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Enhancing International B2B Sales Training in the Wine Sector Through Collaborative Virtual Reality: A Case Study from Marchesi Antinori

Irene Capecchi ¹, Tommaso Borghini ¹, Danio Berti ¹, Silvia Ranfagni ² and Iacopo Bernetti ^{3,*}

¹ PerLab, PIN S.c.r.l.—Educational and Scientific Services for the University of Florence, Prato Campus of University of Florence, Piazza Giovanni Ciardi, 25, 59100 Prato, Italy; irene.capecchi@unifi.it (I.C.); tommaso.borghini@pin.unifi.it (T.B.); danio.berti@unifi.it (D.B.)

² Department of Economics and Management (DISEI), University of Florence, Via delle Pandette, 32, 50121 Florence, Italy

³ Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, Piazzale delle Cascine, 18, 50121 Florence, Italy

* Correspondence: iacopo.bernetti@unifi.it

Abstract: This study aims to identify and evaluate the essential design features, strengths, and limitations of a virtual reality (VR) application that has been developed to train an international sales force effectively for a premium global wine brand. The study emphasizes the value of stakeholder-driven iterative development and systematic evaluations. A case study methodology was adopted for the research, focusing on a VR training application, developed for Marchesi Antinori. The Scrum framework was employed to facilitate iterative stakeholder collaboration. A qualitative evaluation was conducted using focus groups, comprising marketing, communications, and sales representatives. A systematic application of natural language processing (NLP) embedding techniques and recursive clustering analyses was undertaken to interpret stakeholder feedback. The findings suggest that stakeholder-driven, iterative processes can significantly enhance the effectiveness of VR applications by providing a clear structure for immersive storytelling that focuses on terroir characteristics, vineyard operations, and cellar practices. Stakeholders acknowledged the potent educational benefits of VR in regard to business-to-business (B2B) sales training. However, they also highlighted significant limitations, including user discomfort, concerns about authenticity, and variations in market receptivity. Alternative immersive technologies, including augmented reality and immersive multimedia environments, have emerged as valuable complementary approaches. This study addresses a significant gap in the literature by examining the application of VR technology for B2B sales training in the premium wine industry. The study integrates an iterative Scrum methodology with advanced natural language processing (NLP) analytical techniques to derive nuanced, context-rich insights.

Keywords: virtual reality; B2B sales training; wine industry; scrum methodology; stakeholder-driven development; NLP embedding; qualitative analysis; international markets



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1. Introduction

In the contemporary global wine market, which is characterized by rapid evolution, the performance of a premium wine brand is contingent on the competence, adaptability, and cultural intelligence of its sales force. The capacity of sales professionals to articulate the distinctive value proposition of high-end wines, encompassing factors such as terroir

influences, production methodologies, heritage, and brand narrative, has emerged as a strategic competitive factor. This is particularly salient in international markets, where cultural variations and consumer expectations can be significantly divergent.

Conventionally, the training of wine sales personnel has been predominantly reliant upon in-person visits to vineyards and cellars, with the objective of facilitating experiential learning and the acquisition of comprehensive product knowledge. Nevertheless, this model poses considerable logistical and financial challenges, particularly for sales teams with a global presence. The advent of the pandemic further exposed the fragility of traditional face-to-face training formats, thereby accelerating the need for scalable, flexible, and immersive learning solutions. This shift has prompted the exploration of virtual reality (VR) as a medium for delivering high-impact training that is location independent, while maintaining the authenticity and emotional resonance of the wine experience.

Recent studies have documented the growing use of VR in consumer-facing applications, such as wine tourism [1], wine education [2], and marketing experiences [3]. However, research on VR's role in B2B sales training remains scarce. In the broader business-to-business context, however, the application of VR in regard to enhancing knowledge retention, engagement, and relational dynamics has been demonstrated to be promising [4,5]. Nevertheless, its application in the premium wine sector, which demands nuanced storytelling and deep cultural understanding, remains unexplored.

The existing literature provides valuable insights into the potential of virtual reality (VR) in regard to consumer education and marketing. However, there is a dearth of literature addressing the unique needs of international business-to-business (B2B) wine sales teams. These teams require not only technical product knowledge, but also the ability to communicate about brand heritage and terroir in culturally adaptive ways. Furthermore, there is a paucity of evidence regarding the combination of iterative development methodologies, such as Scrum, with advanced NLP-based evaluation techniques to systematically optimize VR training applications in this sector.

The objective of this study is to address the identified gap in the literature by examining the design, development, and evaluation of a stakeholder-driven virtual reality (VR) training application, tailored to the needs of the international sales force at Marchesi Antinori, a leading premium wine brand. The specific aims of this research are as follows:

1. To identify the essential design features and characteristics required for a VR application, developed through iterative and stakeholder-driven processes, to effectively support the training of an international B2B wine sales force;
2. To develop and apply objective and flexible evaluation methodologies for the systematic assessment of the strengths, limitations, and overall effectiveness of integrating VR applications into the training strategies for premium international wine brands;
3. To investigate the perceived opportunities, limitations, and practical implications of adopting VR technology for B2B training within the global wine industry, based on in-depth stakeholder feedback and advanced analytical techniques.

The following sections in this paper present a comprehensive analysis of VR as an innovative solution, including its strengths, limitations, and practical implications for the wine industry. The present study employs a collaborative, iterative development process, guided by stakeholder engagement, to ensure the resulting VR solution effectively meets the specialized needs of international B2B wine sales training.

2. Literature Review

This section provides a comprehensive review of the existing literature at the intersection of sales force training in the wine industry and emerging applications of VR technologies in both consumer and B2B contexts.

The review begins by examining how VR is currently leveraged to enhance consumer engagement, wine education, and brand storytelling within the wine sector, with a particular focus on experiential marketing and immersive sensory learning. It then explores recent trends and challenges in the training of wine sales professionals, highlighting the evolving competencies required for effective B2B sales in international markets and the potential role of VR in addressing these needs. Finally, the review discusses the broader impact of VR on B2B customer experience management and sales training, drawing insights from cross-sector research on immersive technologies in business contexts.

Together, these perspectives inform the identification of a critical research gap regarding the use of VR for training international B2B sales teams in the premium wine industry, a gap that this study aims to address.

2.1. Virtual Reality as an Experiential Tool for Wine Consumer Engagement

VR is increasingly recognized as a transformative tool in regard to consumer wine education, particularly in enhancing sensory learning and immersive brand engagement. By replicating real-world environments, VR enables experiences wherein experiential knowledge is key. Research shows that VR-based wine tasting environments can significantly shape consumer perceptions of aroma, taste, and overall acceptability, thereby influencing their sensory preferences and enjoyment [6].

In the domains of wine tourism and marketing, VR contributes to strengthening emotional connections between consumers and wine brands. Virtual experiences have been shown to stimulate consumer interest in visiting vineyards and participating in wine-related activities, offering users immersive access to vineyard landscapes, winemaking processes, and brand narratives [1]. These applications not only enrich consumer education, but also enhance the perceived authenticity of wine brands.

Further, VR's effectiveness in professional training contexts, such as sommelier education, highlights its broader potential. Immersive simulations have been found to improve users' recall of detailed product knowledge and foster a deeper appreciation for the complexities of wine tasting, benefits that could extend to consumer-facing applications [2]. The role of social presence within VR environments also emerges as a key factor: by supporting virtual interactions, VR enhances consumer engagement and brand loyalty, positioning it as a valuable experiential marketing tool [7].

Moreover, VR has demonstrated strong potential in regard to creating memorable and emotionally engaging consumer experiences. Virtual wine tours and tastings are shown to increase users' sense of presence and sensory involvement, with positive impacts on purchasing decisions and brand affinity [3]. These immersive experiences also build consumer trust and satisfaction, reinforcing emotional ties with wine brands [1].

2.2. Emerging Trends in Sales Force Training

Sales capabilities represent a critical driver of success in the wine industry, particularly given the complexity of distribution channels and the diversity of customer profiles, which include retail managers, sommeliers, and distributors [8]. Existing research consistently underscores the need for sales personnel to combine general sales expertise with deep knowledge of viticulture, enology, and brand heritage to effectively communicate value in international markets. In this context, key trends have emerged that shape the evolving landscape of sales capability development: continuous learning, the integration of technical and interpersonal skills, specialization in niche areas, and the growing emphasis on structured training programs [8].

