puppim de Oliveira, 2019). In particular, routes connecting major urban areas are vulnerable to congestion, leading to time delays and waste of resources as well as unnecessarily high carbon dioxide emissions (Bretzke, 2013). To solve these challenges, start-ups and established companies around the world are working on radically new forms of mobility solutions. One such transport technology currently under development is hyperloop (Nikitas, Kougias, Alyavina, and Tchouamou, 2017). The core technology of hyperloop is based on vehicles designed to transport people in low-pressure tubes accelerated by a magnetic levitation belt. This allows the vehicles to reach high speeds, which inleads to considerable shortened travel times compared to trains. Furthermore, initial studies suggest that also a lower infrastructure footprint and significantly lower use of energy can potentially be realized with this technology compared to traditional trains (Dudnikov, 2017; Nikitas et al., 2017).

Since Elon Musk's (2013) initial hyperloop proposal, several companies are developing hyperloop and its subsystems. In 2019, Hardt Hyperloop, a Dutch start-up, unveiled a full-scale test facility that uses the core elements of hyperloop (EIT, 2020). Virgin hyperloop performed its first test drive with two passengers on a test track in 2020 (Kleinman, 2020).

Key factors for the successful introduction of hyperloop as a mass transportation solution include overcoming technical and economic challenges, as well as gaining acceptance among potential users (Gkoumas & Christou, 2020; Nikitas et al., 2020). In the case of high-speed railway, Della Porta and Andretta (2002) demonstrated that lack of acceptance in the population strongly affects both the development and the implementation of large-scale infrastructure-based projects. Therefore, the examination of users' acceptance is a necessary prerequisite in the early stages of technological development (Taherdoost, 2019). In the context of hyperloop, research on users' acceptance remains scarce. Based on this need for more research, the present study aims to generate a better understanding of user acceptance of hyperloop by identifying willingness to use and the factors that support user acceptance or rejection of this new technology.

Literature review

Current state of research regarding acceptance of hyperloop

While the topic of hyperloop has gained media attention recently, the number of research publications is limited to explanatory and descriptive work, such as that of Musk (2013), and studies that focus on the technical aspects of hyperloop (e.g., Abdelrahman, Sayeed, & Youssef, 2018; Heaton, 2017; Janzen, 2017; van Goeverden, Milakis, Janic, & Konings, 2018). However, hyperloop has not been researched extensively for its social impacts including users' acceptance.

Almujibah, Kaduk, and Preston (2020) identified potentially relevant physiological as well as social challenges that should be tested and considered when designing hyperloop as a new transportation system. The results suggest that high acceleration, high speed, and high magnetic fields should be considered as risks that could produce a feeling of uneasiness and lead to safety concerns for passengers. However, the influence of these fears on user acceptance of hyperloop was not investigated by the authors. Another study examined the expected benefits when using hyperloop and the social discussion about the new mode of transportation, as well as perceived fears associated with using this mode of transport. The results reveal that there is a high benefit expectation, especially among persons aged under 40, while the fear of using hyperloop is rather low across generations (Stegmüller, 2019). However, it is still not clear which factors drive acceptance of hyperloop. Therefore, further research is required to identify the influencing factors and thus provide fundamental acceptance research in this area.

Possible factors influencing the acceptance of hyperloop

Since no specific hyperloop acceptance models have been proposed to date, this study is based on the unified theory of acceptance and use of technology (UTAUT 2) by Venkatesh, Thong, and Xu (2012). UTAUT 2 has been established for the consumer context and is considered in numerous technology acceptance studies

(Tamilmani, Rana, & Dwivedi, 2017). Venkatesh et al. (2012) suggest a direct effect of performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, habit, and price value on the willingness to use a technology, which further predicts the actual use. In addition, the model proposes age, gender, and experience as moderators (Venkatesh et al., 2012).

In the context of hyperloop, none of these constructs were examined or integrated in existing research, but possible impacts can be derived from research regarding similar technologies, such as autonomous buses, trains, and metros, that are currently used and tested in many cities across the world (e.g., Fraszczyk & Mulley, 2017; Pakusch & Bossauer, 2017). In addition, further insights can be derived from research regarding comparably radical new transport technologies such as air taxis. Although there are some differences between air taxis and hyperloop (e.g., speed and technical basis), there are important similarities. Both technologies are planned as autonomous, provide faster and more flexible travel, and are new emerging and futuristic innovations. Consequently, the variables of UTAUT 2 are defined and the applicability to the hyperloop context is discussed by considering existing acceptance research regarding similar technologies such as autonomous public means of transport and air taxis.

