Exploring Sustainable VR Use Cases for Startup Business Models: A Customized Customer Development Approach

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Article

Exploring Sustainable VR Use Cases for Startup Business Models: A Customized Customer Development Approach

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Abstract: Recognized as key players in achieving the Sustainable Development Goals (SDGs), startups are increasingly poised to leverage Virtual Reality (VR) technology for impactful solutions. This study investigates the synergy between startups and VR in advancing SDG-related challenges, echoing previous assertions on startups' aptitude for SDG endeavors and VR's potential for SDG advancement. Through an exploration of VR's applicability in various domains such as Entertainment, Training, Education, and Tourism, this study unveils compelling use cases aligning with SDG aspects, thus validating the hypothesis on startups' potential to harness VR for SDG contributions. The study employs a customized customer discovery technique, an essential process in the Customer Development methodology, to uncover VR's problem-solution fit, offering practical insights for startup business model development. The implications of these findings extend globally, underlining VR's role in addressing SDG issues and laying a robust foundation for startup ventures. Despite its focus on specific consumer markets and sectors, the study's methodology presents a practical approach applicable to broader technology adoptions.

Keywords: Virtual Reality; VR; Use Cases; Sustainability; Startup Business Models; Customer Development; Customer Discovery

1. Introduction

Startups are poised to usher in Virtual Reality (VR) to contribute to addressing SDG issues. This initial conclusion is drawn from the assertion that "startups are the ideal organizations to tackle SDG-related challenges" [1] while acknowledging that "VR holds significant potential for advancing SDGs" [2]. The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030, all people will enjoy peace and prosperity. There are 17 integrated SDGs—they recognize that action in one area will affect outcomes in others and that development must balance social, economic, and environmental sustainability. Creativity, knowledge, technology, and financial resources from all sectors of society are required to achieve the SDGs in any context [3]. However, sustainability remains a global challenge, requiring individuals and businesses to change their behaviors and consumption patterns for sustainable development [4].

Entrepreneurship holds the potential to alleviate poverty, stimulate economic growth, foster innovation, and enhance social and environmental sustainability [5]. Startups, with their agility and innovation focus, are ideal organizations for addressing SDG-related challenges. When a startup generates revenue from transactions based on solving problems related to SDG targets, their impact and business become aligned. Given the exponential business potential of startups, identifying business opportunities within the scope of SDG targets will also yield exponential impacts. Startups' role can be crucial in addressing some of humanity's most pressing issues while generating significant financial value [1]. It is commonly known as problem-solution fit and product-market fit in the startup world.

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VR has emerged as one of the most exciting and innovative technologies in recent years. This technology not only transforms how we play games and watch films [6] but also holds potential beyond entertainment, reshaping how we work, learn, and interact with the world around us. VR has great potential to achieve the SDGs. Various studies and initiatives demonstrate that virtual reality can contribute to gender equality, educational advancement, and more. Although implementing new technologies like VR requires the development of appropriate infrastructure, they can contribute to addressing SDG issues relatively easily in developed countries [2].

Statista's report [7] indicates that VR adoption will increase with the growing use cases. Analysts from Statista expected healthcare services, workforce development, and manufacturing to be the sectors most disrupted by VR technology. Examples of VR usage include surgical training simulations, production operator simulations, and immersive classroom teaching experiences. As a result, the economic benefits of VR are expected to be felt worldwide and will continue to increase as use cases expand. However, analysis of the current market conditions indicates that no proven and widely accepted VR business models exist. This fact suggests a gap, as existing business models cannot be reliably deemed relevant to the market, potentially leading to business failures for adopters. The uncertainty surrounding business prospects is a fact of life for every business [8]. New businesses are always in a risky environment, whether in technology-based business models with entirely new customer approaches or franchise companies with solid business plans applied in new locations [9]. When deciding whether to invest in new technology, businesses are still determining if it will result in more excellent sales and profits, as there are factors beyond their control [8].

Managing innovation and validating business models is a challenge. Entrepreneurs face significant barriers in the early stages of creating and developing new ventures, such as finding potential investors and raising capital, transforming ideas into products/services, validating business models based on products, and scaling their businesses [9]. Despite all that, the development of sustainable business models is increasingly gaining attention in both literature and industry as companies seek ways to enhance their impact on the three pillars of sustainability—economic, social, and environmental (profit, people, and planet) [10]. The findings from previous literature reviews [11] provide additional evidence of this growing interest. The various studies mentioned highlight the importance of business model innovation in achieving sustainable performance for startups across different sectors, including digital technology, transportation, and the food industry. In the context of VR, research has shown many use cases for VR in various fields that have the potential to support SDGs, such as Education [12], Healthcare [13,14], Entertainment [15], and Training [16]. However, how this technology can be effectively adopted in the context of startup business remains a critical question. Who are the potential customers for VR? What business models can be adopted to leverage the potential of VR fully? Based on the series of studies outlined in the previous analysis, there appear to be no specific research findings that directly address these questions. Hence, these questions drive this study to explore VR use cases and how they can assist in developing business models for startups, particularly in addressing SDG-related issues.

The study by Ignat et al. [17] provides insights into developing VR business models and innovation theory, but it is limited to the medical industry. Additionally, the methods used are impractical for startups that tend to be Agile. A study by Brecht et al. [18] proposes the B2B Startup Experimentation Framework (B-SEF) to help reduce uncertainty in business model development. While not specifically addressing VR business models, the experimental approach is generally well-suited to the agile nature of startups. However, B-SEF has limitations, such as an excessive focus on customer desires and practical challenges in executing business experiments. In contrast, frameworks like the Customer Development Process by Blank & Dorf [19] are designed to explore and validate the entire business model [18]. In order to fill the gap, our study aims to explore VR use cases and their implications for startup business models, as well as discover a problem-solution fit that aligns with aspects of the SDGs. Our research questions (RQ) are as follows: "How is the VR business model with use cases that are problem-solution fit and aligned with SDGs aspects?". To answer this question, we adopt Steve Blank's Customer Development method [19]. To achieve our research objectives, we propose to focus on the search phase (customer discovery and validation), particularly

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emphasizing the customer discovery process. The essence of this process is to iterate quickly to turn assumptions into facts and find a problem-solution fit [19]. Given the challenge of identifying VR use cases that align with tested problem-solution fit aspects of SDGs, our study proposes a customized, practical, and systematic Customer Development approach.

2. Materials and Methods

This study was conducted at Shinra company, where an innovation team was formed to identify business opportunities by adopting new technologies, specifically VR technology. As a temporary organization, the team faced the same issue as this study, named the uncertainty of the VR business model, particularly in the Indonesian consumer market. The early-stage startup team was tasked with discovering and generating digital innovations with the potential to succeed in the Go-To-Market (GTM) phase and contribute to the SDGs while increasing company revenue.

This study employs a mixed-methods approach (quantitative and qualitative), collecting data through questionnaires, observations, and unstructured interviews. The collected data will be analyzed based on its type: quantitative data, such as questionnaire results, will be analyzed using descriptive statistical analysis, while qualitative data, such as interview results, will be analyzed using narrative analysis.

The research method adopts the Customer Development approach based on previous studies conducted by Brecht et al. [18]. However, due to time constraints, this study focuses solely on the customer discovery process rather than including the customer validation process. As shown in Figure 1, customer discovery emphasizes problem-solution fit, whereas customer validation pertains to product-market fit [20].

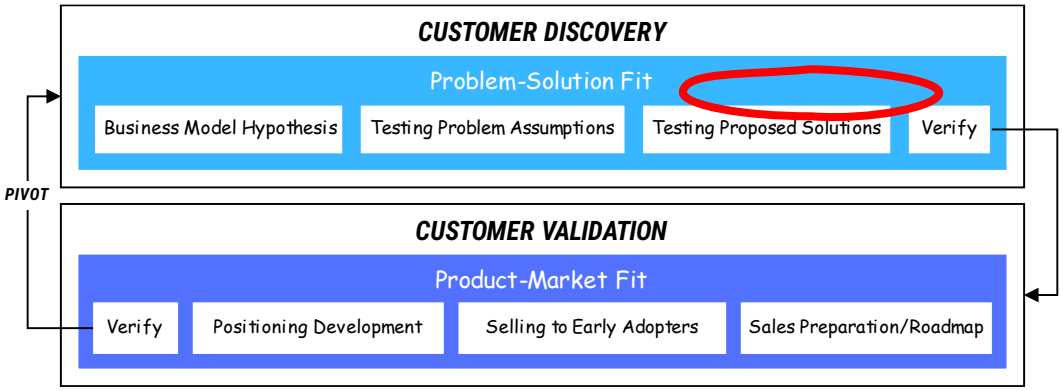

Figure 1. Customer Development process in the search phase.

Customer discovery aims to identify significant customer problems and build a Minimum Viable Product (MVP) [20]. Considering that the research challenge is to find VR use cases that align with SDGs aspects, the proposed steps will start by exploring existing use cases in the industry. The exploring is done through secondary data analysis using keyword search techniques on search engines, such as "Applications of Extended Reality/XR/Virtual Reality/VR/Mixed Reality/MR." This step employs a divergent thinking approach, where data is elaborated freely without strict evaluation, allowing for an organic and comprehensive flow of information from various sources, including scientific articles, reports, documents, websites, and previous surveys.

The next step is identifying and outlining the most promising VR use cases for further development using the SCAMPER method. SCAMPER, developed by Bob Eberle, stands for Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Reverse, a set of creative thinking techniques that encourage breaking away from traditional logic to generate innovative ideas [21,22]. The SCAMPER method is used in this study to formulate innovative ideas aligned with consumer market needs, particularly those targeting Generation Y and Z. The reason for choosing Generation Y and Z, or the "digital natives," is that they are individuals raised in a digital media-rich environment and show a significant dependence on smartphones in their daily routines [23], thus creating a consumer base ready to adopt VR technology.

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The designed use cases are then re-evaluated, considering their benefits and business aspects. The decision-making method used is the Plus Minus Interesting (PMI) model. Several researchers have found many benefits of PMI, the most significant being its assistance in decision-making [24]. It is called the PMI model because it requires critical thinking about an issue or idea and identifying what is considered "plus, minus, and interesting points" [25,26].