Despite this evolution, current training practices often remain fragmented. Much of the literature to date has focused on on-the-job learning within hospitality settings, where

structured programs have been shown to enhance the ability of sales staff to convey wine attributes and engage customers [9]. However, formalized training approaches specifically targeting international B2B sales teams are still lacking, highlighting a clear need for scalable and innovative solutions.

VR emerges as a promising tool to address this gap, offering interactive, repeatable, and cost-effective learning environments. The demand for scalable knowledge transfer and the ability to simulate authentic brand experiences aligns well with the strengths of VR-based approaches [10]. By enabling sales personnel to explore digital reconstructions of vineyards, winemaking processes, and brand heritage, VR can complement and extend traditional training formats.

Moreover, the literature increasingly recognizes that effective wine sales training must not only focus on individual learning, but also foster collaboration within professional networks. Studies of the New Zealand wine industry illustrate how firms leverage business relationships to enhance strategic competencies, suggesting that VR-based training could further support remote collaboration and experiential learning within geographically dispersed sales teams [11]. Relationship building remains central to long-term success in regard to premium wine sales, reinforcing the value of training approaches that strengthen trust and brand loyalty [10].

Beyond the wine sector, research on VR in B2B contexts demonstrates its capacity to transform buyer–supplier coordination, improve knowledge retention, and enhance customer relationships [4,12]. In particular, immersive learning environments have been shown to boost conceptual understanding, self-efficacy, and engagement, factors that are directly relevant for the development of high-performing international sales teams [12].

2.3. The Impact of Virtual Reality on the B2B Customer Experience and Sales Training

In addition to its role in internal training, VR is increasingly recognized as a powerful enabler of enhanced customer experiences within B2B relationships. In the context of customer experience management, VR supports remote product demonstrations, interactive sales presentations, and the development of stronger buyer–supplier relationships, particularly in industries where physical site visits are impractical [5]. These immersive interactions help bridge geographical barriers and foster deeper engagement between firms and their clients.

This trend aligns with the broader digital transformation occurring across B2B markets, where VR is playing a pivotal role in reshaping sales and marketing practices. The ability of VR-driven presentations to provide potential buyers with immersive product experiences has been shown to enhance decision making and strengthen relational dynamics between business partners [13].

Furthermore, the effectiveness of VR-based training is well-supported by emerging research. Immersive learning environments, such as those developed within the industrial metaverse, are demonstrating clear advantages in regard to promoting engagement and knowledge retention. These environments make complex technical concepts more accessible to sales professionals working with sophisticated, high-value products [14]. The impact of immersion on learning outcomes is further underscored by comprehensive reviews of VR in educational contexts, which highlight its capacity to foster active interaction, deep understanding, and improved training results, critical attributes in B2B sales environments, where in-depth product expertise and persuasive communication are key [15].

Beyond its application in training, VR also contributes to enhancing sales force efficiency and customer relationship management (CRM). The integration of VR with advanced CRM systems offers new opportunities for delivering real-time insights, enabling remote collaboration, and creating engaging, interactive sales experiences. These capabilities not

only support more effective customer engagement, but also streamline problem solving and decision making within complex sales operations [16].

2.4. Research Gap and the Aim of This Study

Virtual reality (VR) has emerged as an interesting alternative, offering realistic and immersive simulations of remote locations and winemaking processes. Studies have shown that VR is effective in regard to consumer contexts, particularly in wine marketing, where it provides interactive, memorable experiences [16]. Despite these promising results, research on the use of VR for training staff to sell high-end wines in an international B2B context remains limited. Most studies have focused on B2C applications, such as tourism, tastings, and consumer engagement. However, the specific needs of global sales teams have not been addressed. In high-end markets, where transmitting terroir, cultural heritage, and technical expertise is essential for product differentiation, there is a clear absence of structured, VR-based teaching strategies. Such strategies could support the development of advanced skills in areas such as the history and tradition of winemaking, an understanding of climatic variables, and the relationship between viticulture and landscape. Addressing this gap is essential to realizing the full potential of VR in supporting the international positioning of premium wine brands. However, the role of VR in business-to-business (B2B) sales training, particularly in equipping international sales teams with the technical, cultural, and experiential knowledge necessary to sell premium wine brands, remains under researched. VR has the potential to overcome cost and accessibility barriers, enabling geographically dispersed staff to virtually explore vineyards, observe production methods, and experience estates' historical atmosphere. This paper examines the design and implementation of a collaborative VR application that has been developed for the international sales force at the renowned winery, Marchesi Antinori, to fill this gap. Our research focuses on identifying key features that enhance VR's effectiveness in regard to professional wine industry training, as well as methodological approaches to rigorously evaluate its advantages and limitations. Our analysis contributes to the literature on immersive technologies in the wine industry and offers practical insights to companies seeking to maintain their authenticity and a strong brand narrative, while embracing innovative, cost-effective training solutions in a competitive global market.

3. Materials and Methods

Building on the insights from the literature, this section presents the methodological approach adopted in this study, with particular attention paid to the case study design and the iterative development process, based on the Scrum framework. Additionally, it describes the qualitative evaluation methodology, which employed structured focus groups to systematically capture stakeholder feedback on the design and effectiveness of the VR training application.

3.1. Case Study Overview

This paper presents a study on a virtual reality (VR) application that was specifically developed for Marchesi Antinori, an internationally renowned Italian fine wine producer, with a history spanning over six centuries and 27 generations of uninterrupted family ownership.

This study focused specifically on three historical Antinori estates, located in Tuscany: Tignanello (165 hectares), Badia a Passignano (65 hectares), and Pèppoli (140 hectares). These estates highlight both historical and modern architectures, from the 10th century cellar at Badia di Passignano and the historic Tenuta Tignanello estate, to the innovative contemporary winery "Antinori nel Chianti Classico." Each of these distinctive "wine

locations,” although geographically close, offers unique terroirs that enhance specific nuances, resulting in wines with pronounced character and exceptional recognizability. Key wines produced from these estates include: Badia a Passignano Chianti Classico D.O.C.G. Gran Selezione, Marchese Antinori Chianti Classico D.O.C.G. Riserva, and Pèppoli Chianti Classico D.O.C.G.

The three estates selected for this study were chosen in consultation with Marchesi Antinori’s marketing and communication teams, because they collectively represent the historical depth, cultural heritage, and narrative identity of the Antinori brand. All three estates are deeply rooted in the Chianti Classico region and embody distinct aspects of Antinori’s long-standing relationship with Tuscan viticulture.

The Tignanello Estate is a landmark of modern Italian wine history, whereby innovations in vineyard management and winemaking have led to the creation of the iconic “Super Tuscan” wines, marking a turning point in the global perception of Italian fine wines.

The Badia a Passignano Estate centers around a Benedictine monastery with origins in the 10th century, highlighting the profound historical and cultural connections between monastic tradition and viticulture in Tuscany.

The Pèppoli Estate, documented as far back as the 14th century when it was managed by local monastic communities, reflects centuries of continuous agricultural tradition and, today, serves as a vital expression of the Chianti Classico terroir.

By selecting these historically significant estates, the project ensured that the VR training application would authentically convey the brand’s narrative of continuity, heritage, and excellence across different expressions of the Chianti Classico region.

3.2. The Scrum Framework

3.2.1. The Methodology

This research applied the Scrum framework (Figure 1), a widely recognized agile project management methodology, characterized by iterative processes, its adaptability to evolving requirements, and its ability to facilitate intensive stakeholder collaboration [17,18]. Scrum promotes adaptive planning, evolutionary development, early and incremental delivery, and continuous improvement, making it particularly effective for technology-driven projects that benefit from frequent feedback, flexibility, and swift responsiveness to change [19].

