administrative sciences

MDPI

Article

Value Co-Creation Process and Measurement in 4.0 SMEs: An Exploratory Research in a B2B Marketing Innovation Context

Marcelo Royo-Vela * and Mariell Velasquez Serrano

Department of Commercialization and Market Research, Faculty of Economics, University of Valencia, 46022 Valencia, Spain; dovese@alumni.uv.es

* Correspondence: marcelo.royo@uv.es

Abstract: The purpose of this exploratory research is to contribute to the lack of empirical research exploring techniques and protocols that can be used to measure the level of value obtained from using these technologies in the various marketing processes and in a business-to-business (B2B) context. By doing so, firms operating in fast changing dynamic environments can develop the right means to continuously adapt, integrate, reconfigure, and redeploy resources and capabilities to become more competitive and disruptive in their offerings. The phenomenon of interest is described by applying a case study qualitative approach to three 4.0 companies which use virtual reality (VR)/augmented reality (AR) technologies and by carrying out ten in-depth interviews to managers in those organizations. Results show that some small and medium sized enterprises (SMEs) are more rigorous about performance and tracking metrics compared to other companies providing similar technological services. In this line, results show two stages where potential value can be generated and measured when utilizing VR/AR technologies. The first is during testing and development of VR/AR simulations. In this stage, only the ones with strong research and academic background have been developing and using tracking systems, guidelines, and protocols as resources to measure the value obtained from using these technologies in marketing innovation processes. The second moment where value creation can be measured is during the implementation of the VR/AR simulation with the target user. Further research is needed to develop standardization guidelines and protocols that guarantee the success of the simulations delivered to the hiring firms.

Keywords: 4.0 industry; marketing innovation; B2B; value co-creation; case study

Citation: Royo-Vela, Marcelo, and Mariell Velasquez Serrano. 2021. Value Co-Creation Process and Measurement in 4.0 SMEs: An Exploratory Research in a B2B Marketing Innovation Context. *Administrative Sciences* 11: 20. https://doi.org/10.3390/admsci11010020

Received: 15 January 2021
Accepted: 15 February 2021
Published: 23 February 2021

1. Introduction

The 4.0 technology and solutions have heightened knowledge creation and dissemination, increased competence creation, reduced uncertainty, and strengthened network relations among firms in this sector (Götz and Jankowska 2017). The utilization of big data and analytics, autonomous robots' simulation, horizontal and vertical system integration, industrial Internet of Things, cybersecurity, cloud, or additive manufacturing 3D and augmented reality (AR)/virtual reality (VR) are some of the technologies that have being used as vehicles to add value to the various value-chain processes to prompt innovation in research and development (R&D) projects and to enhance marketing activities implemented by firms nowadays (Ungerman et al. 2018).

Some of the gains from using these technologies can include the development of new ways to balance customization with mass production to alleviate resource scarcity, improve energy efficiency, enable urban production, and reduce the impact product of demographic change (Götz and Jankowska 2017). Ungerman et al. (2018), Kiel et al. (2017), and Kagermann (2015) are some of the various authors that have explored the different benefits and advantages associated with the rise of the 4.0 industry. However, little has been studied on the 4.0 industry on how the outcomes generated from using its technologies in the various manufacturing processes and marketing activities should be accounted as valuable beyond mere practices that enhance the competitiveness of a firm (Dembek et al. 2016).

This investigation aims to contribute to the lack of empirical research exploring how the wide array of interdisciplinary technologies embedded in the 4.0 industry has transformed the way value is co-created and measured by the different stakeholders in a business-to-business (B2B) context. The objective is to identify the different indicators and metrics that can be used to objectively track and measure the level of value obtained from using these technologies in research, marketing communications, training, and product development, thus firms can fully take advantage of the breakthroughs offered by 4.0 solutions. The present work is structured as follows: first, we provide a general definition of the 4.0 industry, followed by a brief explanation of how 4.0 solutions have changed marketing innovation strategies. Second, we analyze the value co-creation process in B2B settings and establish the research question (RQ). Third, we justify the use of case study as the research method and, finally, we present the results obtained as well as the managerial implications and propose next steps for future investigation.

1.1. The 4.0 Industry

Industry 4.0 stands for the fourth industrial revolution, and the concept made its first appearance at the Hannover Fair in 2011 (Madsen 2019). The first one introduced mechanical production; the second revolution involved the electrification and the division of labor, and the third one, called digital revolution, was associated with usage of advanced electronics and information and communication technologies (ICT). The fourth and last revolution is built on "CPS" or cyber-physical systems (Götz and Jankowska 2017). This last refers to the 4.0 industry, internationally known as the industrial Internet of Things (IIoT), meaning the integration of internet technologies into industrial value creation processes, enabling manufacturers to harness entirely digitized, connected, smart, and decentralized value chains (Kiel et al. 2017). In other words, the concept is based on digitalization, robots, and artificial intelligence that transform the manufacturing processes (Madsen 2019).

The 4.0 industry exemplifies the concept of "connected enterprise", implying the cooperation of almost everyone with everybody through IT solutions that can ease geographical distances, reduce response time, and improve communication (Götz and Jankowska 2017), consequently facilitating decision-making processes within an organization or with third parties, advancing research and development (R&D) projects, improving fragmented or delocalized manufacturing processes and speed logistics, shortening distribution channels, and enhancing marketing strategies (Kiel et al. 2017) to ultimately increase labor productivity and achieve higher quality in the activities performed by firms (Ungerman et al. 2018). However, for the successful transformation of firms towards the fourth industrial revolution, it is imperative, on the one hand, to reinforce organizational conditions such as mutual trust, compatibility, close cooperation, and shared norms (Götz and Jankowska 2017). On the other hand, it is critical to adapt a need-pull approach and to know the relevant role played by internal resources as well as external parties that may drive the adoption process (Habraken and Bondarouk 2020).