Performance expectancy addresses the benefits a user receives as a result of using a technology (Venkatesh, Morris, Davis, & Davis, 2003). Considering the fast speed, a clear benefit of using hyperloop is time saving. This is confirmed by Limtanakool, Dijst, & Schwanen (2006), who stated that time saving is a major factor for medium- and long-distance trips. Moreover, Fu, Rothfeld, and Antoniou (2019) identified travel duration as a crucial criterion when deciding between the use of air taxis, autonomous cabs, public means of transport, and private vehicles. Other proposed benefits of using hyperloop are sustainability (Taylor, Hyde, & Barr, 2016) and comfort (Musk, 2013; Razi et al., 2018; Thompson, 2015). Thus, the combination of these aspects represents the unique expected performance of hyperloop.

Effort expectancy refers to the perceived ease of use for a particular technology (Venkatesh et al., 2012). Grotenhuis, Wiegmans, and Rietveld (2007) define effort savings as one of the customers' needs for public transport. This is expressed in physical effort (e.g., waiting), cognitive effort (e.g., planning the route), and affective effort (e.g., uncertainty regarding timely arrival) (Grotenhuis et al., 2006; Stradling, Hine, & Wardman, 2000). Further, long waiting times and lack of flexibility are defined as disadvantages of public transport compared to cars (Beirão & Cabral, 2007) and are considered to affect travel decisions (Polzin, 2016). Consequently, when applied to hyperloop, effort is related to waiting times and the extent of flexibility in travel planning.

Hedonic motivation represents the enjoyment and pleasure experienced during the use of a technology (Venkatesh et al., 2012). Venkatesh et al. (2012) state that novelty appeal increases the influence of hedonic motivation. Further, Golbabaei, Yigitcanlar, Paz, and Bunker (2020) conclude that hedonic motivation in terms of driving-related pleasure and sensation-seeking affects the intention to use autonomic vehicles. Al Haddad et al. (2020) confirm the strong influence of hedonic motivation on acceptance in terms of air taxis. Thus, as an innovative high-speed train, hyperloop could also trigger hedonic motivation according to Venkatesh et al.'s (2012) definition.

Social influence is considered another relevant aspect in terms of using hyperloop. Social image refers to the admiration and feeling of uniqueness that individuals gain when using a particular technology (Fisher & Price, 1992; Yu, Lee, Ha, & Zo, 2015). Further, social status and prestige are important dimensions underlying the attractiveness of car use (Curtis & Perkins, 2006; Steg, Geurs, & Ras, 2001) and the use of autonomous vehicles (Jing, Xu, Chen, Shi, & Zhan, 2020). Thus, the proposed model includes social image to understand whether using hyperloop will also trigger this aspect.

Price value represents a user's deliberation between the benefits the technology provides on the one hand, and the financial costs when using the technology on the other hand (Venkatesh et al., 2012). However, the measurement of this predictor is only possible when the technology can be used by society. Instead of price value, we expect price expectation to be more applicable to the context of hyperloop due to its early stage of development.

In addition to the proposed factors in UTAUT 2, there are additional factors derived from other transport technologies that should be considered in the context of hyperloop. It has already been demonstrated that for new technologies in general (e.g., Godoe & Johanson, 2012), and especially for automated technologies (e.g., Kim, 2019; Winter, Rice, & Lamb, 2020; Xu et al., 2018), fears and concerns resulting in perceived danger are relevant acceptance factors. The specific fears and concerns in terms of hyperloop arise from the characteristics that distinguish this technology from already existing means of transportation, such as high speed, lack of windows, and low-pressure environment (Almujibah et al., 2020). Similar to other new technologies, technology failure (Hulse, Xie, & Galea, 2018) is also a relevant concern. Further, fear of automation resulting from lack of staff was identified as a relevant safety factor for air taxis (Al Haddad et al., 2020; Fu et al., 2019; Hasan, 2019) as well as autonomous public transportation (Dong, DiScenna, & Guerra, 2019). Consequently, fears and concerns were used to extend the proposed acceptance model.