Scrum was deliberately selected for the development of the virtual reality application analyzed in this study due to its inherent flexibility, iterative nature, and structured feedback mechanisms, making it particularly effective for innovative and user-centered software solutions [18]. Alternative approaches, such as Waterfall, Kanban, or Spiral, present certain limitations when applied to complex interactive applications that require continuous user involvement. The Waterfall model, characterized by sequential phases and predetermined requirements, typically restricts its adaptability and responsiveness to evolving stakeholder feedback [20,21]. Conversely, Scrum enables continuous refinement through iterative cycles and regular Sprint Reviews, ensuring that the user’s needs are progressively clarified and fulfilled [19,22]. Compared to Kanban, which primarily emphasizes continuous workflow optimization without formalized iteration cycles, Scrum’s timeboxed iterations (sprints) ensure the systematic, incremental delivery of functional prototypes, aligned with user expectations and clearly articulated through user stories [23,24]. Furthermore, the explicit focus of Scrum on maintaining a shared vision between stakeholders throughout the development process enhances strategic alignment, fosters clear communication, and supports consistent goal-oriented decisions [25]. Therefore, adopting Scrum facilitated structured collaboration among the Product Owner, Scrum Master, and the development

team, while systematically incorporating continuous stakeholder feedback, resulting in a robust, contextually relevant VR application, tailored for training the international wine sales force.

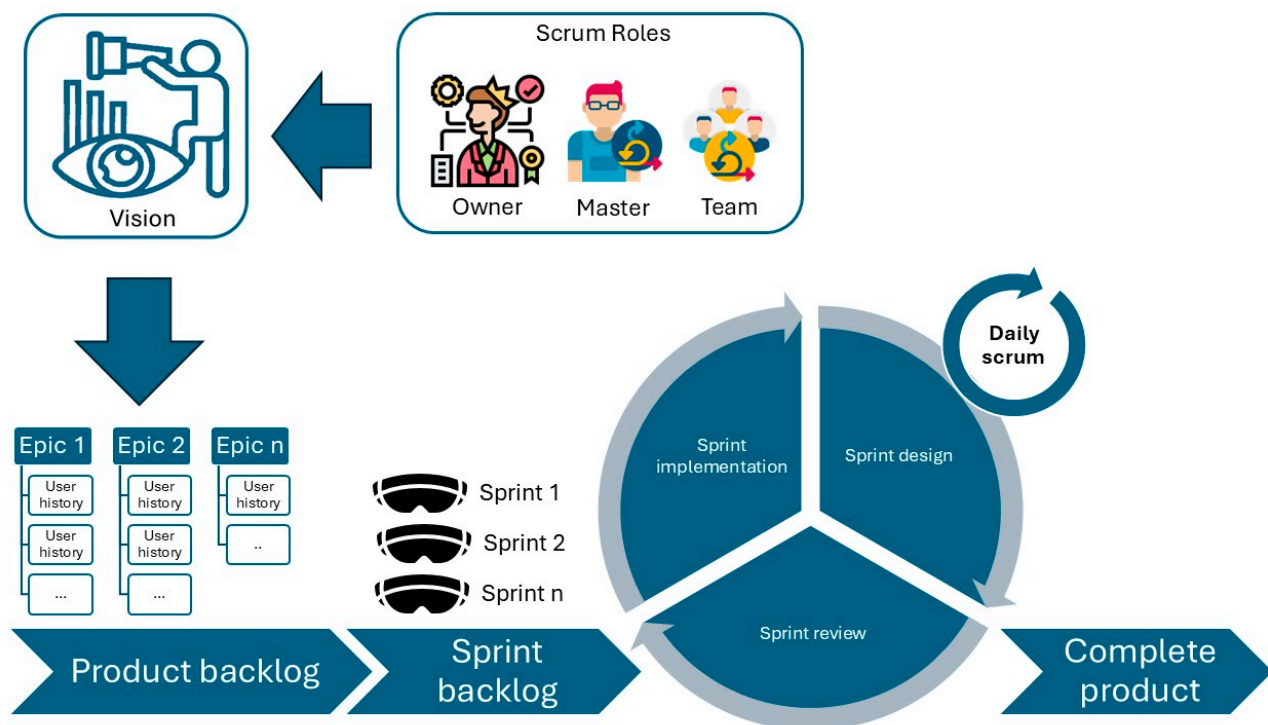


Figure 1. Scrum framework. Arrows indicate the iterative development flow, from vision and backlog definition through sprint cycles to the completed product.

Central to Scrum's effectiveness is the explicit definition of the vision (Figure 1), a high-level, strategic statement that describes the overall goals, target audience, and anticipated impact of the project. In the context of Scrum, the term Scrum Vision refers to this initial shared product vision, which is collaboratively established between key stakeholders (such as marketing, sales, and communication representatives) and the development team at the start of the project. The vision serves as a cohesive foundation that guides all subsequent activities, decision-making processes, and prioritizations throughout the project lifecycle, ensuring continuous alignment between the evolving product and stakeholder expectations [26]. By clearly defining the vision, Scrum ensures alignment and shared understanding among all the participants, fostering coherent and goal-oriented product development.

Within the Scrum framework, three clearly defined roles support the realization of the project vision: the Product Owner, the Scrum Master, and the development team [26]. The Product Owner holds responsibility for managing and clearly communicating the vision, gathering stakeholder requirements, defining priorities, and maintaining an updated and appropriately prioritized Product Backlog. The Scrum Master acts as a facilitator and coach, guiding the team in adhering to Scrum practices, removing impediments, ensuring effective collaboration, and protecting the development team from external disruptions. The development team comprises multidisciplinary professionals, who work collectively and iteratively to produce increments of usable product features aligned with the vision, taking shared accountability for quality and delivery [27,28].

A core artifact in the Scrum process is the Product Backlog (Figure 1), an evolving, prioritized list of functionalities, improvements, bug fixes, and other work items that are essential to achieving the vision. The Product Backlog typically includes hierarchical

elements, organized as Epics, users, and user stories. Epics represent broad strategic themes or major components of functionality that articulate high-level requirements [29]. These Epics are further divided into specific users or personas, which guide the development of detailed, user-centric narratives, known as user stories. User stories are short, precise statements, describing a functionality from the perspective of the end user, which clearly communicate the expected outcomes and acceptance criteria [19,29].

The Sprint Backlog is subsequently derived from the Product Backlog during the sprint planning meeting. The selection of prioritized user stories represents the work committed by the development team to be completed within a short, defined development period, or sprint, typically lasting from one to four weeks [19,27]. During sprint planning, the Product Owner collaborates closely with the development team to discuss, estimate, and agree upon feasible objectives, aligned with both the immediate priorities and the overarching vision. This activity is followed by the Sprint Design phase, wherein the development team breaks down the selected user stories into specific, actionable tasks, ensuring clarity of purpose, technical feasibility, and efficient resource allocation [19].

Throughout each sprint, brief, structured coordination meetings, known as Daily Scrums, are conducted to facilitate continuous team synchronization, track the progress made towards the sprint objectives, identify and swiftly address impediments, and make the necessary adjustments to maintain productivity and alignment with the sprint's goals [17,19]. The Daily Scrum, typically limited to 15 min, promotes transparency and accountability within the team.

At the conclusion of each sprint, a Sprint Review session is organized to assess and validate the product increment produced during the sprint. This review session involves the Product Owner, Scrum Master, the development team, and key stakeholders, providing a formal opportunity to gather direct feedback, demonstrate the completed features, and verify that the increment aligns with the project vision and the original requirements [26,28]. Insights from the Sprint Review inform continuous improvements, contribute to refining the Product Backlog, and support iterative alignment with stakeholder expectations.

The implementation of Scrum within this research provided a structured, yet flexible, methodological framework. It allowed the team to adapt dynamically to emerging requirements, integrate user feedback efficiently, and remain consistently oriented towards achieving the established vision. Through iterative cycles of planning, execution, review, and continuous learning, the Scrum approach facilitated the successful development of a high-quality, immersive virtual reality training solution.

3.2.2. Development of the Framework for the Wine Sector

The application of Scrum methodology within the wine sector requires adapting its general iterative principles to address the specific educational and communicative demands inherent to this industry. In the context of international B2B sales training for premium wines, this adaptation typically involves several sector-specific phases. Initially, the formulation of the vision considers elements critical to wine sales, such as conveying detailed terroir characteristics, brand heritage, vineyard management practices, and cellar operations. Subsequently, the construction of the Product Backlog includes structuring the training priorities into Epics and user stories, reflecting common scenarios encountered by sales professionals, such as vineyard visits, cellar processes, or tasting experiences.

The selection and integration of immersive multimedia content, such as aerial and ground-level 360° footage, interactive vineyard maps, and cellar simulations, is tailored to replicate experiential dimensions that are central to wine storytelling. Finally, we define iterative development cycles (sprints) to accommodate regular feedback from industry stakeholders, including sales and marketing experts, ensuring continuous refinement of

the training content for diverse international market contexts. This approach provides a structured, yet flexible, methodological foundation for developing specialized training solutions in the wine sector, integrating key narrative, experiential, and technical elements that are essential for effectively communicating premium wine attributes to international buyers.