To this research, the 4.0 industry is identified as a group of firms and institutions offering the implementation of a wide array of interdisciplinary technologies into the various firm's processes, not limited to digitalization, automation and robotics in production and manufacturing activities, but covering the whole ecosystem including: humans, machines, and organizations (Götz and Jankowska 2017). Our work focuses on small and medium sized enterprises (SMEs) providing 4.0 technological related services, such as augmented/virtual reality solutions for firms in the same 4.0 industry or others such as the automotive and the consumer goods industries.

Marketing Innovation in the 4.0 Industry

Firms are constantly looking for ways to be more competitive and improve their performance in highly crowded markets, explaining why they are continuously developing new products as well as new strategies to remain relevant in the eyes of the customers and the consumers. Marketing innovation is identified as the search for new creative solutions

to problems and needs. It must be and intrinsic part of a firm's marketing concept and strategy but significantly different from the traditional marketing methods. Marketing innovation is based on the understanding that sticking to existing marketing tactics alone is not enough to ensure success in today's saturated markets (Ungerman et al. 2018).

Innovation in firms' marketing departments has propelled thanks to the 4.0 industry. The technologies embedded in this industry can lead to the shift of centralized production towards decentralized production to shift mass popular products towards personalized products and to increase users' participations, thus each user can contribute to the development of new products, services, and experiences (Zhou et al. 2015).

The use of these technologies is versatile and is becoming ubiquitous; it has increased greatly in recent years among leading innovative organizations. Nowadays, it presents an extensive use in construction industries across different types and sizes of organizations. Through modeling and prototyping, VR can replace traditional, laborious hand calculations, drafting, physical testing, and model building approaches to many other design tasks, consequently reducing costs, development time, and uncertainties involved in engineering and design of projects (Dodgson et al. 2007). Similarly, in the automotive industry, augmented reality based systems can support a variety of services in a factory, such as selecting parts in a warehouse and sending repair instructions over mobile devices to the workers. These systems are still in early development, but in the near future, firms in the sector will be able to make a much broader use of AR to provide real time information to improve decision making and work procedures (Lorenz et al. 2015).

Virtualization technologies, namely, VR and AR comprise the integration of computer-supported reflections of real world environments, presenting augmented objects and elements along with additional valuable information, where users interact and affect these visual representations (Alcañiz et al. 2019). These technologies are vastly applied in diversified fields such as video gaming, tourism, research, education, manufacturing, and logistics (Kohtamäki and Rajala 2016) as well as in the customer journey's stages of pre-purchase, advertising/selling, purchase retailing, and post-purchase experiences by companies (Wedel et al. 2020). Most recently, and with increasing incorporation into a firm's processes, virtualization technologies are being used as a marketing communication tool or as a distribution channel, with the objective to innovate and enhance their offerings as well as savings in terms of costs, time, and man hours (Gottlieb and Bianchi 2017; Salanitri et al. 2016). Additionally, these technologies are also being presented as vehicles for passive and active co-creation of value (Rodriguez-García et al. 2015), since it allows real time, media rich, and highly interactive collaborations between firms, institutions, and individuals that can lead to innovation breakthroughs (Kohler et al. 2011).

Indeed, the adoption of such technologies is forcing many organizations to reconsider the way they conduct and manage innovative activities. Consequently, a growing number of specialized suppliers are currently offering 4.0 technological related services for firms in the 4.0 industry and for several others outside this sector. Their combined services and technological works presented can provide the necessary resources and mechanisms to increase innovations sourced from interactive collaborations between actors in the B2B systems (Kiel et al. 2017). For example, Spain alone has around 280+ small VR/AR creative firms with a competitively priced workforce, presenting continuous growth despite limited private and public investment (Informe XR 2018). In terms of the business scene, Barcelona, Madrid, and Valencia are the main locations to host these types of small businesses, mostly offering content creation, research, and training applications (Bezegová et al. 2017). Hence, the focus of our research is small and medium sized firms (SMEs) and institutions providing augmented/virtual reality solutions for the development of value co-creation activities with firms in the 4.0 industry.

1.2. Value Co-Creation in B2B Ecosystems

Gummerus (2013) proposes that value research consists of two main streams: value creation processes, which include actors, resources, and activities involved in the value

creation process, and value outcomes, which refers to how the actors perceive value. In B2B exchanges, value co-creation has been defined as a process of resource integration activities where firms interact with various actors in their network operating in close collaboration to deliver products, services, or solutions (Chowdhury et al. 2016). These value propositions can deliver significant value during the exchange processes between the suppliers and the customer, but it is the customer who ultimately defines its worth (Gummerus 2013).

Value is co-created by multiple actors, always including the beneficiary (the customer); although he or she cannot deliver value by himself or herself, they can participate in the creation and the offerings of value propositions (Kohtamäki and Rajala 2016). Vargo and Lusch (2016) latest update of service dominant logic (SDL) suggests that value co-creation takes place in direct and indirect interactions among suppliers, third parties, and customers within business ecosystems, where value propositions are "co-produced" through purposeful collaboration among all actors, and value is created when the customer is using the solution given by the supplier in a specific context. Hence, co-production of value propositions and the use of the solution are sub-processes of the value co-creation. Kohtamäki and Rajala (2016) note that the distinction between co-production and co-creation in this context seems minimal, but it is essential to understand the S-D logic perspective of value creation in B2B settings. They further explain that, whereas coproduction is related to situations in which the customer participates in the construction of the supplier's value proposition (e.g., products, services, or solutions), value co-creation is related to situations where the customer and the supplier together generate the customer experience. This process is better illustrated in Figure 1.