In conclusion, acceptance research regarding hyperloop is currently limited. The existing literature on hyperloop, as well as the research on acceptance of similar technologies, reveal some relevant factors regarding the acceptance of hyperloop. This study aims to combine these factors into a conceptual model for the acceptance of hyperloop that will subsequently be tested in an empirical study.

Methods

Sample and study background

Currently, hyperloop is in an early stage of development. For technologies that are not yet available to potential users, acceptance studies are often conducted with so-called early adopters and participants with a high level of openness to innovation, which can bias the results (Dedehayir, Ortt, Riverola, & Miralles, 2017; Orr, 2003; Palm, 2020; Yi, Fiedler, & Park, 2006). To avoid this bias, we decided to use a representative sample for the overall population of the Netherlands, based on a commercial market research panel. The Netherlands was chosen because this country is currently taking a leading role in the development of hyperloop in Europe. For example, the first European Hyperloop Center will open in Groningen in 2022

(Haas, 2019), and the Dutch start-up Hardt Hyperloop forecasts first passenger trips in the Netherlands in 2028 (Saraogi, 2020). The data were collected from 8 to 25 July 2020 via an online study conducted in the Netherlands.

Survey design

The survey contained 16 items regarding acceptance factors (e.g., performance expectancy, perceived danger) as well as the overall acceptance of hyperloop. Participants were asked to express their agreement regarding the items on a 5-point Likert scale (Likert, 1932). The response could vary from either "1 – strongly disagree" to "5 – strongly agree" or "1 – very unlikely" to "5 – very likely."
Furthermore, the questionnaire included six items regarding respondents' level of knowledge in terms of hyperloop and socio-demographic data (e.g., age, gender, income).
It was assumed that most participants were not aware of hyperloop due to its novelty. To set the same understanding of the hyperloop concept, all participants were provided with a short explanation of key facts about this technology at the beginning of the survey.

Items

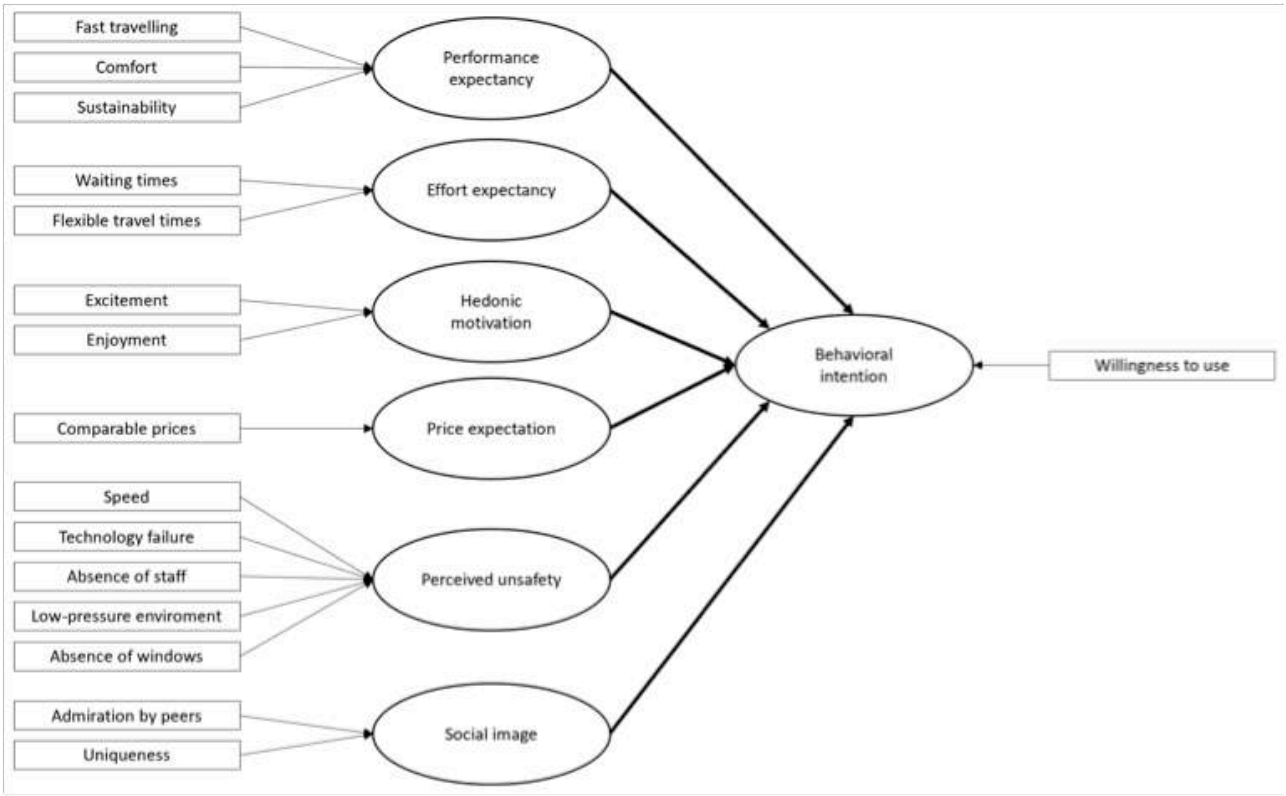
The criterion variable "acceptance of hyperloop" was expressed in the behavioral intention to use it (Venkatesh et al., 2012). Therefore, participants' personal willingness to use hyperloop was measured with the item "How likely is it that you would use hyperloop?". For the acceptance factors, we used statements based on the UTAUT 2 technology acceptance model (Venkatesh et al., 2012) and other research discussed previously, but adapted them to the hyperloop case. An overview of the conceptual model is provided in Figure 1.