The proposed use cases are initially assumptions that need to be converted into facts, particularly from the underlying problem context. Therefore, this study uses the Jobs-to-be-Done (JTBD) framework to formulate problems based on each use case. Introduced by Harvard Professor Clay M. Christensen [27] and popularized by Anthony W. Ulwick [28], JTBD focuses on the understanding that customers buy products to complete specific tasks [29]. In this study, JTBD identifies the "jobs" or tasks customers need to accomplish for each proposed use case. Then, assumptions about potential problems for users in each job are identified and validated through questionnaires distributed to respondents representing the digital native generations. Each respondent is allowed to validate these assumptions, providing insights into the relevance and preferences of the respondents regarding the proposed problems. The questionnaire employed to validate problem assumptions included a 7-point scale to measure the relevance and importance of identified problems. The design of the scoring indicators can be seen in Table 1.

Table 1. Assessment indicators for validating customer problem assumptions.

Score	Label	Description
1	Irrelevant & Unimportant	Never experienced or known about it, and feel it does not need to be noticed and addressed.
2	Irrelevant & Somewhat Important	Never experienced or known about it, but if experienced or known, I would feel it somewhat important to be noticed and addressed.
3	Irrelevant & Important Enough	Never experienced or known about it, but if experienced or known, I would feel it quite important to be noticed and addressed.
4	Irrelevant & Important	Never experienced or known about it, but if experienced or known, I would feel it important to be noticed and addressed.
5	Relevant & Somewhat Important	I have experienced or known it occurs in the surrounding environment and feel it somewhat needs to be noticed and addressed.
6	Relevant & Important Enough	I have experienced or known it occurs in the surrounding environment and feel it is quite important to be noticed and addressed.
7	Relevant & Important	Have experienced or known it occurs in the surrounding environment and feel it is important to be noticed and addressed.

The questionnaire was first tested on 30 respondents to ensure its reliability. Cronbach's alpha was calculated to assess the internal consistency of the questionnaire items. A Cronbach's alpha value of 0.7 or higher was acceptable for establishing reliability. If the questionnaire met the expectations (i.e., at least one valid problem assumption for each proposed use case), it was then distributed to a larger sample of a minimum of 100 respondents. The problem-testing stage allows for iterative testing depending on the results, with targets achieved through descriptive statistical analysis.

The next step involves solution testing, which in this study involves creating an MVP as a product concept and testing it with participants from the previous questionnaire sessions. There are many debates about the use and idea behind MVPs, especially in the context of digital startups [30]. Despite ongoing debates, the essence of the MVP is the fastest way to get through the Build-Measure-Learn feedback loop with minimal effort [31], and its primary goal is solution testing. In this study, the MVP is built using a prototyping approach, specifically functional prototypes, while adhering to the principle of minimal effort. MVP data is collected through individual trials, participant

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observations, and unstructured interviews. Narrative analysis is conducted on observation results and interview transcripts to evaluate participants' responses and interactions with the MVP. Narrative analysis was chosen for its ability to interpret how the text is constructed systematically, revealing implicit meanings [32], thus providing a deeper understanding of participant responses to explore the significance of the findings in further product development.

The final step involves verifying the problems, product, and business model for the proposed VR use cases. Problem and product verification, in this case involving problem-solution fit analysis, will be documented in the Value Proposition Canvas (VPC) format. In contrast, business model verification will be documented in the Business Model Canvas (BMC) format. Both of these instruments were developed by Alex Osterwalder and Yves Pigneur [33,34]. Considering VPC is very business-oriented, with its main profit-oriented goal making it difficult to focus on impact-oriented solutions [35], this study proposes the use of the Sustainability Value Proposition Canvas (sVPC) by Denis Gillet et al. [35] (Figure 2), which is dedicated to SDGs with a focus on impact-oriented solutions.

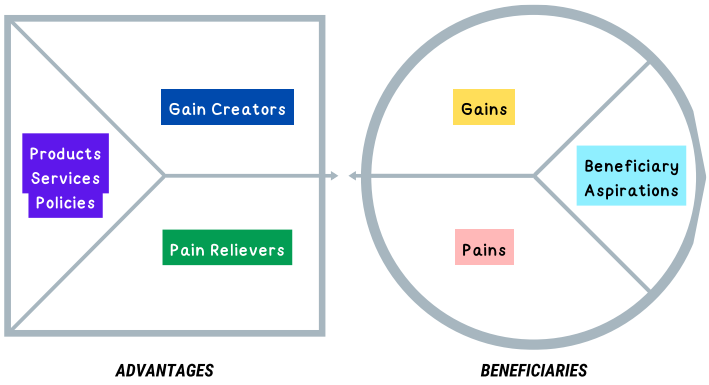

Figure 2. Sustainability Value Proposition Canvas (sVPC).

The business model formulation uses BMC, a strategic business planning tool described in the book "Business Model Generation" [36]. This tool allows companies to document current and desired future business models [37]. On the other hand, Gonçalo Cardeal et al. [10] proposed an extension of the BMC that incorporates sustainability aspects, called the Business Model Canvas for Sustainability (BMCS), which integrates all dimensions of sustainability comprehensively into a single canvas to ensure alignment and vertical coherence in business analysis. In our study, the BMC was also adjusted to follow the sVPC concept (Figure 3), namely in terms of vocabulary using the term "beneficiaries" instead of "customer." This adjustment highlights that the business model is focused on impact-oriented solutions aimed at assisting the community [35].

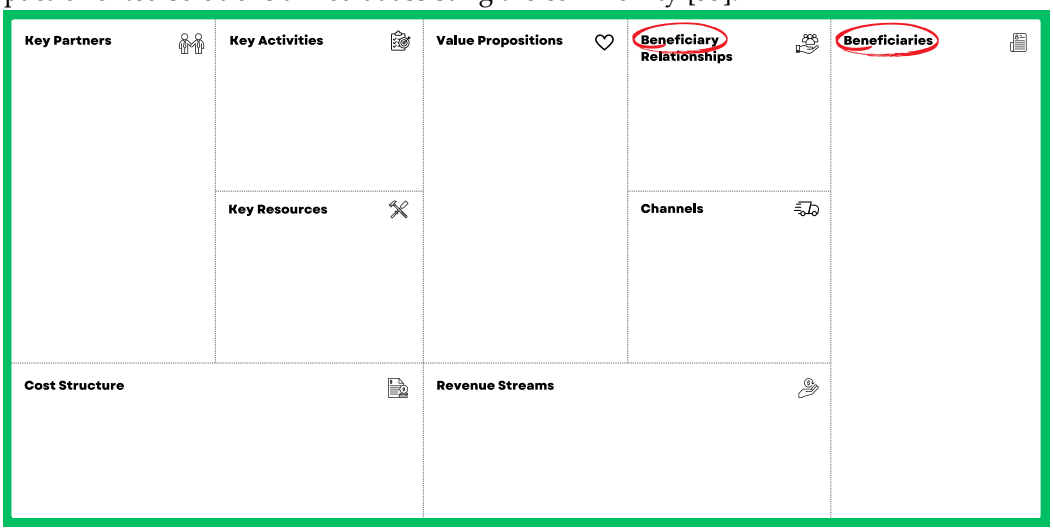

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Figure 3. Proposed Sustainable Business Model Canvas (sBMC).

Figure 4 illustrates this study's overall proposed customer discovery process techniques and its supporting instruments (methods, techniques, and tools used). Generally, this process is divided into three main stages: (1) Exploring Use Cases, (2) Feasibility Test, and (3) Business Model Generation, with five specific steps including: (1) Generating Ideas, (2) Idea Selection, (3) Problem Testing, (4) Product Concept Testing, and (5) Verify.

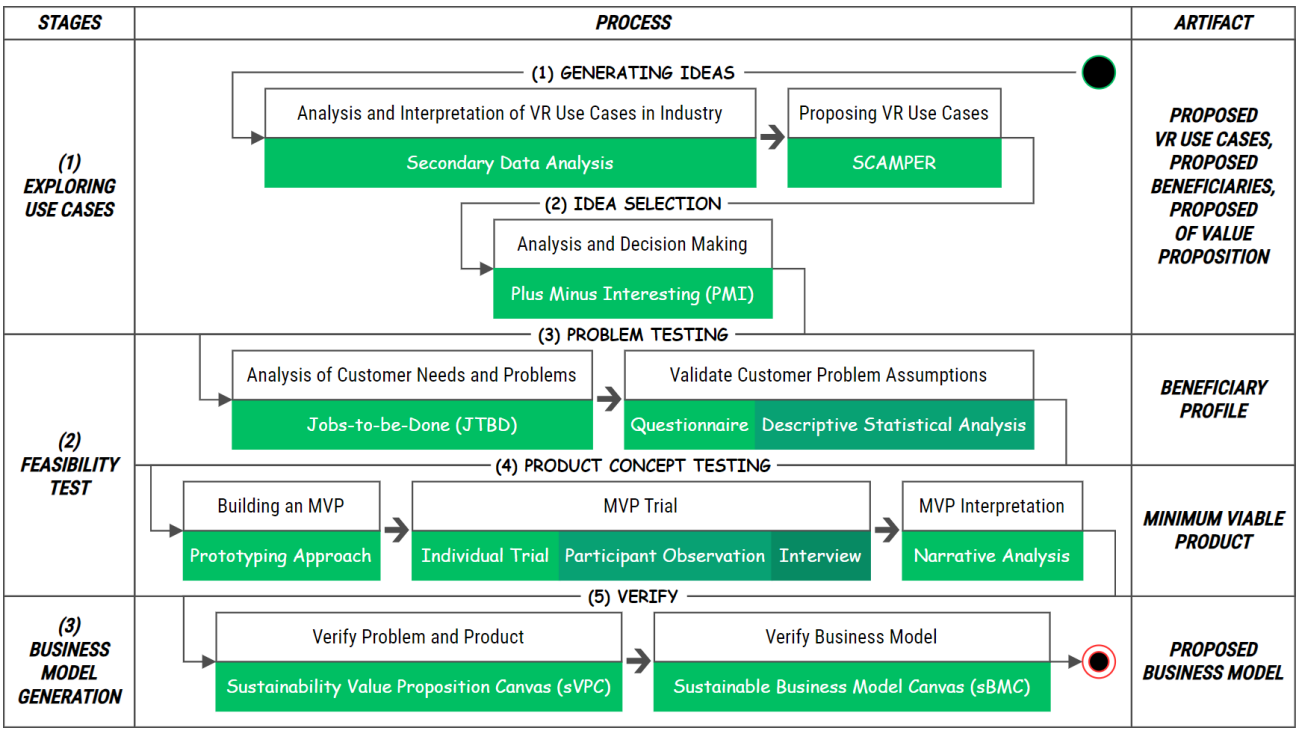

Figure 4. Proposed techniques on the customer discovery process.