3.3. App Evaluation

3.3.1. Focus Group Methodology

To effectively assess the usability and impact of the VR application developed for training an international sales force in the wine industry, the focus group method was selected for its ability to capture detailed, context-specific insights that standardized usability questionnaires might overlook. While traditional usability questionnaires provide structured and quantifiable measures of user satisfaction, efficiency, and ease-of-use [30,31], they often fail to fully reflect deeper user perceptions regarding emotional engagement, cultural acceptance, and immersive experience, elements particularly critical in VR-based training [32]. Additionally, given the small size of international sales teams in the wine sector, it is challenging to obtain statistically significant results through conventional questionnaires, unless they are reduced to a very small set of items, which limits the depth of the insights gained.

In contrast, the interactive and conversational nature of focus groups enables participants from a variety of professional backgrounds, such as marketing, communications, and international sales, to articulate their nuanced experiences and perceptions of brand storytelling, heritage communication, and the authenticity of the wine experience within a VR context [33,34]. Moreover, in international markets, where cultural nuances and differing attitudes toward technological innovation can shape user acceptance, focus groups provide valuable insights into factors that may influence the adoption and practical use of a VR application [35]. For these reasons, focus groups were deemed the most suitable approach for thoroughly evaluating the VR training tool and generating actionable insights for future refinement.

The focus group was conducted in accordance with established qualitative research guidelines to ensure methodological rigor and data reliability. A trained moderator facilitated the group, using a structured, yet flexible, discussion guide, containing open-ended questions, designed to stimulate interactive dialogue and elicit the participants' views on the usability, effectiveness, and overall impact of the VR application [33,35]. Six company representatives were purposefully selected to provide diverse and relevant perspectives. The group included four men and two women, all of whom held university degrees in marketing, management, or business organization and had extensive professional experience in their respective fields. Two members came from each of the marketing, communications, and international sales departments to ensure a balanced perspective on the application's use in regard to international B2B sales training. To minimize potential bias, none of the participants were part of the Scrum development team. Informed consent was obtained from all the participants, in accordance with the project's privacy policy regarding data confidentiality [34]. The session was held in a neutral, comfortable setting to foster open and candid interaction [33], and was recorded and transcribed verbatim to support systematic qualitative analysis. The resulting data were analyzed to identify key themes, patterns, and consensus points regarding the user experience, opportunities, and limitations of the VR application.

3.3.2. Identifying Focus Group Themes Using NLP Embeddings and UMAP Clustering

The qualitative data analysis conducted in this study followed a structured workflow, combining advanced natural language processing (NLP) techniques with hierarchical clustering. Initially, transcripts from the focus groups were meticulously segmented into discrete, sentence-level units to ensure granular semantic representation. Each sentence was then converted into semantic vectors (embeddings), using OpenAI's text-embedding model (text-embedding-ada-002; OpenAI, San Francisco, CA, USA). Given the high-dimensional nature of these embeddings, dimensionality reduction was performed using Uniform Manifold Approximation and Projection (UMAP) to generate a lower dimensional, yet semantically meaningful, representation of the textual data. Subsequently, clustering analysis was conducted using k-means, a method chosen for its effectiveness in identifying naturally occurring groups within data. To ensure rigor and replicability, a comprehensive validation approach involving multiple clustering metrics, the Within-Cluster Sum of Squares (WSS), the Davies–Bouldin Index (DBI), the Calinski–Harabasz Index (CHI), and silhouette scores, was applied. This multi-metric evaluation guided the selection of the optimal number of clusters, enhancing both the analytical transparency and interpretability of the results. The overall analytical pipeline enabled the systematic identification and nuanced interpretation of thematic insights from stakeholder feedback, which in turn informed the iterative refinement of the VR application. Further technical details on the analytical procedures and parameters used are provided in Appendix A.

3.3.3. Software and Hardware

The virtual reality application presented in this study was developed using the Unity 3D engine (version 2022), an advanced cross-platform real-time development framework, widely employed for immersive simulations and interactive experiences. To implement multi-user interactivity, the Photon Fusion networking asset was integrated into Unity, enabling real-time synchronization and collaboration among geographically dispersed participants. Avatar management and locomotion systems were specifically designed and optimized for the Meta Quest VR headset, leveraging its built-in SDK for smooth navigation and realistic user interactions within the virtual environment. The Fusion, Meta Avatar, and Meta Interaction SDKs were integrated using the Multiplayer Meta Avatars VR Template asset.

The immersive multimedia content utilized in the application was captured using advanced panoramic cameras. Ground-based 360-degree filming was performed using Insta360 RS2 and Insta360 Pro 2 cameras (Insta360, Shenzhen, Guangdong, China), which provide high-resolution spherical imagery and seamless stitching capabilities. Aerial 360-degree footage was acquired through the use of a DJI Mavic 3 Pro drone (DJI, Shenzhen, Guangdong, China), offering high-quality stabilized imagery from aerial perspectives, critical for representing expansive vineyard landscapes and facility overviews.

For the subsequent analysis of the qualitative data derived from the user evaluation process, the R programming environment (CRAN-R) was employed. The analytical pipeline included a combination of specialized statistical and machine learning libraries: *umap* was utilized for dimensionality reduction, while clustering validation and assessment were performed using *FactoMineR*, *factoextra*, *clusterSim* (for the Davies–Bouldin Index), and *fpc* (for the Calinski–Harabasz Index). Additionally, the R libraries, *jsonlite* (v2.0) and *httr* (v1.4.7), were integrated into the pipeline to manage API interactions, particularly for interfacing with OpenAI's ChatGPT APIs to obtain advanced textual embeddings, critical for semantic analysis and clustering.

This carefully selected combination of software platforms, imaging hardware, and analytical tools ensured both high-quality immersive experiences and robust, scientifically validated qualitative analyses.

3.4. Data Sources

All the data and materials used in this case study were either provided directly by Marchesi Antinori or collected on site, in close collaboration with the company's personnel. The technical information on vineyard characteristics, cellar processes, and product specifications were specifically supplied by Antinori's agronomic and oenological teams. The visual and multimedia content, including 360° aerial and ground-level footage, was acquired during filming sessions held at the company's estates. These sessions were supported logistically and guided by estate managers and technical staff. Furthermore, the stakeholder feedback analyzed in this study was gathered through structured focus groups involving Antinori employees from the marketing, communication, and international sales departments. The collaborative nature of the project ensured that all the data reflect authentic, context-specific knowledge, directly sourced from within the company.

4. Results

The following section reports the main results from the study, including the outcomes of the iterative development process and the thematic analysis of stakeholder feedback.

4.1. Scrum Results

4.1.1. Roles

The initial phases of the Scrum methodology were structured by defining clear roles and responsibilities within the project team (Figure 2). The **Product Owner** was a marketing and communication expert appointed by the brand administrator, responsible for articulating the product vision, aligning the development with strategic brand objectives, and conveying stakeholder requirements. The **Scrum Master**, a senior programmer from VR PercLab at the University of Florence, facilitated agile practices and ensured effective team collaboration.