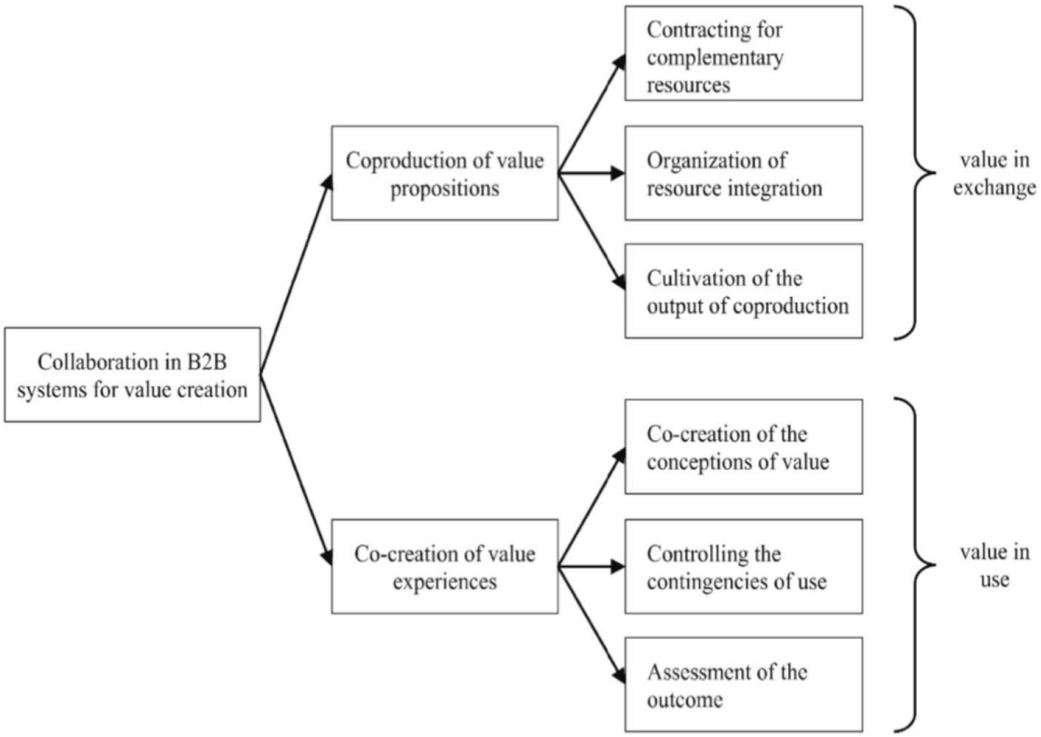

Figure 1. Practices of collaboration in business-to-business (B2B) systems for value creation (Kohtamäki and Rajala 2016, p.10).

A more holistic, dynamic, and realistic perspective of value creation is presented, comprising the exchange among a wider, more comprehensive (than firm and customer) configuration of actors (Vargo and Lusch 2016). The systemic process of value creation considers the collective efforts of interdependent actors, accounting for how they incorporate and interchange resources to co-create value for themselves and for others in the system (Figueiredo and Scaraboto 2016) at various network stages, where the potential tasks and roles performed are exchangeable (Gummerus 2013). Here, there are not strictly producers or consumers' roles but, rather, all actors are enterprises involved in the process of benefiting their own existence by helping the existence of other enterprises through service-for-service exchange, either directly or indirectly, through the provision of some output in the form of a good or a service (Vargo and Lusch 2016).

Value is no longer sourced from the sole offering of goods and services solving a need or a problem faced by customers but from the meaningful interactions between firms, partners, third parties, and customers through new connective tools (Ramaswamy and Ozcan 2016). The benefits of implementing value creation activities can include: (1) the production of superior or customized value propositions for the target customer, (2) prompting the development of more value co-creation opportunities among the different entities that are part of the B2B system, (3) driving innovation breakthroughs, (4) higher financial benefits (such as profits and revenues), and (5) increasing positive referrals for the supplier (Payne et al. 2008). However, according to Chowdhury et al. (2016), the primary benefits for the network of actors engaging in value co-creation processes are knowledge dissemination and access to complementary resources.

1.3. Measuring Value Outcomes in B2B Settings: Research Objective and Research Question Setting

Collaborations with firms have been amplified by the rise of digitalized technologies and interactive platforms present in the 4.0 industry, since they allow a multiplicity of exchanges in the network (Ungerman et al. 2018). The combined services and technological works offered by specialized suppliers in this industry can provide the necessary resources and mechanisms that can enable different types of co-creation opportunities in B2B settings (Ustundag and Cevikcan 2017). Such services can include utilization of augmented/virtual reality solutions for the enhancement of prototyping processes as well as development and launch of more individualized products and service offerings, which in turn can result in the creation of new forms of value for the stakeholders (Zhou et al. 2015).