3. Results and Analysis

The results of the study are presented in four sections, namely: (3.1.) Proposed VR Use Cases, Beneficiaries, Value Proposition, (3.2.) Beneficiary Profiles, (3.3.) Minimum Viable Product, and finally, (3.4.) Proposed Business Model.

3.1. Proposed VR Use Cases, Beneficiaries, Value Proposition

3.1.1. Proposed VR Use Cases

After employing a combination of methodologies, including secondary data analysis, SCAMPER, and PMI, this study successfully generated and curated a comprehensive list of VR use case ideas. The following Table 2 presents the culmination of these efforts, outlining the outcomes for the proposed use cases identified through our rigorous process.

Table 2. Proposed VR Use Cases.

Code	Actors	Description	Field	Source of Ideas	SDGs
U1	Individual, Professional	Conducting public speaking training simulations	Training	[16,38–45]	3, 4, 8
U2	Music fan	Attending concerts and festivals virtually	Entertainment	[46–51]	3, 12
U3	Individual, Family, Community	Experiencing the sensation of watching in a movie theater	Entertainment	[15]	3

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U4	Traveler	Exploring various hotels virtually for reservations	Tourism	[52]	3, 8
U5	Mental Patients	Conducting virtual private consultation sessions for mental health	Health	[13,14,53,54]	3, 5, 10, 16
U6	Individual, Community	Hanging out in a virtual café	Entertainment	[55,56]	3, 12
U7	Avid reader, Literacy activist	Exploring book collections and library facilities without the need for physical presence	Education	[12,57–59]	3, 4, 8
U8	Traveler, Surveyor	Reviewing tourist locations with a 360-degree panoramic view	Tourism	[60–67]	3, 12, 13, 14

Furthermore, a hypothesis was formulated (within the context of Customer Development theory) that implementing a VR application catering to various user groups, such as individuals, professionals, families, communities, and groups with specific interests, such as mental health patients and literacy activists, would enhance their experience by providing greater access, convenience, and deeper engagement. The alignment between problems and solutions (problem-solution fit) with VR technology will contribute to the achievement of SDGs 3, 4, 5, 8, 10, 12, 13, 14, and 16, demonstrating the potential of VR to offer impactful and sustainable solutions across various sectors.

3.1.2. Proposed Beneficiaries

Various user groups, including individuals, professionals, music fans, families, communities, travelers, mental health patients, and literacy activists, will benefit from VR applications by enhancing their experiences in public speaking training, virtual concerts, movie theater sensations, hotel explorations, mental health consultations, socializing in virtual cafes, exploring libraries, and reviewing tourist locations. These benefits will address their specific needs for access, convenience, and immersive experiences.

3.1.3. Proposed of Value Proposition

Virtual reality will transform the human experience by providing access, convenience, and immersive experiences in diverse aspects of life, such as public speaking, virtual entertainment, mental health, social interactions, education, and tourism. This transformation aligns with the Sustainable Development Goals (SDGs) 3 (Good Health and Well-being), 4 (Quality Education), 5 (Gender Equality), 8 (Decent Work and Economic Growth), 10 (Reduced Inequalities), 12 (Responsible Consumption and Production), 13 (Climate Action), 14 (Life Below Water), and 16 (Peace, Justice, and Strong Institutions).

3.2. Beneficiary Profiles

The proposed beneficiaries in this study are the Y and Z generations. The reason for selecting Generation Y and Z, commonly referred to as "digital natives," is because they are individuals who have been raised in a rich digital media environment and exhibit significant dependence on smartphones in their daily routines [23], thus creating a consumer base ready to adopt VR technology.

Table 3 details the results of the JTBD analysis for assumed beneficiary needs, formulated through reverse thinking for each proposed use case.

Table 3. JTDB analysis for assumed beneficiary needs.

Code	Needs	Type	Use Case
U1J1	Improve communication skills	Functional	**U1**
U1J2	Convey messages effectively	Functional	
U1J3	Advance career prospects	Functional	
U1J4	Build self-confidence	Emotional	

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U1J5	Reduce anxiety about speaking in front of an audience	Emotional	
U1J6	Gain respect and recognition from peers	Social	
U1J7	Enhance social standing	Social	
U2J1	Experience live performances	Functional	**U2**
U2J2	Access exclusive events and entertainment	Functional	
U2J3	Share memorable experiences with friends and community	Social	
U2J4	Engage with fellow fans	Social	
U3J1	Convenient access to a wide range of films	Functional	**U3**
U3J2	Enjoy high-quality entertainment	Functional	
U3J3	Bond with family and friends	Social	
U3J4	Create shared viewing experiences	Social	
U4J1	Find suitable accommodation	Functional	**U4**
U4J2	Ensure comfort and convenience during travel	Functional	
U4J3	Feel secure and satisfied with lodging choices	Emotional	
U4J4	Reduce travel-related stress	Emotional	
U4J5	Share travel plans and recommendations with others	Social	
U5J1	Manage mental health issues effectively	Functional	**U5**
U5J2	Feel understood and supported	Emotional	
U5J3	Reduce stigma associated with mental health	Emotional	
U5J4	Maintain relationships and social connections	Social	
U5J5	Receive support from loved ones	Social	
U6J1	Find a comfortable space for relaxation or work	Functional	**U6**
U6J2	Experience a pleasant ambiance	Emotional	
U6J3	Take a break from routine	Emotional	
U6J4	Socialize and connect with friends or colleagues	Social	
U6J5	Participate in social activities	Social	
U7J1	Access a wide range of books and resources	Functional	**U7**
U7J2	Utilize study and work spaces	Functional	
U7J3	Enjoy a quiet and focused environment	Emotional	
U7J4	Experience the joy of learning and discovery	Emotional	
U7J5	Engage with other readers and learners	Social	
U7J6	Participate in community events and discussions	Social	
U8J1	Explore new places and cultures	Functional	**U8**
U8J2	Plan and enjoy vacations	Functional	
U8J3	Feel excitement and adventure	Emotional	
U8J4	Break from everyday life and routines	Emotional	
U8J5	Share travel experiences with others	Social	

Next, Table 4 outlines everything that might inconvenience beneficiaries before, during, and after attempting to complete a task or simply hinder them from completing it [34].

Table 4. JTBD analysis for assumed beneficiary problems.

Code	Problems	Type	Use Case
U1P1	Lack of language proficiency	Functional	**U1**
U1P2	Limited access to public speaking practice venues [68]	Functional	
U1P3	Concerns about evaluation	Emotional	
U1P4	Lack of confidence due to unfamiliarity with the environment [68]	Emotional	
U2P1	Location constraints	Functional	**U2**
U2P2	Ticket quota limitations	Functional	
U2P3	Crowd density	Social	
U3P1	Film selection limitations	Functional	**U3**
U3P2	Social limitations	Social	
U3P3	Screen limitations	Functional	

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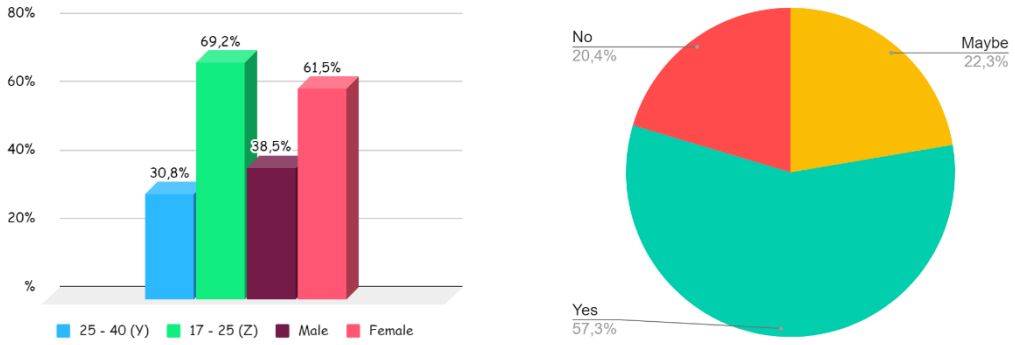
U3P4	Lack of special sensations	Functional	
U4P1	Location and facility uncertainty	Functional	**U4**
U4P2	Mismatch with expectations	Functional	
U5P1	Fear of judgment or stigma	Emotional	**U5**
U5P2	Discomfort in discussing personal issues	Emotional	
U5P3	Inability to adjust to schedule or availability	Functional	
U6P1	Discomfort due to crowded and noisy cafes	Emotional	**U6**
U6P2	Time pressure to vacate tables	Emotional	
U6P3	Limited space for privacy	Emotional	
U7P1	Stiff and unappealing atmosphere	Emotional	**U7**
U7P2	Time or opening hours constraints	Functional	
U7P3	Visit quota limitations	Functional	
U7P4	Complex book arrangement and indexing systems	Functional	
U8P1	Long queues	Functional	**U8**
U8P2	Crowding and congestion	Social	
U8P3	Uncertainty in accessibility	Functional	

Figure 5, which consists of parts (a) and (b), illustrates the demographics of respondents in the problem assumption validation questionnaire and their willingness to participate in the MVP trial. The sample (n = 104) consisted of Generation Y participants aged 25-40 and Generation Z participants aged 17-25, all hailing from Indonesia. Specifically, 69.2% of respondents belong to Generation Z, while 30.8% belong to Generation Y. The gender distribution further indicates that 61.2% are female and 38.8% are male, showing a notable skew with a significantly higher number of females and a more significant representation of Generation Z. Nevertheless, this distribution adequately represents the digital native generations and is justified given that all respondents are young individuals familiar with information technology. Additionally, Figure 5(b) shows that 57.3% of respondents are willing to participate in the MVP trial, 22.3% are undecided, and 20.4% are unwilling to participate.