The unique benefit of hyperloop's technology, and thereby the performance expectancy, was assessed in terms of fast traveling ("Hyperloop allows me to travel faster"), comfort ("I will have a comfortable ride with hyperloop") and sustainability ("A hyperloop trip is more environmentally friendly than a flight, train, or car trip"). As discussed previously, in the case of hyperloop effort expectancy is operationalized with waiting times ("Hyperloop reduces the waiting time at stations") and flexible travel times ("Hyperloop offers flexible travel times"). Further, hedonic motivation was assessed through excitement ("Traveling with hyperloop is exciting and stimulating") and enjoyment ("Traveling with hyperloop brings me joy") connected to a ride with hyperloop. Due to the novelty of hyperloop, price expectation was measured through the expectation of comparable prices to alternative transportation means ("The pricing of a hyperloop ticket is comparable to alternative means of transportation"). To assess the perceived danger, participants were asked about their fears regarding speed ("I am concerned about the speed the hyperloop will reach during a trip"), technology failure ("I am concerned that the technology might fail"), absence of staff ("I am concerned about the absence of staff in the vehicles"), low-pressure environment ("I am concerned about the low-pressure environment the vehicles are traveling through") and absence of windows ("I am concerned that the vehicles do not have windows"). Social image was expressed through admiration of peers ("By traveling with hyperloop I can impress others") and uniqueness ("Traveling with hyperloop distinguishes me from others").

Considering the effect of knowledge on the acceptance of new technologies (Golgbabaei, Yigitcanlar, Paz, & Bunker, 2020), the survey contained a question about the existing state of knowledge regarding hyperloop ("Have you heard about hyperloop?"). Here, the response options are: "I do not know it," "I have heard about it," "I have heard about it and looked into it," and "I know a lot about it." The relevant socio-demographic variables included age, gender, current occupation, monthly income, and use of other means of transportation.

Figure 1 shows the resulting hypothesized model for the acceptance of hyperloop.

Figure 1. Conceptual model for examining the acceptance of hyperloop.



Results

Sample description

The data set consists of N = 387 participants. The average participant age is M = 41 (SD = 11.92) years, and participants ranged in age from 18 to 75 years. The sample consists of 51% male and 49% female respondents. A wide variety of income groups and occupations are represented in the sample. With regard to the use of other means of transport, more than 70% of respondents reported using a car at least once a week, whereas the majority of respondents indicated that they used airplanes and (high-speed) trains less than once a month or never. With regard to the level of knowledge, 55.8% of participants stated that they knew nothing about hyperloop technology. Table 1 provides an overview of the characteristics in the sample.