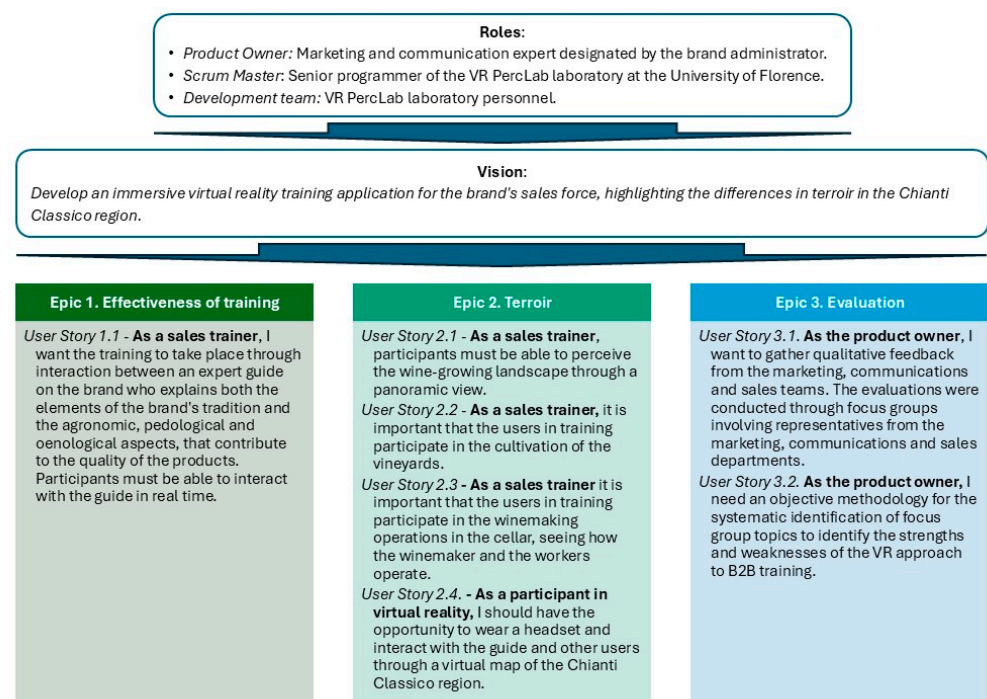


Figure 2. Roles vision and Product Backlog.

The **development team** included specialized professionals from VR PercLab: a **software engineer** for programming within Unity 3D; a **3D artist and UI designer** for creating and integrating 3D models and interfaces; a **VR developer** for capturing and processing 360-degree video content; and a **data analyst**, responsible for analyzing qualitative data and user feedback through the use of advanced semantic techniques.

This streamlined, role-based structure supported efficient workflow management, effective communication, and rapid iterative cycles, enabling the agile development of a highly engaging and contextually accurate VR training application.

4.1.2. Vision and Product Backlog

The Scrum implementation commenced with defining a clear and compelling **vision** for the project, formulated by the Product Owner, in collaboration with brand stakeholders. The vision articulated the overarching goal (Figure 2): *developing an immersive virtual reality (VR) training application designed explicitly for the brand's sales force, with a particular emphasis on conveying the distinctive terroir characteristics of the Chianti Classico region*. This vision served as the guiding framework for subsequent development activities, ensuring alignment and coherence across the entire project lifecycle.

Based on this defined vision, the **Product Backlog** was developed collaboratively. This backlog outlined the primary functionalities of the application, structured in terms of high-level Epics and detailed user stories. The backlog was prioritized to reflect both strategic business needs and practical implementation considerations.

The first Epic, labeled **"Effectiveness of Training,"** encompassed user stories focused on maximizing the educational impact of the VR training experience. A representative user story (User Story 1.1) emphasized that as a sales trainer, the training sessions should occur through dynamic interactions between the participants and an expert guide representing the brand. The guide's role was defined as integrating the brand's historical traditions and detailed explanations regarding the agronomic, pedological, and oenological aspects that are essential to the quality of the products. Additionally, real-time interactivity was highlighted as a fundamental requirement, enabling participants to actively engage with the expert guide and deepen their understanding.

The second Epic, called **'Terroir'**, specifically aimed to convey the distinctive environmental and agricultural conditions of the Chianti Classico wine region through immersive experiences. Several detailed user stories were identified: User Story 2.1 defined an interactive element in which virtual reality participants, using a headset, could interact directly with an interactive virtual map of the Chianti Classico region, independently accessing infographics relating to the environmental and oenological characteristics of the different terroirs. User Story 2.2 outlined the need for participants to perceive the wine-growing landscape through immersive panoramic viewpoints, thus emphasizing the need for a spatial understanding of the terroir. User Story 2.3 required the development of immersive ground-level content that would allow participants to virtually engage in vineyard cultivation operations. In addition, User Story 2.4 similarly required immersive video content of the cellar operations, allowing users to observe winemaking processes up close, providing contextualized learning on how wine producers and workers operate. Finally, User Story 2.5 ended the training with an interactive illustration of the characteristics of the wines.

The third Epic, **"Evaluation,"** addressed the qualitative and methodological assessment of the VR training application. User Story 3.1 stipulated the need for the systematic collection of qualitative feedback from relevant stakeholders from marketing, communication, and international sales departments. This was achieved through structured focus group discussions, involving representative members of each department. User Story 3.2 introduced the requirement for an objective, data-driven methodology for the sys-

tematic analysis of focus group transcripts. This analytical procedure aimed to clearly identify strengths and weaknesses of the VR training approach, guiding future development through empirically supported insights.

This carefully structured and prioritized Product Backlog, anchored by a clear vision, facilitated focused and iterative development cycles. By continually revisiting and refining the backlog during successive Scrum sprints, the development team efficiently delivered a VR solution that effectively met the training objectives and highlighted the unique terroir characteristics, achieving alignment with both stakeholder expectations and user requirements.

4.1.3. Sprint Planning

The Scrum implementation continued with the sprint planning phase. During this phase, the entire team worked together. This included the development team, the Scrum Master, and the Product Owner. They selected specific user stories and tasks from the Product Backlog (Figure 3). This selection was driven by the priorities identified in the Product Backlog, their strategic importance to the vision, and the development team's established speed of working.

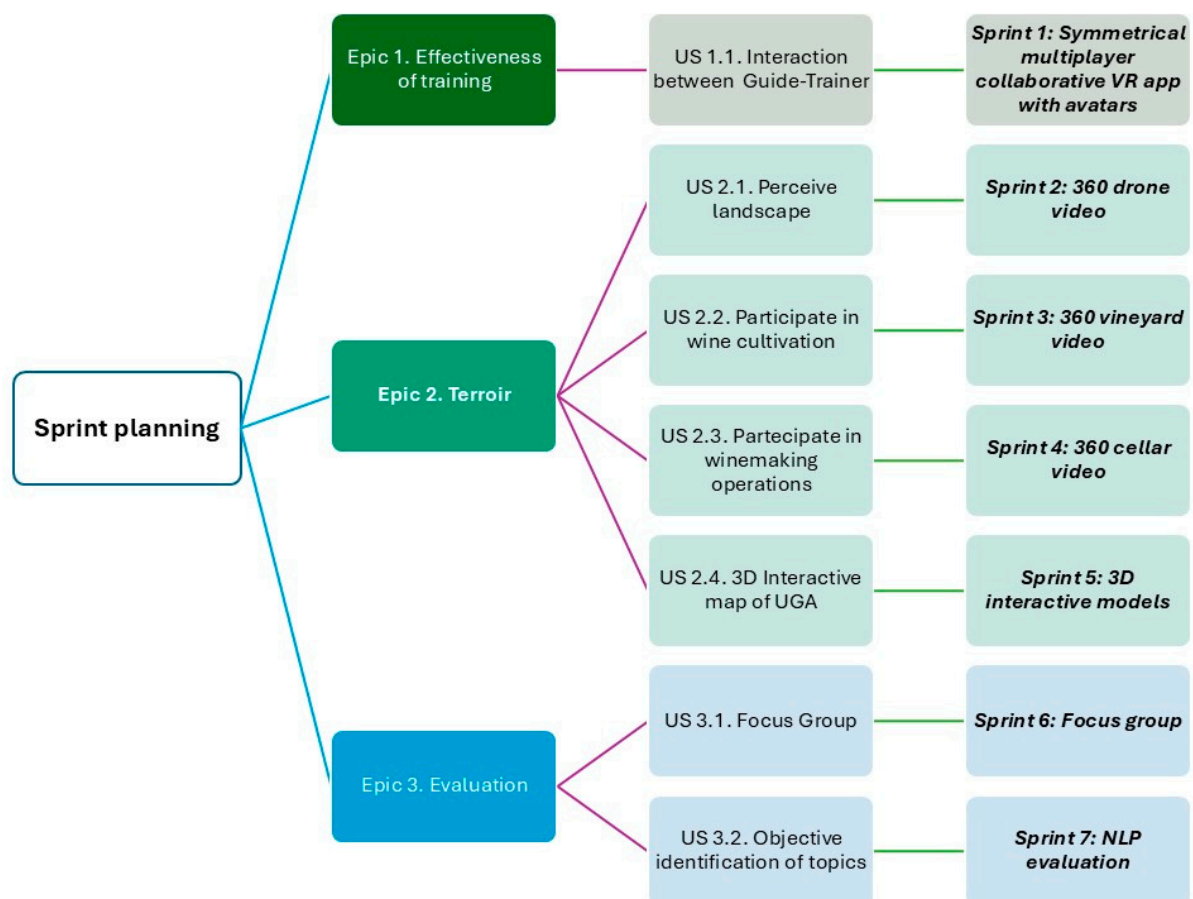


Figure 3. Relationship between Epics, user stories, and sprints.