(**a**) (**b**)

Figure 5. (**a**) Demographics of respondents in the problem assumption validation questionnaire; (**b**) Demographics of respondents in the willingness to become a participant.

The reliability coefficient (Cronbach's alpha) for participants' responses to the problem assumption validation survey ranged from 0.83 to 0.84 (Table 5). According to [69], which cites [70], the proposed satisfaction level is 0.70. Therefore, we can argue that the ratings given to the examined statements demonstrate high reliability [69].

Table 5. Descriptive statistics of the problem assumption validation questionnaire.

Problems	Min	Max	Mean	Std. Dev.	Cronbach's a	Use Case
U1P1	2	7	6,24	0,83	0,84	**U1**
U1P2	3	7	5,96	1,03	0,84	
U1P3	1	7	5,85	1,19	0,84	
U1P4	1	7	5,81	1,1	0,84	

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U2P1	1	7	5,18	1,67	0,83	**U2**
U2P2	1	7	5,52	1,56	0,83	
U2P3	1	7	5,44	1,59	0,83	
U3P1	1	7	5,63	1,53	0,83	**U3**
U3P2	1	7	5	1,86	0,84	
U3P3	1	7	4,93	1,91	0,83	
U3P4	1	7	5,03	1,83	0,83	
U4P1	1	7	5,9	1,28	0,83	**U4**
U4P2	1	7	6,06	1,19	0,84	
U5P1	1	7	5,53	1,53	0,84	**U5**
U5P2	1	7	5,61	1,39	0,84	
U5P3	1	7	5,44	1,48	0,83	
U6P1	1	7	5,81	1,16	0,84	**U6**
U6P2	1	7	5,49	1,55	0,84	
U6P3	1	7	5,49	1,51	0,84	
U7P1	1	7	5,35	1,66	0,84	**U7**
U7P2	1	7	5,47	1,46	0,83	
U7P3	1	7	5,38	1,38	0,83	
U7P4	1	7	5,76	1,26	0,83	
U8P1	4	7	6,09	0,81	0,84	**U8**
U8P2	1	7	6,13	0,99	0,84	
U8P3	3	7	6,15	0,87	0,84	

The findings of this study, as presented in Table 6, reveal varying levels of relevance attributed by respondents to each assumed problem. For instance, the issues represented by U1P1 and U8P3 are considered highly relevant, with 97.12% of respondents rating these issues as relevant. Similarly, U8P1 and U8P2 are deemed relevant by 96.15% of respondents, indicating a very high level of agreement regarding their significance. U1P3 and U1P4 also received high relevance ratings of 93.27% and 94.24%, respectively, underscoring their importance. Other issues, such as U1P2 and U6P1, are regarded as relevant by 90.38% and 90.39% of respondents, respectively, demonstrating substantial recognition of their significance. The issues U4P2 and U5P2 also received high ratings, with relevance scores of 91.35% and 87.50%, respectively, reflecting a strong consensus on their importance. Moderate levels of relevance were observed for issues like U2P1, U2P3, and U5P1, which are considered relevant by 78.85%, 79.81%, and 79.81% of respondents, respectively. Similarly, U6P3 and U7P1 received relevance ratings of 79.81% and 77.88%, respectively, indicating moderate recognition of their significance. Issues such as U3P2, U3P3, and U3P4 were rated slightly lower in relevance, with scores of 75.95%, 72.12%, and 75.96%, respectively.

Table 6. Percentage of problem assumption validation results.

Scores / Problems	1	2	3	4	5	6	7	Total Relevance
U1P1	0%	0,96%	0%	1,92%	9,62%	46,15%	41,35%	97,12%
U1P2	0%	0%	1,92%	7,69%	20,19%	32,69%	37,5%	90,38%
U1P3	1,92%	0,96%	1,92%	1,92%	23,08%	39,42%	30,77%	93,27%
U1P4	0,96%	0,96%	1,92%	1,92%	29,81%	35,58%	28,85%	94,24%
U2P1	4,81%	7,69%	3,85%	4,81%	25%	34,62%	19,23%	78,85%
U2P2	2,88%	4,81%	4,81%	4,81%	21,15%	30,77%	30,77%	82,69%
U2P3	3,85%	3,85%	4,81%	7,69%	20,19%	30,77%	28,85%	79,81%
U3P1	4,81%	1,92%	1,92%	2,88%	29,81%	23,08%	35,58%	88,47%
U3P2	10,58%	3,85%	5,77%	3,85%	27,88%	26,92%	21,15%	75,95%
U3P3	10,58%	4,81%	7,69%	4,81%	24,04%	25,96%	22,12%	72,12%
U3P4	7,69%	8,65%	3,85%	3,85%	25%	30,77%	20,19%	75,96%
U4P1	1,92%	0%	2,88%	9,62%	11,54%	34,62%	39,42%	85,58%

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U4P2	1,92%	0%	1,92%	4,81%	12,5%	35,58%	43,27%	91,35%
U5P1	3,85%	2,88%	1,92%	11,54%	17,31%	32,69%	29,81%	79,81%
U5P2	3,85%	1,92%	0,96%	5,77%	23,08%	39,42%	25%	87,50%
U5P3	2,88%	3,85%	4,81%	7,69%	18,27%	40,38%	22,12%	80,77%
U6P1	0,96%	0,96%	2,88%	4,81%	22,12%	38,46%	29,81%	90,39%
U6P2	2,88%	3,85%	7,69%	1,92%	23,08%	31,73%	28,85%	83,66%
U6P3	3,85%	0,96%	6,73%	8,65%	17,31%	35,58%	26,92%	79,81%
U7P1	4,81%	3,85%	6,73%	6,73%	19,23%	31,73%	26,92%	77,88%
U7P2	3,85%	0,96%	5,77%	8,65%	18,27%	39,42%	23,08%	80,77%
U7P3	0,96%	2,88%	8,65%	8,65%	23,08%	34,62%	21,15%	78,85%
U7P4	0,96%	0,96%	3,85%	10,58%	14,42%	37,5%	31,73%	83,65%
U8P1	0%	0%	0%	3,85%	17,31%	45,19%	33,65%	96,15%
U8P2	0,96%	0%	0%	2,88%	19,23%	33,65%	43,27%	96,15%
U8P3	0%	0%	0,96%	1,92%	19,23%	36,54%	41,35%	97,12%

Overall, the data reveals that most assumed problems are considered relevant and significant by the majority of respondents, indicating a strong recognition of these issues among digital natives. Supporting this argument, Figure 6 demonstrates that despite varying levels of importance based on respondent preferences, the sum of total relevance consistently reaches high percentages, with trends exceeding 75%.

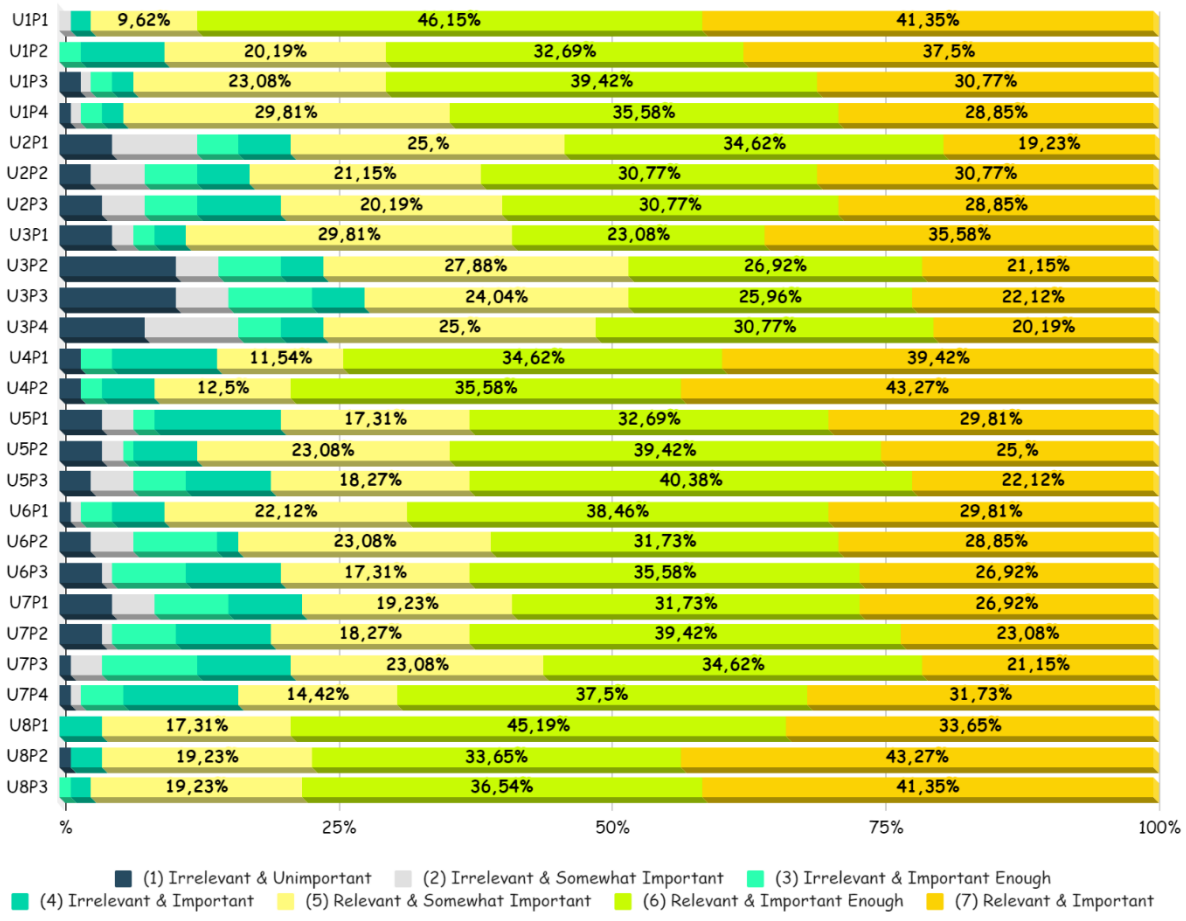

Figure 6. Percentage of problem assumption validation results.