Table 1 - Overview of sample characteristics

		Total sample (*N* = 387)
Gender	Male Female	51.2 % 48.8 %
Age	≤20 21–30 31–40 41–50 51–60 ≥60	4.1 % 21.2 % 24.5 % 24.0 % 25.8 % 0.3 %
Monthly income	≤€1,000 €1,001 to €2,000 €2,001 to €3,000 €3,001 to €4,000 €4,001 to €5,000 ≥€5,501 *No answer*	10.6 % 18.9 % 24.5 % 14.7 % 8.0 % 4.4 % 18.9 *%*
Current occupation	Student Part time worker Full time worker Self-employed Retired Unemployed *Other*	6.2 % 46.3 % 23.5 % 7.8 % 1.8 % 7.5 % *7.0 %*
Prior knowledge of air taxis	I do not know it. I have heard about it. I have heard about it and looked into it. I know a lot about it.	55.8 % 30.7 % 11.4 % 2.1%

Acceptance of hyperloop technology

The results indicate a rather positive overall acceptance of hyperloop (M = 3.35, SD = 1.15) with 51.4% of the participants considering the use of hyperloop to be probable or highly probable. Male respondents showed a significantly higher acceptance of hyperloop (M = 3.48, SD = 1.13) compared to female participants (M = 3.21, SD = 1.15, t(383.32) = 2.3541, p =.019). In addition, the results indicate a significant negative correlation between age and hyperloop acceptance (r = -.13, t(385) = -2.6513, p =.008). Furthermore, respondents who had at least heard about hyperloop (M = 3.82, SD =.82) have a significantly higher hyperloop acceptance than respondents without prior knowledge (M = 2.98, SD = 1.23, t(375.05) = -8.1037, p < 0.001).

Factors influencing the acceptance of hyperloop

To assess the impact of the proposed predictors on hyperloop acceptance, a structural equation model was calculated using the lavaan package version 0.6-6 (Rosseel, 2012) in R. Maximum likelihood was used as the estimation method. The final sample for the structural equation model was N = 387 as there were no missing data on the necessary variables.