The benefits of using these technological related services are seen in diversified fields beyond the 4.0 industry, including research, education, tourism, and marketing communication to name a few (Kohtamäki and Rajala 2016). Yet, there is little research exploring how the technologies embedded in a business network have changed the way value is co-created with the different actors in the network (Ungerman et al. 2018) and even less on how the utilization of these solutions in the various manufacturing processes and marketing activities should be accounted as valuable (Zhou et al. 2015) beyond mere practices that enhance the competitiveness of a firm (Dembek et al. 2016). In order to master such a networked value creation process, firms' managers need to explore the opportunities for joint value creation that these technologies and the business ecosystems enable. The multi-actor collaboration for value creation can not only influence the ecosystem level practices to tackle competition but also affect strategy formation and innovation development (Kohtamäki and Rajala 2016).

This investigation aims to contribute to the lack of empirical research exploring how VR/AR technologies have transformed the way value is created in B2B settings. In complex B2B systems, actors carry out activities, performing independent tasks (e.g., resource generation), doing joint activities (e.g., resource exchange), or facilitating resource integration during technology-enabled value co-creation processes (Breidbach and Maglio 2016). Hence, we can identify firms and VR/AR service suppliers as the organizing parties behind the value co-creation practice and customers, employees, or any other stakeholder as the executers of co-creational activities.

The organizations in the business network are in charge of utilizing various resources for the successful development of integrated solutions (Jaakkola and Hakanen 2013). These can be of high value or worthless, physical or digital, depending on the configuration (Lenney and Easton 2009). Still, how these resources are combined with other resources—systematically, consciously, and actively by actors—is what ultimately determines the generation of value (Gadde and Håkansson 2011). There is existent literature enumerating the functional requirements needed for VR and AR tools to enable the integration of computer-supported reflection of real world environments with additional and valuable information, thus participants can intuitively interact with and affect the depicted visualizations (Ustundag and Cevikcan 2017). However, little has been explored regarding what resources or supportive technologies can be used to measure the value generated from implementing these solutions into the value co-creation activities, or what criteria can be used by the stakeholders to evaluate the benefits generated from this practice. Thus, the following RQ is established:

RQ: How are firms and VR/AR service suppliers identifying and/or measuring the value generated from the co-creational activities performed by other actors?

2. Materials and Methods

A case study method was considered an adequate methodological option to carry out our research, as it enables the exploration of the focal phenomenon in its natural context (Partanen et al. 2008). Case study can be implemented to test a theory, to generate a theory (Ragin and Amoroso 2011), or, in this case, to describe an occurrence (Yin 2009). The case study method has been commonly used in the field of business economics, especially characterized by rapid changes triggered by technological advances, which continues to show an important gap between academic research and the reality of firms (Cepeda-Carrión 2006). According to Easton (2010), the analysis of a small number of entities and their practices can provide a great deal of largely qualitative data that can offer insights into the nature of the phenomena explored. Hence, we decided to perform a multiple case study under the positivism approach, which enables the reflection of the results of each case studied while allowing the identification of patterns, communalities, and differences across organizations (Cepeda-Carrión 2006).

The study focused on three units of analysis, where the criteria used for firm selection were to provide a broad spectrum of what can be accomplished with 4.0 technologies in terms of research, marketing communications, training, and product development. The first unit of analysis was Innoarea Projects, a young consulting company specialized in providing ad hoc solutions through virtual reality and augmented reality systems for clients in the 4.0 industrial sector. The second unit was The Institute for Research and Innovation in Bioengineering (i3B) of a Polytechnic University. The institute integrates R+D+I activities with multidisciplinary teams of about 60 academic researchers working towards the improvement of human skills using 4.0 technologies. The i3B Institute consists of five research units. One of those is the European Laboratory for Immersive Neurotechnologies (LENI), and Quatechnion is its spin-off. Therefore, Quatechnion is a technological spin-off born in the iB3 Research Institute-LENI Lab, specialized in the application of neuroscience and new technologies in the business field. For this reason, this unit has the stronger research and academic background. The third unit of analysis was a startup incubator called Oarsis, a venture builder company focused in creating partnerships with entrepreneurs from different industries with deep expertise in virtual and augmented reality. Table 1 includes more information about these empirical units under research.

Table 1. Research units general information.

Unit of Analysis	Company Age	Turnover	Number of Employees	Venue	Service Offered/Experience in VR/AR
Innoarea	4 years	<0.5 M	<30 (12)	Valencia, Spain	Technological solutions based on VR/AR for the industry
Quatechnion (i3B, LENI)	8 years	<0.5 M	<30 (5–20)	Valencia, Spain	Technological solutions based on consumer neuroscience, VR/AR and artificial intelligence
Oarsis	5 years	<0.5 M	<30 (28)	Madrid/Valencia, Spain	Business incubator to develop startups based on VR/AR/MR

VR: virtual reality; AR: augmented reality; i3B: Institute for Research and Innovation in Bioengineering; LENI: European Laboratory for Immersive Neurotechnologies.

The primary source of data for this study consisted of in-depth semi-structured interviews with key informants from the case study firms mentioned above, including senior managers such as CEO, business development managers, lead researchers, and marketing experiential managers. They were chosen based on their specialized knowledge and expertise utilizing these technologies in research and business strategies for both the 4.0 industry and the consumer goods industry. A total of ten interviews (eight men and two women) were conducted over a nine-month period between July 2017 and March 2018. Three belong to Innoarea, three work in iB3, and four are managers from Oarsis.