3.3. Minimum Viable Product

A recapitulation of the solution testing design can be found in Table 7 below.

Table 7. Recapitulation of solution testing design.

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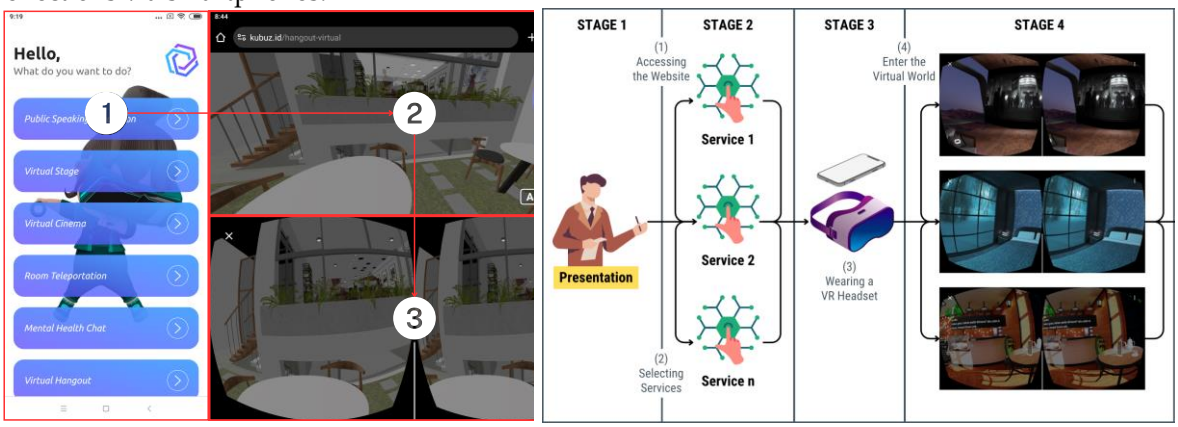
Element	Description
Development Instruments	A-Frame WebXR framework, Next.js, Sketchfab
Channel	Website
Operating system	Android, iOS
End User Devices	Mobile devices (Smartphones), VR Headsets—Virtual Reality 3D Glasses Smartphone Headsets (B*b* VR Z6)
Participants	6 participants represented the Generation Y group, 6 participants represented the Generation Z group, a total of 12 participants

The development of the MVP is supported by the WebXR A-Frame framework, Next.js, and the 3D asset platform Sketchfab. The MVP is accessed through a website compatible with mobile devices running on Android or iOS operating systems, as well as VR headsets such as Google Cardboard, specifically the B*b* VR Z6 used in this study. The participants involved in the testing comprise 12 individuals, consisting of 6 Generation Y participants and 6 Generation Z participants.

3.3.1. Demonstration

Figure 7(a) delineates the main flow of the MVP interface, commencing with the selection of service menus at number (1), proceeding to enter the chosen service at number (2), culminating in transitioning to virtual reality mode at number (3). Various service scenarios tested encompass public speaking simulation, virtual stage, virtual cinema, hotel room teleportation, personal consultations for mental health, hanging out in virtual cafes, accessing information through virtual libraries, and participating in live streaming of virtual tours. Each service scenario is crafted to address a range of previously validated issues. Meanwhile, Figure 7(b) presents a comprehensive overview of the journey undertaken by participants during the MVP trial. The process begins with an exposition of the proposed problems, accompanied by an explanation of how the MVP solution can address each problem. Each service is then elucidated to the participants, who actively explore each feature through the available menu. Subsequently, participants immerse themselves in the virtual world using VR headsets, experiencing an interface that presents stereoscopic visual scenes and audio reflections via smartphones.



(**a**) (**b**)

Figure 7. MVP demonstration (1): (**a**) MVP interface flow; (**b**) MVP trial journey for participants.

Figure 8 shows screenshots of the interface representing each service in the MVP. Figure 8(a) shows a public speaking simulation in stereoscopic mode designed for conducting public speaking training simulations. Figure 8(b) presents a virtual concert scene that offers participants an immersive experience, making them feel as if they are watching the concert from the front row. In Figure 8(c), there is a display of a virtual cinema scene providing participants with the experience of watching movies with an imaginative atmosphere and immersive sound. Figure 8(d) shows room teleportation in stereoscopic mode, allowing users to explore various hotels virtually for reservations. Figure 8(e) presents a scenario in a personal consultation situation for mental health therapy, with a relaxed atmosphere conducive to storytelling and light conversation. Meanwhile, Figure 8(f) depicts a virtual

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café scenario, providing a comfortable atmosphere conducive to working, completing assignments, or simply hanging out and meeting friends. Finally, Figure 8(g) illustrates a virtual library visit scenario. Meanwhile, Figure 8(h) depicts a real-time virtual tour scenario through a 360-degree video, seemingly guided by a tour guide.

Figure 8. MVP demonstration (2): (**a**) Public speaking simulation stereoscopic mode display (video asset source: https://shorturl.at/m0Apc); (**b**) Virtual stage concert stereoscopic mode display (video asset source: https://shorturl.at/BYCGs); (**c**) Virtual cinema stereoscopic mode display (3D model source: https://skfb.ly/6SWzw); (**d**) Room teleportation stereoscopic mode display (image asset source: https://shorturl.at/DO5TT); (**e**) Mental health chat scene display (3D model source: https://skfb.ly/oI8uY); (**f**) Virtual hangout scene display (3D model source: https://skfb.ly/6RsMK); (**g**) Virtual library scene display (3D model source: https://skfb.ly/6D8HF); (**h**) Live-streaming virtual tours scene display (3D model source: https://skfb.ly/ooWEo).

3.3.2. Reaction

While explaining and guiding participants in using the MVP during the trial session, active data collection was also conducted through direct observation as well as discussions and interviews. During the observation, several exciting aspects were noted, including variations in participants'

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responses to the VR experience. Some participants showed impressive reactions, expressing admiration for the technology they were experiencing, often stating how immersive and realistic the VR environments felt. These participants frequently commented on the potential of VR to revolutionize various fields, from education to entertainment. On the other hand, a few participants had more neutral or even critical responses, highlighting areas where the technology could improve. The average participant was able to endure using the VR headset for approximately 4 minutes continuously for one type of service. This duration was generally sufficient for users to engage meaningfully with each VR scenario, though it also highlighted the importance of optimizing user comfort in VR environments. Furthermore, two participants experienced nausea as a side effect during the session. This discomfort was possibly caused by delays in graphic movements or differences in perspective angles in the VR experience. Participants' statements such as "The graphics seem delayed when moving, which makes me dizzy" and "Watching a 360 video with perspectives not aligning with mine makes me feel nauseous" underscored the need for technical refinements to enhance the user experience. Further details about these findings can be seen in Table 8 below.

Table 8. MVP trial session observation results.

Findings	Description
Response Variation	Responses from participants varied, from impressive to critical.
Physical Endurance	On average, participants were able to use the VR headset for around 4 minutes without stopping.
Side Effects Nausea	Two participants experienced nausea, due to delays in graphical movement or differences in viewing angles.

3.3.3. Feedback

Feedback on the idea of enhancing public speaking training through VR simulations (U1) was predominantly positive. Participants expressed interest in improving the training environment. One participant stated, "In my opinion, if the situation of public speaking training can be enhanced, it would be good." Another highlighted the importance of interactive features, suggesting, "Avatars being able to do things like teasing and taunting, hehe, that could be utilized for a more realistic simulation." These suggestions emphasize the potential benefits of incorporating dynamic interactions and varied simulation scenarios to better meet training needs.

Participants voiced a common desire to attend concerts and festivals (U2) more easily, noting the challenge of securing tickets due to limited availability (U2P2). One participant shared, "Sometimes or even frequently, my friends and I want to attend concerts but don't get tickets due to limited availability." The idea of offering exclusive virtual tickets was met with approval, with another participant acknowledging, "I agree if there are exclusive tickets that allow us to experience the concert realistically, even from a distance." Enhancements such as high-quality streaming and interactive features were suggested to provide a realistic and engaging virtual concert experience.

The concept of experiencing movies in a virtual movie theater (U3) received positive feedback. Participants were intrigued by the idea of watching films differently, with one stating, "I find it interesting to watch differently." The immersive aspect and the ability to interact with other viewers in real-time were highlighted as appealing features. One participant suggested, "A more advanced version that allows for watching Korean dramas while directly interacting with other viewers in different locations could be quite appealing." Another participant asked, "Oh yes, sometimes I want to watch Netflix even though I only subscribe to Disney Hotstar. So, can I join someone who has a Netflix account and is currently watching using VR? So that I can watch along too." These suggestions indicate a strong interest in creating customizable and interactive viewing experiences (U3J3, U3J4).

Feedback regarding virtual hotel exploration for reservations (U4) was largely positive. Participants recognized the potential for VR technology to enhance travel planning reliability and comfort (U4J2, U4J3). One participant commented, "It can indeed be utilized for surveying tourist spots or hotels. Sometimes, I hesitate or feel disappointed when visiting a tourist attraction, even though it seems promising on YouTube. Perhaps with various immersive experiences with VR, it

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becomes more reliable, and we also feel more comfortable." Suggestions included developing immersive virtual tours of hotel facilities and tourist spots, with a focus on intuitive navigation and easy access to detailed information.