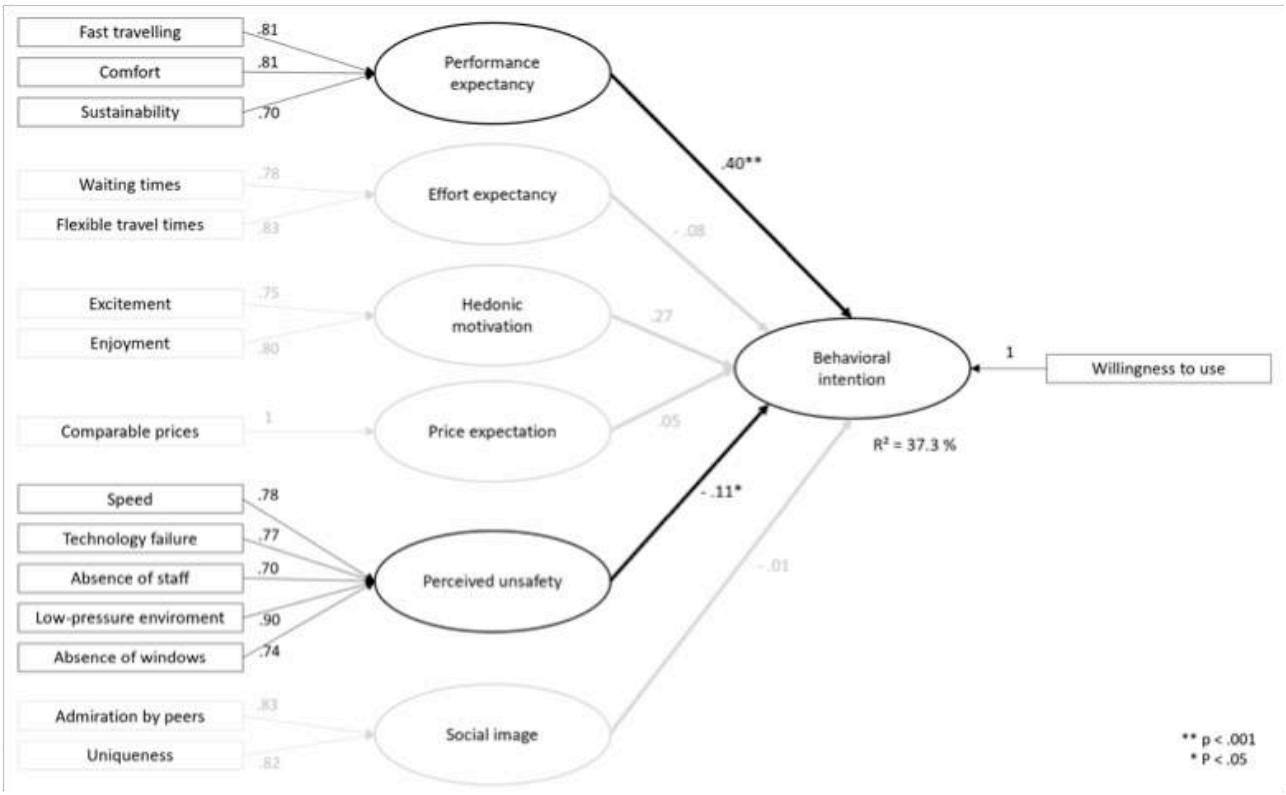
Model fit

In terms of item reliability, the correlations between the items and related constructs range from r = 0.697 to r = 0.897, which indicates proper loadings. All acceptance factors show a high internal consistency, which is indicated by Cronbach's alpha α =. 81 for performance expectancy, α =.78 for effort expectancy, α =.75 for hedonic motivation, α =.88 for perceived danger and α =.81 for social image. The overall fit of the structural model is determined by examining the ratio of the Chi-square value ($\chi^2(85) = 164.69$) to the number of degrees of freedom (85). In this case, the value is below 2.5 and therefore indicates a good model fit. The Tucker-Lewis index (TLI: 0.963) and comparative fit index (CFI: 0.974) are in the acceptable range. Further indices such as the root mean square error approximation (RMSEA: 0.049) and root mean square residual (RMSR: 0.037) indicate a good fit between the theoretical and the empirical model.

Structural model

The final structural model provides an overview of the significance of the path coefficients and the model's predictive power (Figure 2). Overall, the assumed model explains R^2 = 37.3% of the variance of the behavioral intention. Based on the variance inflation factor (VIF), there is no significant multicollinearity between the predictor variables (VIF < 5). The analysis of the path coefficients confirmed that performance expectancy (β =.400, p =.002) has a significant positive influence on the intention to use hyperloop whereas perceived danger (β = -0.109, p =.025) has a significantly negative effect. Effort expectancy (β = -0.081, p =.561), hedonic motivation (β = 0.273, p =.147), price expectation (β = 0.049, p =.500) and social image (β = -0.005, p =.965) do not significantly predict the intention to use hyperloop.

Figure 2. Results for the structural equation model. Significant results are presented in black. TLI =.963; CFI =.974; RMSEA =.049; SRMR = 0.037; Chi-square = 164.69; degrees of freedom = 85.



Discussion and implications

In terms of acceptance factors, our results are partially consistent with previous research on hyperloop and research on similar technologies. Performance expectancy has a strong positive influence on the acceptance of hyperloop, which is in line with Madigan et al.'s (2016) results. The authors suggest that the expected performance is the main factor that people take into account to decide whether or not they want to use an automated road transport system instead of other public means of transportation. In addition, this finding is consistent with several studies on the acceptance of air taxis (Fu et al., 2019; Rohlik & Stasch, 2019).

Surprisingly, effort expectancy has no significant impact on the acceptance of hyperloop. One potential explanation could be the strong impact of performance expectancy. The relation between these two constructs is reported to be a trade-off in many cases (Jing et al., 2020; Payne, Bettman, & Johnson, 1992), where effort expectancy (e.g., waiting time) is compensated by performance expectancy (e.g., fast travel time). It can be assumed that, in the case of hyperloop, the expected benefits outweigh the costs, which means that potential consumers are willing to accept some effort (e.g., in the form of waiting times) to benefit from the unique services provided by hyperloop (e.g., very fast travel times). Consequently, effort expectancy itself is no longer decisive for the acceptance of hyperloop.

Our findings did not confirm the positive impact of hedonic motivation on the acceptance of hyperloop. This is in contrast with previous studies suggesting that hedonic motivation influences the intention to use automated road means of transport (Madigan, Louw, Wilbrink, Schieben, & Merat, 2017) or air taxis (Al Haddad et al., 2020). This deviation could result from the aspect that the enjoyment of using hyperloop is difficult to assess by participants due to its novelty, and consequential lack of knowledge and experience regarding this technology. Furthermore, social image has no significant effect on the acceptance of hyperloop. One possible explanation for this is that hyperloop is perceived to be a means of public mass transportation rather than a way to express exclusivity or social status.