To ensure consistent interviewing procedures, we drafted an interview guideline rooted in four general sections (see Appendix A): the first focused on general information about the interviewee and the firm's description, the second explored VR system functionality and its most common uses in business and in research, the third surveyed the role of the participants performing various tasks inside the VR simulations, and the last section studied the criteria used by firms and VR consultants to determine the level of success obtained. Constant dialogue was encouraged, and respondents' answers were complemented with follow-up questions to further explore concepts, patterns, and interrelations (Beverland and Lindgreen 2010). The length of the interviews varied from 45–70 min, either conducted face-to-face or over video calls, all recorded and transcribed.

The transcripts were checked against the audiotapes and examined using thematic analysis to identify, analyze, and report patterns that surfaced from the data collected (Boyatzis 1998). Interpretations of emergent themes were derived directly from interview transcripts, interviewer notes and academic literature. The inferences presented resulted from the process of analysis and interpretation (Spiggle 1994) and transcripts extracts with statements made by the interviewees were selected to fit with the narratives covering the queries explored. Additionally, an extensive set of secondary data was collected and analyzed in parallel, which includes presentation material, videos, live demonstrations, and firms' websites, to support and provide validity of the findings (Partanen et al. 2008).

3. Results Analysis and Discussion

As presented earlier, the systemic process of value creation considers the collective efforts of interdependent actors in the network, where their roles are not strict in terms of who the producers or the consumers are but, rather, all actors are enterprises, benefiting themselves while helping others involved in the value co-creation process (Vargo and Lusch 2011). To do so, the actors carry out activities that can include transformation or transfer of resources with the objective to benefit the more aggregated actor, namely the organization to which they belong (Lenney and Easton 2009). The numerous interactions and the outcome of those activities performed jointly can have a widespread impact on the evolvement of business strategies (Gadde and Håkansson 2011). However, how is the value generated from the co-creational activities identified and/or measured?

The experts and their statements have helped us to identify two stages where the inputs generated from the utilization of VR/AR technologies can be identified or measured and judged as valuable to the hiring firms and the service suppliers. These are:

(1) During testing and development of VR/AR simulations, thanks to the several tests performed with a sample of avid and non-avid users of these technologies, VR/AR developers and consultants can identify the elements that enhance or impact the level of immersion and interactivity achieved by the participants taking part in the simulations. According to both lead researchers of iB3, these tests are valuable since they can help to determine if sensorial stimuli, information codes, and locomotion metaphors are adequate for the virtual simulation that must be delivered to the hiring firm. Similarly, the VR/AR developer of Innoarea noted that these tests help to reduce cyber discomfort in users and to confirm if the participants can correctly perceive the brand cues and the commercial dialogues presented to them in the simulation, complying with the objectives previously traced by the hiring firms. However, the lead researchers and the research director from iB3 indicated that some VR/AR firms are more rigorous about performance and tracking metrics compared to other, newer firms currently offering similar technological services. The director of research stated that:

> "there is a lack of rigorous guidelines in the methodology used to analyze visualization technologies as a new mean of communication. There is a lack of unified protocols and standardized parameters to be used in the development of a simulation, an even less tracking metrics to measure engagement, immersion, sense of presence and so on".

While reviewing the transcripts and the extracts from the interviews, it was perceptible that most developers and consultants rely on observation and qualitative data (surveys and interviews to sample users) to assess design, level of immersion, and interactivity in the simulations. Only the VR/AR suppliers with strong research and academic background, such as iB3, LENI, and Quatechnion, have been using more sophisticated tracking systems as resources to quantitatively measure behavioral variables from participants' interactions in the simulations. These systems include: neurometrics, human behavior tracking (HMT), body or brain response (EEG and MRI), heart rate variability (HBT), or skin conductivity. The resulting quantitative data combined with other qualitative information (sourced from focus groups, questionnaires, etc.) help developers and consultants to more objectively identify the adjustments that need to be made to support and guarantee the delivery of successful simulations to the hiring firms.

(2) During the implementation of the VR experience with the target user, all the respondents concurred that firms use both objective and subjective arguments to measure the value obtained from these simulations. The CEO and the lead researcher from Innoarea explained to us that some firms from the 4.0 industries use VR simulations at industrial fairs to showcase and commercialize their products:

> "these reusable and adaptable VR simulations allow us to reduce cost or increase synergies, customers, or sales, all of which can be considered as value measurements". (see below point d)

The VR expert from Oarsis suggested that the insights gathered from customers interacting in their VR solutions could be considered objective arguments as well. Firms can identify the preferences and the functionalities relevant to the target customer. Similarly, firms can pinpoint the commercial messages that resonate better with the customers, thus helping their sales representatives in the development of more persuasive and assertive commercial dialogues to close a sale. Additionally, the VR experiential marketer from Oarsis mentioned that:

> "firms use other brand metrics to measure value such us brand awareness or engagement during the experiential simulation". (see below point c)

Firms using VR can be perceived as innovative, edgy, and trendy, providing a differentiated service to customers, positioning themselves ahead of the competition. However, it was expressed by most of the respondents that firms at the end of the day use their own criteria and subjective appreciations to assess the level of value obtained from a VR simulation. As it was indicated by a lead developer:

> "none of the numeric data proving success is relevant unless the executives of the hiring firm have a clear knowledge of what the technology is, and what it can accomplish in relation to their expectations and business objectives. They have to believe in VR and its potential to deliver value".