Participants expressed mixed feelings about VR-based mental health therapy (U5). While there were concerns about patients becoming too reliant on the virtual world, as one participant noted, "In my opinion, if the mental health therapy situation is developed and implemented, there's a concern that patients might become too comfortable with the VR world and refuse to interact with others in the real world," there was also recognition of potential benefits. Another participant acknowledged, "Certainly, due to its virtual nature, it becomes more flexible. Sometimes, it's also challenging to schedule consultations with doctors if it requires in-person meetings." Suggestions included integrating social engagement features and motivational prompts to encourage real-world interaction outside of therapy sessions.

The idea of virtual café experiences (U6) received positive feedback. Participants appreciated the concept of enjoying a café ambiance virtually. One participant suggested, "In my opinion, the café doesn't have to be entirely in 3D; it could also be a real café but with a 360-degree view." Another participant recommended incorporating ASMR content, stating, "It would be even better if the videos were ASMR, providing sensations when listening to soft sounds like the wind, finger tapping, coffee cup clinks, whispers, or brush sounds touching the microphone. Such content is highly popular on social media." These suggestions indicate a preference for realistic environments and engaging sensory experiences.

Participants had mixed reactions to the concept of virtual libraries (U7). While some viewed it as a gimmick, others recognized its potential value. One participant commented, "In my opinion, the concept of a virtual library is merely a gimmick. On Kindle, you just need to click for a quick search, and you can start reading immediately." However, another participant saw potential in the ambiance and events offered by virtual libraries, noting, "However, it's a different story if what's being offered is the ambiance of a library, reading spaces, or its events; for accessing content, it should still be on-demand and at least as comfortable as existing digital libraries." These suggestions highlight the importance of providing intuitive navigation (U7P4), comfortable reading spaces (U7J2, U7J3), and access to engaging content (U7J4).

Feedback on using VR for panoramic views of tourist locations (U8) was positive. Participants appreciated the potential for immersive exploration and virtual travel experiences. One participant shared, "It's very helpful to use if it is for requesting surveyor assistance or paying someone to review a place that I can't access." Another participant, who enjoys mountain climbing, suggested, "I enjoy mountain climbing; if possible, I'd also like to offer exclusive tickets for people who want to experience mountain climbing directly but with a 360-degree VR device." Additionally, a participant proposed enhancing user control, asking, "What about VR that's wirelessly connected to a camera at the destination and can be moved according to our eye direction?" These suggestions indicate a strong interest in customizable viewing experiences and user-generated content features.

3.4. Proposed Business Model

The verification of problem assumptions, solutions, and business models indicates that VR applications have significant potential to enhance user experiences across various fields, such as public speaking training, virtual concerts, movie-watching experiences, hotel exploration, mental health therapy, virtual cafes, virtual libraries, and panoramic tourism. Data collected from a sample of Generation Y and Generation Z participants in Indonesia reveals that most assumed issues are deemed relevant and significant by respondents, with recognition rates exceeding 75%. During the MVP trial, participants provided diverse feedback, ranging from admiration for the immersive VR technology to criticism of technical aspects needing improvement, such as graphic delays causing nausea. The average duration for continuous VR headset use was about 4 minutes, which was sufficient for meaningful engagement but highlighted the importance of optimizing user comfort. Overall, respondents demonstrated a strong interest in the proposed VR applications. They acknowledged VR's potential to revolutionize education, entertainment, mental health, social

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interactions, and tourism. For instance, the idea of enhancing public speaking training through VR simulations received positive feedback, with suggestions for more dynamic interactive features. The concept of exclusive virtual concert tickets and movie-watching in a virtual theater was well-received, with recommendations for high-quality streaming and interactive features. Virtual hotel and tourist spot exploration were seen as improving reliability and comfort in travel planning. Despite some concerns about VR-based mental health therapy, respondents recognized its flexibility and convenience. The virtual cafe and library concepts received mixed reactions, but there was an appreciation for realistic environments and engaging sensory experiences. All feedback and collected data were thoroughly documented in the Sustainability Value Proposition Canvas (sVPC) and the Sustainable Business Model Canvas (sBMC), highlighting VR's potential to provide impactful and sustainable solutions across multiple sectors. This aligns with achieving Sustainable Development Goals (SDGs) 3, 4, 5, 8, 10, 12, 13, 14, and 16.

3.4.1. Sustainability Value Proposition Canvas

The use of VR for public speaking training simulations (Figure 9) significantly supports SDGs 3, 4, and 8. For SDG 3 (Good Health and Well-being), VR helps reduce anxiety and boosts confidence [16,39,45], thus contributing to improved mental health. By providing a simulated environment where individuals can practice public speaking in a controlled setting, VR enables users to confront their fears and develop essential communication skills, ultimately enhancing their overall well-being. This aligns with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. Regarding SDG 4 (Quality Education), VR offers interactive and practical communication training, providing inclusive and high-quality educational programs [2,72]. Through immersive simulations, VR enables learners to engage in realistic scenarios and receive instant feedback, facilitating experiential learning and skill development. By leveraging VR technology for education, individuals from diverse backgrounds can access effective communication training, thus promoting educational equality and supporting the goal of ensuring inclusive and equitable quality education for all. For SDG 8 (Decent Work and Economic Growth), VR enhances employability and productivity by developing crucial public speaking skills, fostering better job opportunities and economic growth. By providing a platform for individuals to hone their communication abilities, VR contributes to the expansion of the economic scale related to virtual reality [2,73]. Improved public speaking proficiency not only increases individuals' competitiveness in the job market but also enhances their overall effectiveness in various professional settings, thereby supporting sustainable economic growth and promoting full and productive employment for all.

Figure 9. sVPC of public speaking simulation (U1).

The use of VR for attending concerts and festivals virtually (Figure 10) supports SDGs 3 and 12. For SDG 3 (Good Health and Well-being), VR enables safe and stress-free participation in live events,

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enhancing mental well-being and reducing the risk of injuries or exposure to illnesses. It also offers inclusive access [49] for individuals with disabilities, aligning with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. For SDG 12 (Responsible Consumption and Production), VR reduces environmental impacts like waste and carbon emissions from travel and large-scale event infrastructure, promoting more sustainable consumption and production patterns. By attending concerts and festivals virtually, participants can enjoy the experience without contributing to the environmental degradation often associated with physical events, such as littering and excessive resource use. This supports the goal of providing VR technology-based programs aimed at reducing food waste and decreasing post-harvest losses and other food losses in the production and supply chains [2,74].

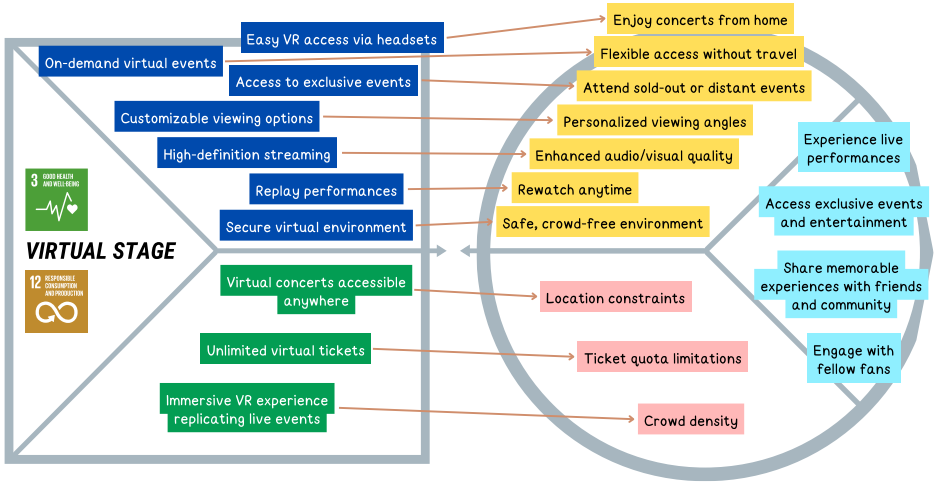

Figure 10. sVPC of virtual stage (U2).

The utilization of VR to replicate the sensation of watching movies in a theater (Figure 11) significantly supports SDG 3 (Good Health and Well-being) by enhancing accessibility and comfort. VR eliminates physical barriers, allowing individuals with mobility issues or health concerns to enjoy movies without constraints. This aligns with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. Additionally, VR promotes mental well-being by providing a private and immersive environment where viewers can escape the stressors of the outside world. This inclusivity and stress-reducing aspect of VR movie experiences can positively impact the mental health and overall well-being of beneficiaries, supporting the objectives of SDG 3.

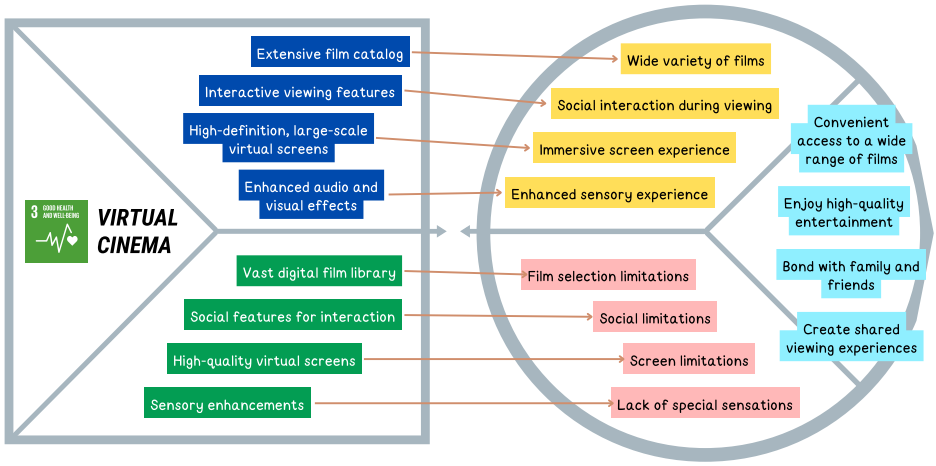

Figure 11. sVPC of virtual cinema (U3).