The Scrum methodology included detailed sprint planning sessions, involving the Product Owner, Scrum Master, and the development team. User stories and corresponding tasks were selected from the Product Backlog, based on their priority, contribution to the project's overall vision, and the estimated velocity of the team.

In regard to **Sprint 1**, the team developed the entry space for the **Immersive Collaborative Virtual Reality (ICVR)** environment, a 3D interactive space enabling synchronous

user interactions through customizable avatars (32 options available, Figure 4). This term refers to a VR-based learning environment that combines immersive sensory experiences (360° video, spatialized audio, interactive 3D elements) with collaborative features that are designed to support knowledge sharing, discussion, and interactions among multiple users. In the context of international B2B sales training, the ICVR approach enables geographically dispersed sales teams to engage with the brand's heritage, terroir, and production processes in a shared virtual space, fostering both individual learning and collaborative sense making. This conceptualization aligns with emerging definitions of ICVR in the professional training literature, where the focus is on enhancing both the immersion and social presence in such environments to support experiential learning.



Figure 4. Avatar selection interface within the VR training application, enabling users to personalize their virtual identity and enhance their immersion during simulated vineyard and cellar experiences.

Sprint 2 focused on creating an interactive 3D scene of the “Saletta Sospesa” tasting room within the “Antinori nel Chianti Classico” winery. This included two 3D interactive maps: one of the Chianti Classico wine region (Figure 5a), and one detailing the Pèppoli, Badia a Passignano, and Tignanello estates with vineyard data and geological core samples (Figure 5b,c).

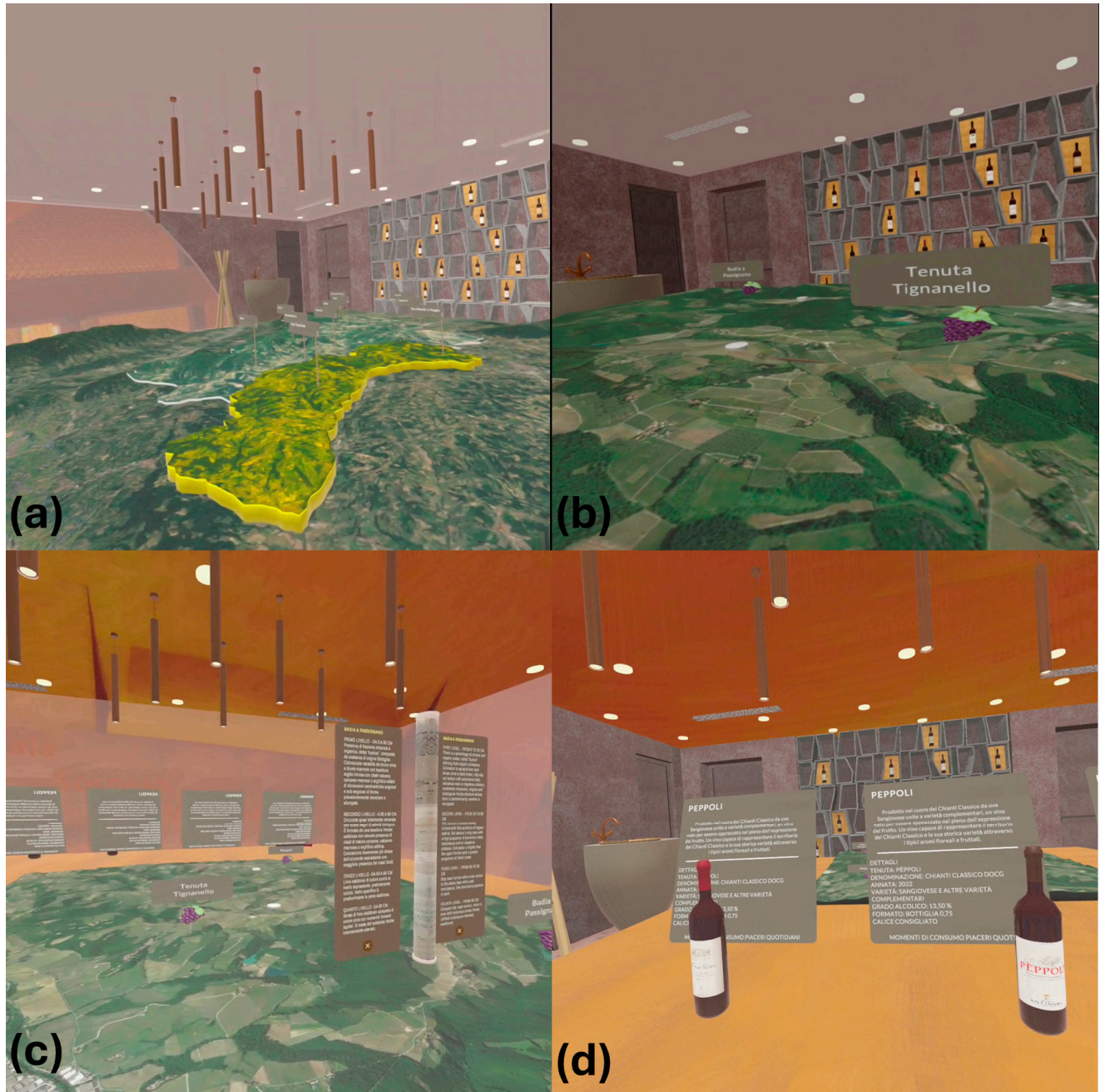


Figure 5. Interactive “Saletta Sospesa” virtual tasting room within the VR application: (a) “Saletta Sospesa” tasting room with Chianti Classico regions; (b) “Saletta Sospesa” with estate; (c) “Saletta Sospesa” with a geological section sample; and (d) 3D models of the wine bottles.

The subsequent development process was organized sequentially around the three wine estates (Pèppoli, Tignanello, and Badia a Passignano) to clearly communicate each site’s unique terroir, vineyard practices, and cellar operations. For each estate, three sprints captured their distinct elements through the use of immersive content.

At the Pèppoli Estate, drone-based aerial, 360° videos provided comprehensive vineyard overviews (Sprint 3, Figure 6a). Ground-level 360° filming highlighted key vineyard management tasks, such as leaf thinning (Sprint 4, Figure 6b), while cellar practices, including topping-up wooden vats, were captured in immersive detail (Sprint 5, Figure 6c).



Figure 6. Representative 360° video frames illustrating key vineyard, cellar, and landscape content developed for the VR training application: (a) Pèppoli Sprint 1; (b) Pèppoli Sprint 2; (c) Pèppoli Sprint 3; (d) Tignanello Sprint 1; (e) Tignanello Sprint 2; (f) Tignanello Sprint 3; (g) Badia a Passignano Sprint 1; (h) Badia a Passignano Sprint 2; and (i) Badia a Passignano Sprint 3.

For the Tignanello Estate, the initial sprints documented the vineyard landscapes and key parcels (Sprint 3, Figure 6d), grape tasting and vineyard quality control practices (Sprint 4, Figure 6e), and cellar management, with a focus on barrel operations (Sprint 5, Figure 6f).

Similarly, the development for the Badia a Passignano Estate featured aerial 360° footage, emphasizing the historical monastery and surrounding vineyards (Sprint 3, Figure 6g), detailed ground-level videos of grape harvesting (Sprint 4, Figure 6h), and immersive cellar videos of barrel tasting activities (Sprint 5, Figure 6i).

The VR experience concludes with Sprint 6, which presents an interactive scene in the “Saletta Sospesa” (Figure 5d). This final scene features 3D models of the wine bottles produced by each estate, accompanied by oenological data. Users can interact with the models, selecting different bottle sets, corresponding to each estate.

Structuring the development process around individual estates ensured that each site’s unique terroir, vineyard practices, and cellar operations were effectively conveyed through a sequentially designed immersive experience. This approach reinforced the coherence of the educational narrative and aligned the VR application with the project’s overarching vision.