To sum up, all the respondents concurred that the hiring firms use a set of key performance indicators (KPIs) to measure value in accordance with the previously traced objectives and the types of simulations. These are:

(a) For prototyping and new product development, participants can experience, modify, and customize a product or a service during an interactive experience inside a simulation. For example, the chief marketing executive (CME) of Innoarea described how they had been working with the plastic provider of a chain supermarket, developing a "gaming experience" for customers and experts in supermarket planimetry. Some of the tasks performed by the participants included several decision-making processes regarding five plastic bottles placed in shelves and exhibitions. The inputs registered included color, shape, size, cap, and label designs. The CME stated that:

> "the responses were of great help to determine the best bottle design in terms of brand image, visualization, and space efficiencies"

Here, the value lays in the information registered by the service supplier and the hiring firms, insights that can be later included in the design and the production of tailored goods.

(b) Training solutions for new industrial processes in which Innoarea and iB3 have been developing VR/AR training and assistance solutions for two different firms, simulating the assembly tasks involved in the manufacturing of new vehicles. The VR experts from Innoarea and i3B explained that:

> "normally, when a new model is launched, a three-month training is imparted in a pilot production plant, so the personnel learn all the new production processes",
>
> And,
>
> "thanks to VR/AR this is no longer needed, with the use of a five-square-meter space, a helmet and commands, the training session could take place anywhere and anytime".

The registry of the operators' task completions in the simulation provides valuable data for the hiring firms that can help detect bottlenecks in the manufacturing process, save time, accelerate the learning curves of the employees, and significantly reduce costs of configuration and execution.

(c) Branded experiences in massive events involve the implementation of VR/AR experiential activations in concerts, sports events, and store openings, which can create higher affinity towards the brand that gives audiences the opportunity to experiment with these technologies. The VR expert and the experiential marketer from Oarsis concurred that people want to be part of the simulation and share their experience in all of their social media apps. The experiential marketer exemplified it:

> "we filmed 1600 consumers participating in the activations and gave them the clip as a gift for them to share with contacts in their network. Here the value was the branded content that reached more than half a million impacts in the first 10 days, becoming a form of indirect advertising at no cost for the hiring firm".

They also commented that, beyond the free publicity, firms use other metrics to measure the value generated from these experiential activations, such as brand awareness, affinity, engagement, and social media impressions.

(d) Product catalogs and exhibitions involve AR catalogs and VR rooms showcasing a list of products (tiles, machinery, etc.) and allow potential customers the opportunity to examine a variety of offerings in detail. For example, the CEO of Innoarea explained to us that some firms use VR/AR at industrial fairs to showcase and commercialize their products. As he stated:

> "international settings like these are pricey, of high demand, with reduced space, complex logistics and with high security standards"
>
> And
>
> "these constraints can be reduced with the utilization of VR/AR, where the potential customers have the opportunity to experience and manipulate products in simulated environments".

Here, firms and sales representatives can take notice of the customers' preferences in terms of design and functionality and identify the commercial messages that are of primary importance to them to make a purchasing decision. Moreover, these VR/AR simulations are reusable and adaptable and can be modified at any time for future needs. Consequently, cost efficiencies, synergies, and increase of potential leads and sales are some of the indicators used by the hiring firms to measure value.

Nevertheless, even though using VR can be perceived as innovative, edgy, and trendy and provides a differentiated service to customers or positions them ahead of the competition, it was expressed by the majority of the respondents that firms, at the end of the day, use their own criteria and subjective appreciations to assess the level of value obtained from a VR simulation. As it was indicated by a lead developer:

> "none of the numeric data proving success is relevant unless the executives of the hiring firm have a clear knowledge of what the technology is, and what it can accomplish in relation to their expectations and business objectives. They have to believe in VR and its potential to deliver value".

4. Conclusions

This research allows us to answer the RQ identifying two stages or moments where potential value can be generated and measured when utilizing VR/AR technologies in a B2B context. The first is during testing and development of VR/AR simulations. Here, most VR/AR suppliers use observation, questionnaires, and surveys applied to a sample set of users in order to validate if the simulations comply with the hiring firms' objectives. However, only VR consulting firms with strong research and academic background (e.g., university spin-offs) combine this qualitative data with more sophisticated tracking systems that enable the quantitative measurement of the various cognitive and behavior variables influencing participants' performance. Thus, further research is needed to develop standardization guidelines and protocols that guarantee the success of the simulations delivered to the hiring firms. The second moment where value creation can be measured is during the implementation of the VR/AR simulation with the target user. Depending on the simulation purposes (e.g., prototyping, training, experiential activations, and exhibitions), firms use different key performance indicators to assess value, such as insights from potential customers, brand awareness and affinity, social media reach, reduction in costs, savings in time and logistics, and increase in sales.

Firms as organizational entities determine what is considered of value in accordance with their business objectives, ideals, or values shared in their network (Figueiredo and Scaraboto 2016). As Gummerus (2013) explains, one party interprets the goodness of the activities performed by multiple parties based on their perspective, which could be a subjective and biased interpretation of what is valuable.

Limitations and Future Lines of Research

First, most of the evidence presented in this research's case study was exclusively qualitative (interviews, live demonstrations, firms' websites, academic articles, seminars, videos, etc.). Although the resulting findings were considered of value, it is limited, and its trustworthiness has to be properly appraised (Gillham 2000).

Second, the few cases used for analysis can place doubt in the objective substantiation of the dynamics involved in the co-creation of value though VR/AR technologies. The units of analysis and their offerings, ethics, and ways of working with firms may differ

from others in the same sector providing similar services. Therefore, to avoid a biased appreciation of what these technologies can objectively accomplish for firms, it is necessary to carry out more research exploring the point of view of the hiring firms and the target user.