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The application of VR for virtual hotel tours (Figure 12) significantly supports SDGs 3 and 8. For SDG 3 (Good Health and Well-being), virtual tours allow travelers to assess accommodations remotely, reducing the need for physical travel and exposure to health risks. This aligns with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. By offering safer travel planning alternatives, VR enhances the well-being of beneficiaries, providing them with a secure and convenient way to explore hotel options without the stress and potential health risks associated with physical visits. For SDG 8 (Decent Work and Economic Growth), VR facilitates virtual exploration, which supports the growth of the tourism industry by making it easier for potential guests to explore hotel options. This contributes to economic development by creating opportunities for hotel businesses and promoting sustainable economic growth. The use of VR in the tourism sector can drive the expansion of the economic scale related to virtual reality [2,73], fostering innovation and increasing productivity within the industry. By enhancing the customer experience and making the hotel selection process more efficient, VR helps generate more business opportunities and supports the creation of decent work for all.

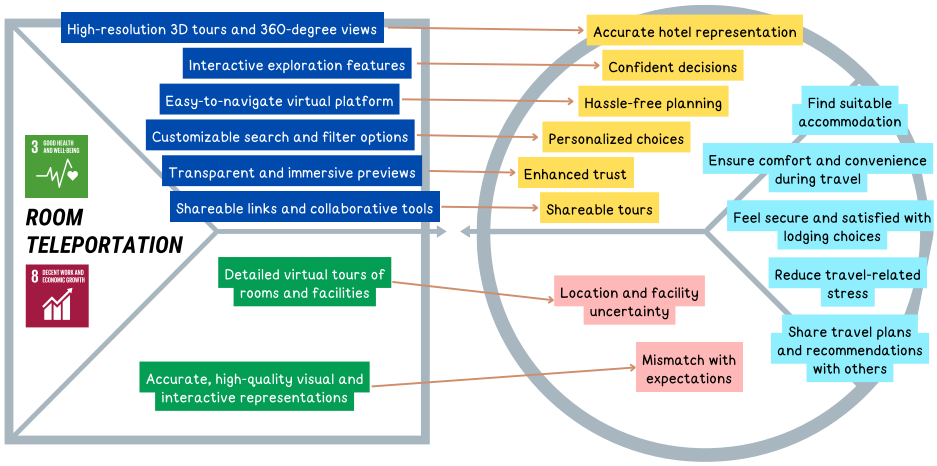

Figure 12. sVPC of room teleportation (U4).

The utilization of VR for virtual private mental health consultation sessions (Figure 13) significantly supports SDGs 3, 5, 10, and 16 by addressing various aspects of well-being and societal challenges. For SDG 3 (Good Health and Well-being), virtual consultations provide accessible and convenient mental health support, reducing barriers to seeking help and promoting early intervention. This aligns with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. Regarding SDG 5 (Gender Equality), VR consultations offer a safe and confidential space, mainly benefiting women who may face cultural or social stigmas in accessing mental health services. For SDG 10 (Reduced Inequalities), virtual sessions bridge the gap in mental health care access, ensuring individuals from marginalized communities receive the support they need regardless of location or socioeconomic status. This supports the goal of ensuring diversity in virtual reality spaces to reduce racial bias [2,75]. Finally, for SDG 16 (Peace, Justice, and Strong Institutions), VR provides a secure and private environment for mental health consultations, promoting the protection of individuals' rights and fostering inclusive societies. This technological application emphasizes the importance of redefining personal VR spaces to safeguard commercial and national interests [2,76].

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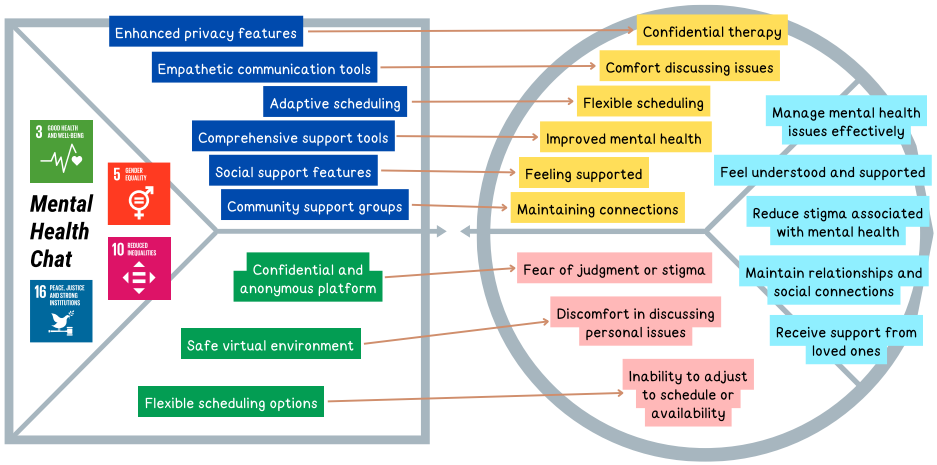

Figure 13. sVPC of mental health chat (U5).

The adoption of VR for socializing in virtual cafés (Figure 14) significantly supports SDGs 3 and 12 by enhancing individual well-being and promoting sustainable consumption patterns. For SDG 3 (Good Health and Well-being), virtual café experiences provide opportunities for social interaction and relaxation, which are crucial for mental health and social well-being. By offering a virtual space for socializing, VR cafés help reduce feelings of isolation and promote connections, thereby improving overall mental health among beneficiaries. This aligns with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. Regarding SDG 12 (Responsible Consumption and Production), virtual cafés present an eco-friendly alternative to traditional social venues, reducing the environmental footprint associated with transportation and waste generation. Many individuals' frequent cafés primarily for socializing, relaxation, or work purposes rather than solely intending to purchase food or drinks. However, conventional cafés often require customers to make purchases to access these social spaces. Virtual cafés address this by providing a space for social interaction without the need for physical consumption. By encouraging virtual socialization, VR helps foster more sustainable consumption patterns, supporting the goal of ensuring sustainable consumption and production. This approach aligns with the aim of using VR technology-based programs to reduce food waste and decrease losses in the production and supply chains [2,74].

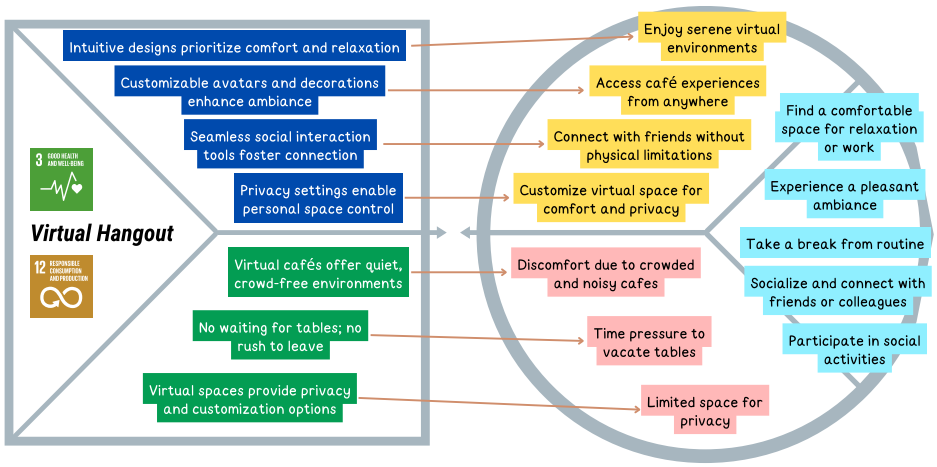

Figure 14. sVPC of virtual hangout (U6).

The use of VR to explore book collections and library facilities without the need for physical presence (Figure 15) significantly contributes to the achievement of SDGs 3, 4, and 8. Firstly, concerning SDG 3 (Good Health and Well-being), VR libraries mitigate health risks by providing

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access to educational resources without the need to be in crowded physical spaces, thereby promoting both mental and physical well-being. This aligns with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. Secondly, regarding SDG 4 (Quality Education), VR libraries offer universal access to education and literacy in an innovative and engaging manner. By providing immersive and interactive learning experiences, VR libraries facilitate inclusive and empowering learning opportunities that promote educational equality. This supports the need to provide educational programs using VR technology [2,72]. Lastly, in the context of SDG 8 (Decent Work and Economic Growth), VR libraries contribute to economic growth by enabling access to knowledge and skills relevant to the global job market. By providing virtual access to vast collections of books and resources, VR libraries empower individuals with the tools they need to enhance their skills and knowledge, thereby creating better job opportunities and enhancing productivity. This aligns with the expansion of the economic scale related to virtual reality [2,73], which is essential for sustainable economic development.

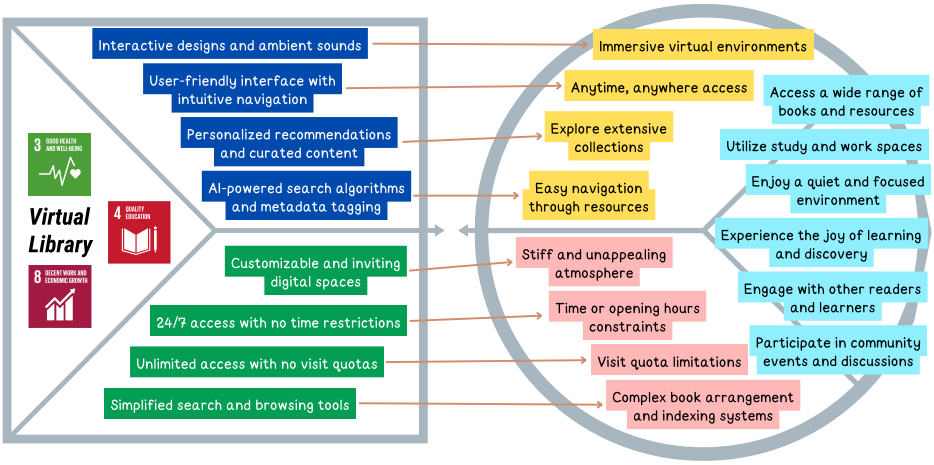

Figure 15. sVPC of virtual library (U7).