In line with previous studies, which demonstrated that perceived safety is an important predictor of the acceptance of novel transport technologies such as air taxis (Al Haddad et al., 2020; Fu et al., 2019; Hasan, 2019), our data indicates a significant negative impact of perceived danger on the acceptance of hyperloop. The identified safety concerns (high speed, lack of windows, and low-pressure environment) are in line with Almujibah et al. (2020). In addition, we found that safety concerns due to lack of staff and technology failure are relevant for the acceptance of hyperloop.

With regard to prior knowledge, it can be concluded that most respondents are not aware of hyperloop and its acceptance was higher among participants who were already familiar with this technology. This demonstrates the effect of increased education on overall acceptance, which is confirmed by studies in the context of autonomous vehicles (e.g., Golgbabaei et al., 2020).

As the acceptance of hyperloop is determined by performance expectancy in particular, stakeholders interested in introducing it should take this factor and its facets into account in communication, and focus on them when providing knowledge,

to receive broad support from potential users. Moreover, combining information with increased virtual or real experience of hyperloop or its components could make the benefits more visible and thus increase positive attitudes towards hyperloop among the population (Golgbabaei et al., 2020). Increased perceived safety after an experience opportunity has been reported for similar technologies such as autonomous shuttles (Distler, Lallemand, & Bellet, 2018). Increasing knowledge about a technology in various sectors was also found to reduce perceived risks (e.g., Almujibah et al., 2020; Klerck & Sweeney, 2007; Nepomuceno, Laroche, & Richard, 2014). This is important since our data indicate that perceived danger significantly decreases the acceptance of hyperloop. However, stakeholders should be aware that knowledge can also have an opposite and thus negative effect, since it can make the safety concerns more salient. In this case, providing and communicating alternative solutions for known concerns (e.g., reducing the fear of lack of windows by providing augmented windows) could be a potential helpful strategy to reduce fears. Clearly, more research is needed in this regard.

Limitations and further research

Due to the early stage of development of hyperloop, the awareness and the knowledge of potential users is limited, and first-hand experience is lacking. Consequently, subjects have not yet formed beliefs about the technology and thus may not be able to take a clear position on some aspects. This effect is visible in the items regarding fears and concerns, where a high proportion chose the answer category “neither agree nor disagree” (27–37%). It is possible that participants who have not yet formed an opinion saw this answer category as a fallback option. Since experience is necessary for more valid assessment of opinions, future studies could implement experience opportunities in their research. Due to the early stage of development, it is not possible to provide a real travel experience in the hyperloop. Future studies could use virtual reality (VR) or augmented reality (AR) to simulate a hyperloop travel experience. This would provide a more realistic assessment of the attitudes regarding hyperloop.

In our study, 37.3% of the acceptance variance is explained. Further research is required to identify other relevant predictors to explain more variance of the willingness to use. Thus, future studies could examine price value, habit, and social influence of the UTAUT 2, measurement of which will become possible upon the future availability of the technology. In addition, qualitative research could be utilized to better understand the fears and needs of potential users. Finally, since the present study only refers to a sample for the Netherlands, the acceptance of hyperloop in other European countries should be examined in future research to understand whether regional differences exist.

Conclusion

In this study, relevant acceptance factors were combined into a conceptual model for the acceptance of hyperloop and subsequently empirically tested with a representative sample of the population. The resulting data indicate that performance expectancy reflected in high speed, comfort, and environmental aspects increases the acceptance of hyperloop. Further, the model suggests that the acceptance is decreased by perceived danger resulting from fears and concerns such as technology failure. Since the data indicates there is limited knowledge regarding

hyperloop among the population, increasing knowledge could affect the future acceptance decision of individuals. New information that supports perceived key benefits of hyperloop, such as speed, comfort, and environmental friendliness, would increase acceptance, while information creating awareness of potential technological failure might increase perceived danger and thus create resistance.

In summary, this study provides an initial understanding of the factors leading to either acceptance of or resistance to hyperloop and thus establishes the basis for further research on this new form of transportation.

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