Finally, the identification of the 4.0 industry as a cluster is relatively unexplored, even though their combined services and technological works can simulate spatial concentrations and provide the necessary resources and mechanisms to push and accelerate knowledge creation and dissemination between firms (Kiel et al. 2017), as with conventional clusters but without geographical limitations and at a faster pace (Götz and Jankowska 2017). Therefore, further exploration is required so firms from different industries and clusters can deploy the right means and adapt to this industrial transformation to fully take advantage of the benefits associated with this wide array of technologies.

Author Contributions: Conceptualization, M.R.-V. and M.V.S.; literature review, M.R.-V. and M.V.S.; methodology, M.R.-V.; results analysis, M.R.-V. and M.V.S.; discussion and conclusions, M.R.-V. and M.V.S.; writing—original draft preparation, M.V.S.; writing—review and editing, M.R.-V.; supervision, M.R.-V. Both authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix A.1. Script Followed IN In-Depth Semi-STructured Interviews

Appendix A.1.1. General Questions

1. Can you please tell me a little bit about the firm you work for and the type of projects you are currently working on utilizing VR?
2. Which kind of projects (simulations) would you say are the most demanded? How so?
3. What types of firms are using this type of simulation? Can you give me an example?
4. Do you actively recruit firms to use your services or do they approach your firm? How would you describe the process? Can you give me a few examples?
5. Do you think that firms' executives understand what VR is and what it can do in terms of business strategies? Yes? No? Why?
6. How would you describe the processes that follow the development and delivery of a VR simulation? How do you make sure that it complies with the hiring firm's expectations?

Appendix A.1.2. Specific Questions

7. In your experience, what are the main requirements for the development of a successful VR simulation? Can you please elaborate? Do you mind giving me examples?
8. Do you do any previous segmentation of the users participating in the VR simulation? If so, do what are the parameters? Can you please elaborate?
9. Would you say there is prior training or instructions imparted to the users before they take part in any simulation? If so, do you mind giving me a few examples?
10. What would you say are the factors influencing the way participants interact inside a VR simulation? Can you please elaborate? Do you mind giving me a few examples?
11. Do the activities performed by the participants inside the simulation are intuitive or somehow directed? How? Why? Can you please give me an example?
12. How do you make sure that the participants' actions comply with the research or business objectives set to be accomplished with the VR simulation? Can you please elaborate?

13. Are you implementing any sort of tracking system of the actions performed by the participants? If so, what kind? Can you please give me an example?
14. What kind of information or input do you get from the participants actions performed inside the VR simulation? What do you do with it? Can you please elaborate?
15. How do you determine if the inputs or information obtained from the VR simulation are of some sort of value? Would you mind giving me a few examples?
16. How do the hiring firms determine if the information that you have registered is of use to them? Can you please elaborate?

References

Alcañiz, Mariano, Bigné Enrique, and Jaime Guixeres. 2019. Virtual reality in marketing: A framework, review and research agenda. *Frontiers in Psychology* 10: 1530. [CrossRef]

Beverland, Michael, and Adam Lindgreen. 2010. What makes a good case study? A positivist review of qualitative case research published in Industrial Marketing Management, 1971–2006. *Industrial Marketing Management* 39: 56–63. [CrossRef]

Bezegová, Edita, Ledgard Marta A., Molemaker Roelof-Jan, Oberč Barbara Pi, and Alexandros Vigkos. 2017. Virtual Reality and It's Potential for Europe. Available online: https://ec.europa.eu/futurium/en/system/files/ged/vr_ecosystem_eu_report_0.pdf (accessed on 16 September 2018).

Boyatzis, Richard E. 1998. *Transforming Qualitative Information: Thematic Analysis and Code Development*. Thousand Oaks: Sage.

Breidbach, Christoph F., and Paul P. Maglio. 2016. Technology-enabled value co-creation: An empirical analysis of actors, resources, and practices. *Industrial Marketing Management* 56: 73–85. [CrossRef]

Cepeda-Carrión, Gabriel A. 2006. La calidad en los métodos de investigación cualitativa: Principios de aplicación práctica para estudios de casos. *Cuadernos de Economía y Dirección de la Empresa* 29: 57–82.

Chowdhury, Ilma. N., Gruber Thorsten, and Judy Zolkiewski. 2016. Every cloud has a silver lining—Exploring the dark side of value co-creation in B2B service networks. *Industrial Marketing Management* 55: 97–109. [CrossRef]

Dembek, Krzysztof, Singh Prakash, and Vikram Bhakoo. 2016. Literature review of shared value: A theoretical concept or a management buzzword? *Journal of Business Ethics* 137: 231–67. [CrossRef]

Dodgson, Mark, Gann David M., and Ammon Salter. 2007. The impact of modelling and simulation technology on engineering problem solving. *Technology Analysis and Strategic Management* 19: 471–89. [CrossRef]

Easton, Geoff. 2010. Critical realism in case study research. *Industrial Marketing Management* 39: 118–28. [CrossRef]

Figueiredo, Bernardo, and Daiane Scaraboto. 2016. The systemic creation of value through circulation in collaborative consumer networks. *Journal of Consumer Research* 43: 509–33. [CrossRef]

Gadde, Lars-Erik, and Hakan Håkansson. 2011. Interaction in networks. In *Handbook of Marketing Theory*. London: SAGE Publications Ltd., pp. 355–64.

Gillham, Bill. 2000. *Research Interview*. London: A&C Black.