The tourism sector has frequently been criticized for its negative environmental impacts resulting from travel and activities at tourist destinations [77]. However, the utilization of VR for virtual tourism (Figure 16) significantly contributes to SDGs 3, 12, 13, and 14, promoting well-being and environmental sustainability. Virtual tourism offers accessible and immersive experiences, reducing stress and health risks associated with physical travel, thereby aligning with SDG 3 (Good Health and Well-being). This is in line with the goal of creating a digital virtual world where social and economic activities can be conducted safely and freely [2,71]. Moreover, by minimizing the environmental impact of traditional tourism, VR tourism supports SDG 12 (Responsible Consumption and Production) by reducing carbon emissions and promoting sustainable travel practices. Virtual tourism helps mitigate the carbon footprint associated with travel, contributing to efforts to combat climate change [2,78]. Additionally, virtual tourism plays a role in reducing waste generated by careless tourists. In virtual environments, visitors are not physically present to leave behind litter or produce waste, thus helping to preserve natural landscapes and ecosystems. This aspect of VR tourism aligns with the goal of conserving and sustainably using oceans, seas, and marine resources for sustainable development (SDG 14) [2,79].

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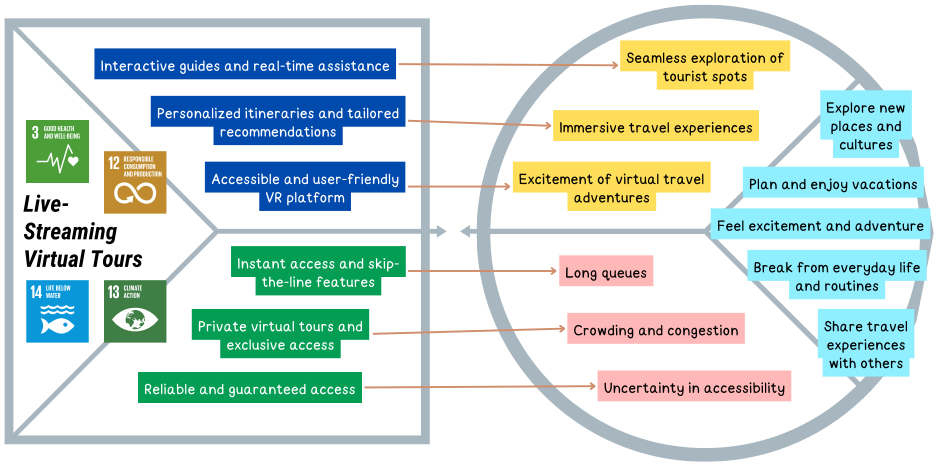

Figure 16. sVPC of live-streaming virtual tours (U8).

3.4.2. Sustainable Business Model Canvas

The proposed sBMC (Figure 17) provides support for the achievement of SDGs in various ways. The proposed business model presents a value proposition canvas stating: "Transforming human experiences through virtual reality to provide access, convenience, and immersive experiences across various aspects of life." This value proposition offers significant benefits to a diverse range of customer segments. Verified digital natives are key beneficiaries, including individuals looking to enhance their public speaking skills through online simulations, music enthusiasts enjoying virtual concerts, and movie fans seeking cinematic experiences from the comfort of their homes. Additionally, travelers exploring virtual hotel options, individuals seeking online mental health consultations, socializers gathering in virtual cafes, book lovers exploring virtual library collections, and tourists and surveyors interested in reviewing tourist locations with 360-degree panoramic views also benefit greatly. Overall, this business model contributes to several Sustainable Development Goals (SDGs), including SDGs 3, 4, 5, 8, 10, 12, 13, 14, 16, and 17. The value proposition particularly aligns with SDGs 3, 4, 5, 8, 10, 12, 13, 14, and 16 by addressing diverse needs and enhancing the quality of life for beneficiaries. Additionally, the key resources, key activities, and key partners identified within this business model contribute specifically to SDGs 8, 9, and 17. The primary activities of this business model include VR content development, digital platform management, marketing and promotion, partnership management, and customer support. These activities not only create new job opportunities but also drive innovation within the VR industry, supporting SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure). Furthermore, collaboration with key partners, such as technology companies, content producers, and marketing firms, strengthens the overall network and supports SDG 17 (Partnerships for the Goals), fostering a robust and innovative ecosystem.

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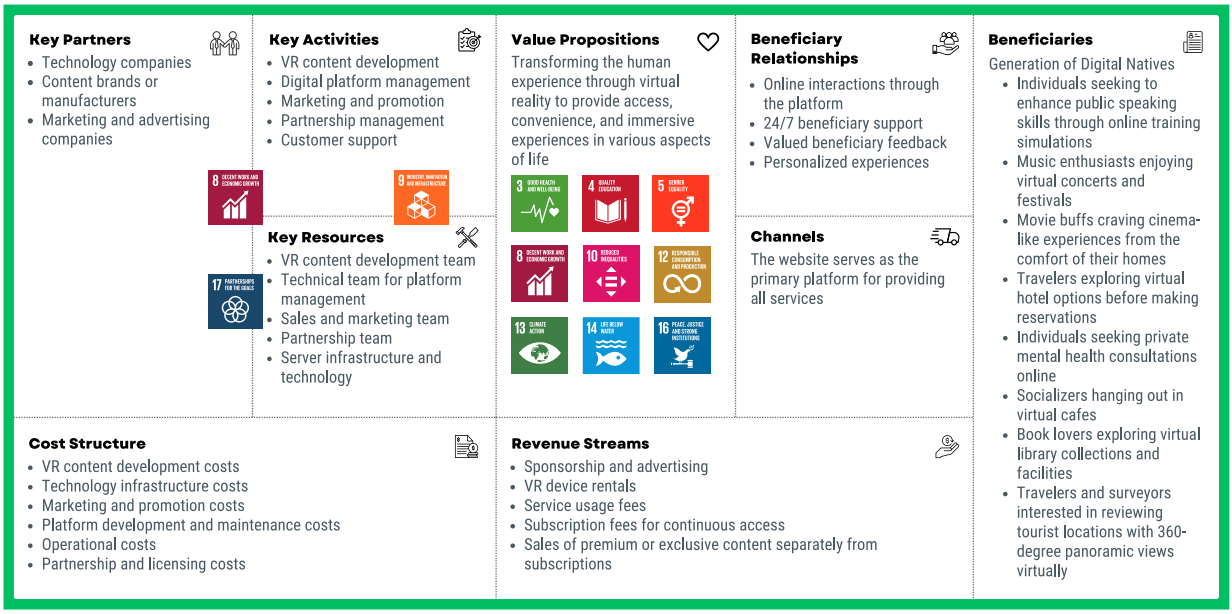

Figure 17. Proposed Sustainable Business Model Canvas (sBMC) for Startups.

4. Discussion

In this study, we explored various use cases of Virtual Reality (VR) and their implications for startup business models while seeking a problem-solution fit aligned with the Sustainable Development Goals (SDGs). The primary objective of this research was to address the question, "How is the VR business model with use cases that are *'problem-solution fit'* and aligned with SDGs aspects?"

We adopted a customized Customer Development method as the overarching framework for our research. This method, developed by Steve Blank [19], focuses our study on the customer discovery process. The process emphasized rapid iteration to turn assumptions into facts and identify a problem-solution fit. Our research process consisted of three main stages: Exploring Use Cases, Feasibility Tests, and Business Model Generation. Within these stages, we delineated five specific steps: (1) Generating Ideas, (2) Idea Selection, (3) Problem Testing, (4) Product Concept Testing, and (5) Verify.

Through this customer discovery process, we successfully identified various VR use cases with the potential to support SDG aspects. For instance, the use of VR for public speaking training (U1) could support SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 8 (Decent Work and Economic Growth). Our research findings indicate that VR holds significant potential to provide impactful and sustainable solutions across various sectors. By offering immersive, accessible, and comfortable experiences to beneficiaries, VR can serve as a powerful instrument in achieving sustainable development goals.

Furthermore, we developed sustainable business models based on our customer discovery findings. These business models were designed to support the implementation of identified VR use cases while ensuring economic and social sustainability. Our findings support the initial hypothesis that startups play a crucial role in introducing VR as a solution to SDG-related challenges. These results align with previous research indicating the significant potential of VR in advancing SDGs [2].

Overall, this study highlights the substantial potential of VR in offering sustainable solutions to global challenges. By applying the Customer Development approach, we successfully identified a problem-solution fit that aligns with the goals of sustainable development. The implications of these findings extend not only to the business world but also to global efforts to achieve SDGs. By harnessing the potential of VR to create innovative solutions, startups have the opportunity to become significant agents of change in addressing complex issues faced by the global community. Additionally, the customized customer discovery technique employed in this study has the potential to serve as a methodological foundation for future research aimed at identifying customers or beneficiaries for the adoption of new technologies. Thus, this research not only provides new insights

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into the potential of VR in supporting SDGs but also offers a practical framework for sustainable and impactful business innovation.

5. Conclusions

In this study, several use cases of VR significantly have the potential to support startups in building business models that are problem-solution fit while aligning with SDG aspects. These findings support our hypothesis that startups are poised to usher in VR to contribute to addressing SDG issues. Our results are consistent with previous research stating that startups are the ideal organizations to tackle SDG-related challenges [1] and that VR holds significant potential for advancing SDGs [2]. Therefore, these findings successfully address questions regarding how this technology can be effectively adopted in the context of startup businesses, such as who the potential customers for VR are, what business models can be adopted to leverage the potential of VR fully, and how VR can assist in developing business models for startups, particularly in addressing SDG-related issues. The implications of these findings are significant on a global scale, especially for the business world. VR use cases that are problem-solution fit can have a positive impact on resolving SDG issues and provide a strong foundation for startup business models. Moreover, the customized customer discovery technique employed in this study is practical and can be widely used in studies aimed at finding customers or beneficiaries for any technology adoption. However, this study has several limitations. It only explores VR use cases in the fields of Entertainment, Training, Education, and Tourism, so the results may not fully apply to other business sectors. Additionally, the study is limited to consumer markets specifically targeting Digital Native Generations (Y and Z), which may not reflect the interests or needs of other market segments. For future research, it is recommended to investigate the business potential of VR in various market types (B2C, B2B, etc.) and a broader range of target beneficiaries. Further studies are also needed to validate and understand the purchase intentions underlying customers as beneficiaries regarding the benefits of VR technology.

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