Each sprint, typically lasting two to four weeks, involved structured phases of design, implementation, testing, and feedback analysis. During the design and implementation phases, the team conducted on-site filming with drone-based and ground-based 360° cameras, integrated video assets into the VR environment, and developed interactive 3D models. Testing and quality control involved verifying video fidelity, the functionality of interactive elements, the accuracy of terroir-related data visualizations, and the robustness of the multiplayer environment, including avatar synchronization and interaction consistency.

4.2. Focus Group Results

Subsequently, the focus group realization phase required careful preparation, involving the strategic selection of six representative participants from the marketing, communication, and sales departments. During the focus groups, participants extensively utilized the VR application, providing immediate, detailed feedback on its usability, alignment with the brand identity, the effectiveness of the training methodologies, and the overall user experience.

Before applying the NLP-based embedding and clustering techniques, all the focus group transcripts were systematically pre-processed to ensure data quality and consistency. The audio recordings of the session were transcribed verbatim. The resulting text was then reviewed by the research team to correct transcription errors and to anonymize any identifying information. The transcript was segmented at the sentence level, using punctuation and syntactic cues, to generate discrete text units that were suitable for embedding. Basic text normalization procedures were also applied (e.g., removal of non-informative symbols, standardization of abbreviations). No thematic coding or manual categorization was performed prior to the NLP analysis, to preserve the objectivity of the subsequent computational clustering process. This preparatory step ensured that the text data were clean, coherent, and ready for unbiased semantic embedding and recursive clustering.

4.2.1. First-Level Recursive Clustering Results

The qualitative data collected through structured focus groups were systematically analyzed using advanced natural language processing (NLP) embedding techniques and hierarchical clustering to objectively identify emergent themes. Sentence-level embeddings were generated from the focus group transcripts using OpenAI’s “text-embedding-ada-002” model, converting qualitative textual feedback into semantic vectors. Dimensionality reduction was then performed using Uniform Manifold Approximation and Projection (UMAP), enabling clear visualization and facilitating subsequent clustering. Optimal cluster determination was guided by standard validation metrics, including the Within-Cluster Sum of Squares (WSS), the Davies–Bouldin Index (DBI), and the Calinski–

Harabasz Index (CHI), alongside silhouette scores, to assess cluster quality, cohesion, and separation (Figure 7).

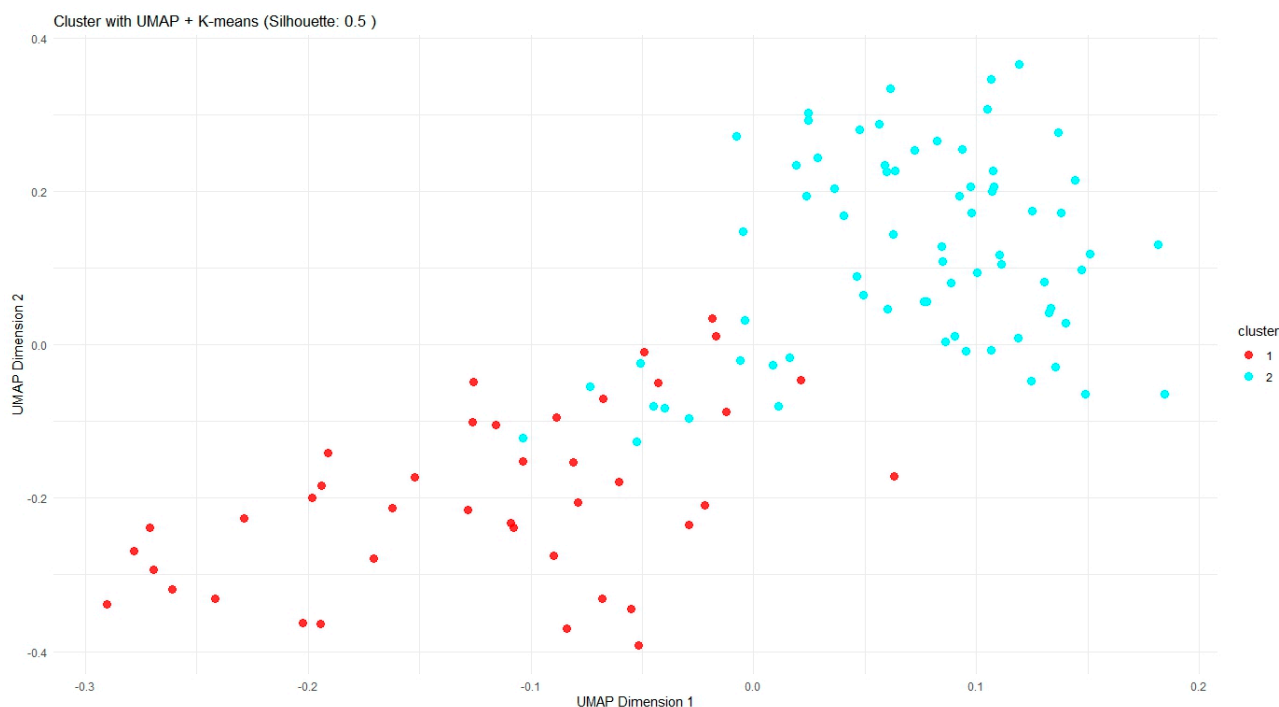


Figure 7. First-level clustering evaluation metrics (WSS, DBI, CHI), used to determine the optimal number of clusters for interpreting the thematic differentiation of stakeholder feedback.

The initial application of UMAP and k-means clustering yielded two prominent thematic clusters with an overall silhouette score of approximately 0.50 (Figure 8), signifying moderate but clear thematic differentiation in the participant feedback.

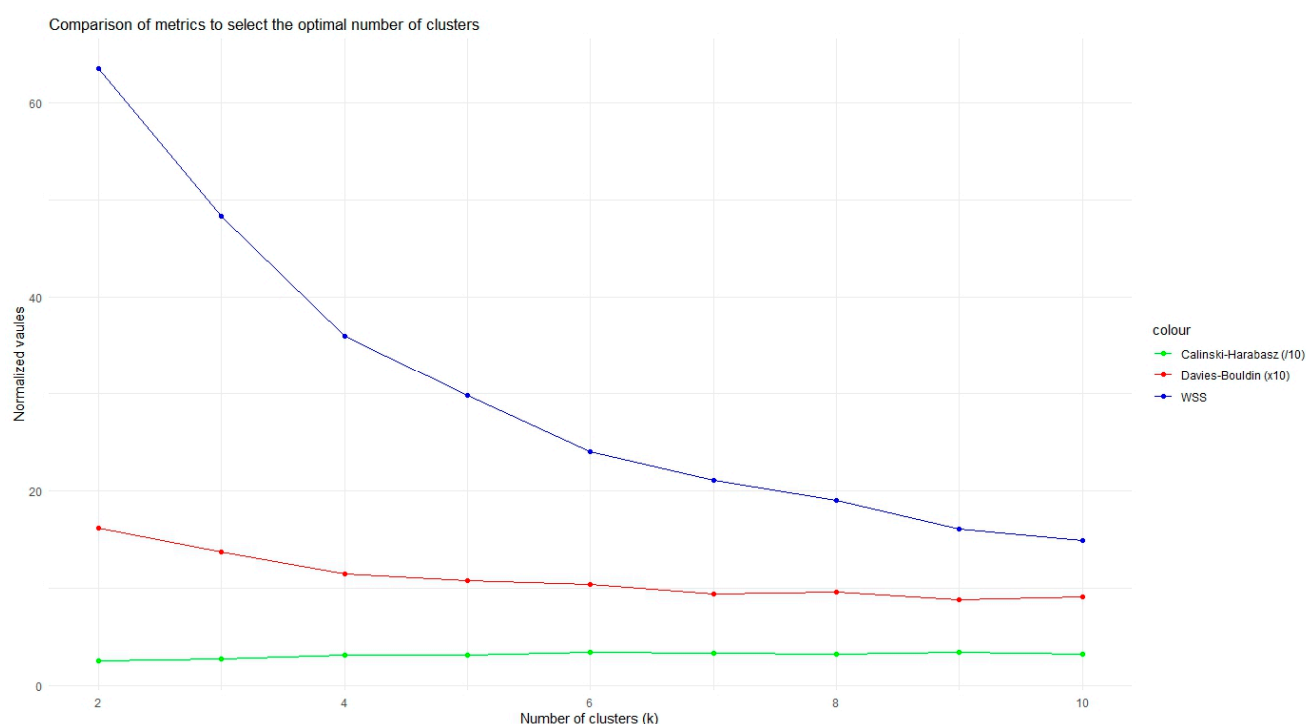


Figure 8. UMAP visualization of first-level thematic clusters from focus group data illustrating emergent themes in participant feedback on the VR application.