Gottlieb, Udo, and Constanza Bianchi. 2017. Virtual trade shows: Exhibitors' perspectives on virtual marketing capability requirements. *Electronic Commerce Research and Applications* 21: 17–26. [CrossRef]

Götz, Marta, and Barbara Jankowska. 2017. Clusters and Industry 4.0–do they fit together? *European Planning Studies* 25: 1633–53. [CrossRef]

Gummerus, Johanna. 2013. Value creation processes and value outcomes in marketing theory: Strangers or siblings? *Marketing Theory* 13: 19–46. [CrossRef]

Habraken, Miliu, and Tanya Bondarouk. 2020. Embracing Variety in Decision-Making Regarding Adoption of Industry 4.0. *Administrative Sciences* 10: 30. [CrossRef]

Informe XR. 2018. Radiografia de la Realidad Virtual, Aumentada y Mixta en España. Available online: https://espacio.fundaciontelefonica.com/wp-content/uploads/2018/10/INFORME-XR_DEFINITIVO_23102018.pdf (accessed on 16 September 2018).

Jaakkola, Elina, and Tarru Hakanen. 2013. Value co-creation in solution networks. *Industrial Marketing Management* 42: 47–58. [CrossRef]

Kagermann, Henning. 2015. Change through digitization—Value creation in the age of Industry 4.0. In *Management of Permanent Change*. Wiesbaden: Springer Gabler, pp. 23–45.

Kiel, Daniel, Müller Julian, Arnold Christian, and Kai-Ingo Voigt. 2017. Sustainable industrial value creation: Benefits and challenges of industry 4.0. *International Journal of Innovation Management* 21: 1740015. [CrossRef]

Kohler, Thomas, Fueller Johann, Matzler Kurt, Stieger Daniel, and Johann Füller. 2011. Co-creation in virtual worlds: The design of the user experience. *MIS Quarterly*, 773–88. [CrossRef]

Kohtamäki, Marko, and Risto Rajala. 2016. Theory and practice of value co-creation in B2B systems. *Industrial Marketing Management* 56: 4–13. [CrossRef]

Lenney, Peter, and Geoff Easton. 2009. Actors, resources, activities, and commitments. *Industrial Marketing Management* 38: 553–61. [CrossRef]

Lorenz, Marcus, Rüßmann Michael, Waldner Manuela, Engel Pascal, Harnisch Michael, and Jan Justus. 2015. Industry 4.0: The future of productivity and growth in manufacturing industries. *Boston Consulting Group* 9: 54–89.

Madsen, Dag Ø. 2019. The emergence and rise of Industry 4.0 viewed through the lens of management fashion theory. *Administrative Sciences* 9: 71. [CrossRef]
Partanen, Jukka, Möller Kristian, Westerlund Mika, Rajala Risto, and Arto Rajala. 2008. Social capital in the growth of science-and-technology-based SMEs. *Industrial Marketing Management* 37: 513–22. [CrossRef]
Payne, Adrian F., Storbacka Kaj, and Pennie Frow. 2008. Managing the co-creation of value. *Journal of the Academy of Marketing Science* 36: 83–96. [CrossRef]
Ragin, Charles C., and Lisa M. Amoroso. 2011. *Constructing Social Research: The Unity and Diversity of Method*. Thousand Oaks: Pine Forge Press.
Ramaswamy, Venkat, and Kerimcan Ozcan. 2016. Brand value co-creation in a digitalized world: An integrative framework and research implications. *International Journal of Research in Marketing* 33: 93–106. [CrossRef]
Rodriguez-García, Teresa, Miguel Baños-González, and Mario Rajas-Fernández. 2015. Posibilidades de co-creación y comunicación de valores de marca en mundos virtuales. *Prisma Social: Revista de Investigación Social*, 222–73.
Salanitri, Davide, Lawson Glyn, and Brian Waterfield. 2016. The relationship between presence and trust in virtual reality. In Proceedings of the European Conference on Cognitive Ergonomics, Nottingham, UK, September 5–8; pp. 1–4. [CrossRef]
Spiggle, Susan. 1994. Analysis and interpretation of qualitative data in consumer research. *Journal of Consumer Research* 21: 491–503. [CrossRef]
Ungerman, Otakar, Dedkova Jarmila, and Katerina Gurinova. 2018. The impact of marketing innovation on the competitiveness of enterprises in the context of industry 4.0. *Journal of Competitiveness* 10: 132. [CrossRef]
Ustundag, Alp, and Emre Cevikcan. 2017. *Industry 4.0: Managing the Digital Transformation*. New York: Springer.
Vargo, Stephen. L, and Robert F. Lusch. 2011. It's all B2B...and beyond: Toward a systems perspective of the market. *Industrial Marketing Management* 40: 181–87. [CrossRef]
Vargo, Stephen. L, and Robert F. Lusch. 2016. Institutions and axioms: An extension and update of service-dominant logic. *Journal of the Academy of Marketing Science* 44: 5–23. [CrossRef]
Wedel, Michel, Bigné Enrique, and Jie Zhang. 2020. Virtual and augmented reality: Advancing research in consumer marketing. *International Journal of Research in Marketing* 37: 443–65. [CrossRef]
Yin, Robert K. 2009. *Case Study Research: Design and Methods (Applied Social Research Methods)*. London and Singapore: Sage.
Zhou, Keliang, Liu Taigang, and Lifeng Zhou. 2015. Industry 4.0: Towards future industrial opportunities and challenges. Paper presented at 2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD), Zhangjiajie, China, August 15–17; pp. 2147–52.