Cluster Validation and Justification

To ensure the validity and interpretability of the first-level clustering, both quantitative and qualitative validation steps were applied. The combination of WSS, DBI, CHI, and silhouette scores provided an objective basis for determining the optimal number of clusters and assessing their internal cohesion and separation. Additionally, the representative sentences closest to each cluster centroid were manually reviewed to confirm the thematic consistency and coherence within each group. This integrated validation process ensured that the first-level clusters reported here reflect distinct and meaningful thematic domains emerging from the focus group data.

Cluster 1: The Role of Virtual Reality in the Wine Sector and Communication

The first thematic cluster aggregated participant responses primarily centered around the strategic and innovative potential of virtual reality (VR) technology in the wine industry. Discussions within this cluster extensively explored how VR can be leveraged effectively within the wine sector, particularly highlighting distinctions between its educational role in business-to-business (B2B) contexts and its potential applications oriented towards end consumers. Participants acknowledged the significant advantages of VR in regard to B2B training scenarios, emphasizing its unique capacity to convey complex technical and cultural information through interactive and immersive storytelling approaches. Particularly valued was VR's potential to enhance the comprehension of terroir characteristics, production methods, and brand heritage, thereby empowering international sales representatives and enhancing the depth and effectiveness of training programs.

Additionally, participants discussed opportunities and challenges associated with integrating VR into broader wine-related communication and tourism initiatives. While VR was recognized as a powerful tool to attract and educate customers through enriched virtual experiences, some participants noted potential drawbacks, such as the risk of excessive technological mediation potentially diluting authentic brand experiences and traditional storytelling methods integral to wine marketing and tourism.

Cluster 2: Limitations and Alternatives to Virtual Reality

The second thematic cluster focused extensively on the perceived limitations, challenges, and considerations regarding broader adoption of VR technology within wine education and communication. A recurring topic among the participants was the consensus that VR, despite its many advantages, cannot fully replace the authenticity and sensory richness inherent to real-life vineyard visits or cellar experiences. Participants expressed concerns regarding the physical discomfort and cognitive strain that prolonged headset use might impose, thus limiting widespread acceptance among certain user demographics.

The analysis further revealed insights regarding the differing global market reactions toward VR technology adoption. Participants noted substantial variations across international markets, observing stronger receptivity and enthusiasm toward VR in regions like the United States and Asia, while identifying a more conservative stance prevalent among European wine consumers and professionals. These insights indicated the importance of region-specific VR strategies, rather than a uniform, global approach.

Lastly, within this cluster, the participants proposed and debated viable alternatives or complements to immersive VR. Prominent among these were augmented reality (AR), immersive rooms equipped with high-definition projection technologies, and high-quality traditional video media. These alternatives were suggested as potentially less isolating and more inclusive solutions, capable of preserving traditional elements of wine tasting events and educational interactions without fully relying on immersive virtual headsets.

The delineation of these two distinct thematic clusters underscored the nuanced perspectives of the stakeholders concerning VR implementation. The analysis clearly highlighted both promising potential opportunities and significant constraints, provid-

ing valuable guidance for strategic decisions on future developments and integration approaches within wine sector training and communications. Subsequent recursive clustering analyses at deeper levels were performed to further dissect these initial clusters, revealing additional nuanced sub-themes, relevant to refining the VR application and its educational effectiveness.

4.2.2. Second-Level Recursive Clustering Results

The second-level recursive clustering refined the analysis further, identifying distinct sub-themes within each main cluster. Figures 9 and 10 show the subclusters derived through the use of UMAP dimensionality reduction and k-means clustering. The silhouette scores for Cluster 1 (0.33) and Cluster 2 (0.367) indicate satisfactory clustering performance, especially considering the high-dimensional embedding vectors employed. Such silhouette scores are acceptable in text clustering applications with complex embeddings, given the inherently high-dimensional nature of textual data and the nuances captured by advanced NLP models like the one used in this study.

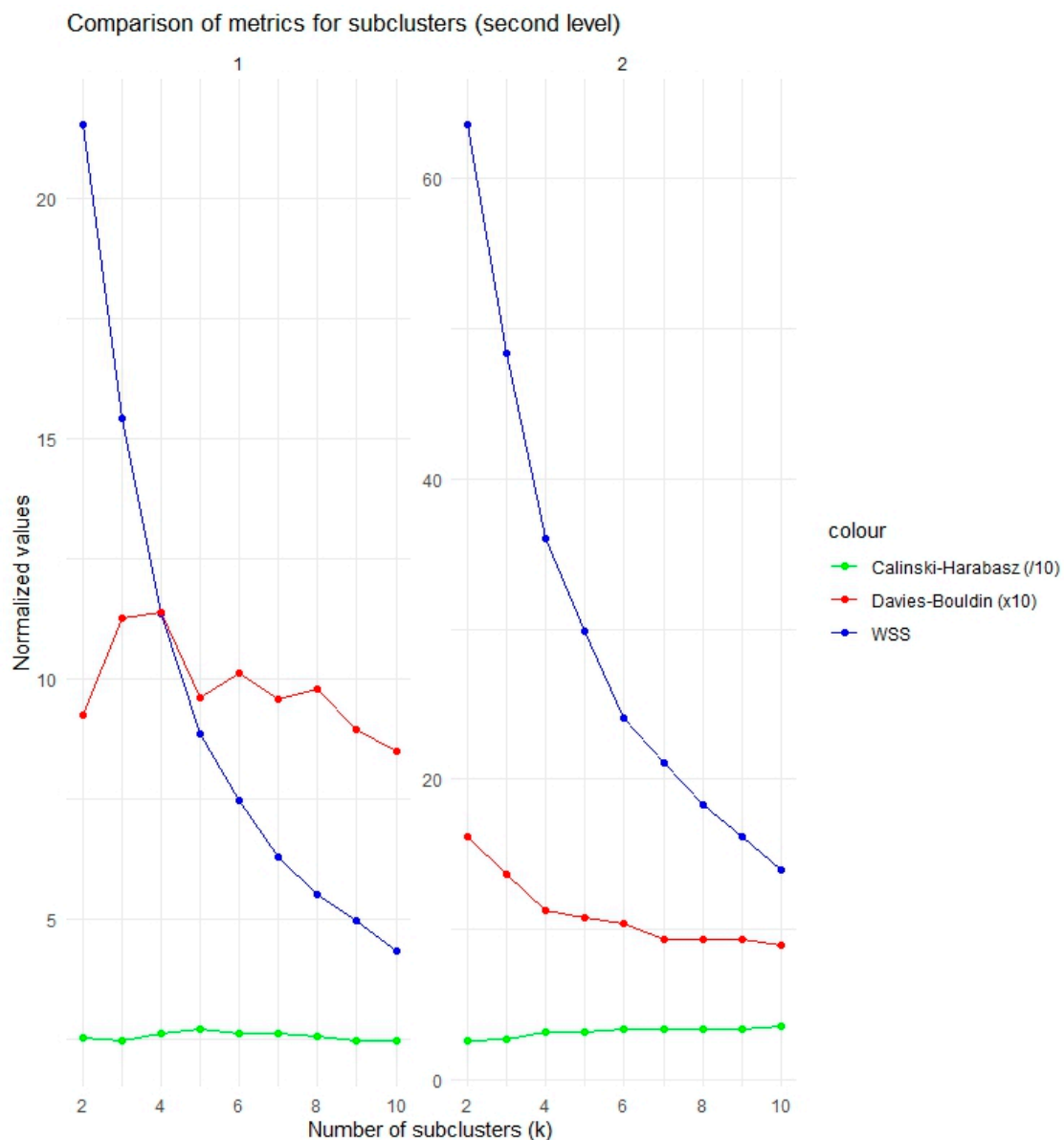


Figure 9. Comparison of clustering evaluation metrics (Calinski–Harabasz Index, Davies–Bouldin Index, and WSS) across both first-level and second-level clustering.

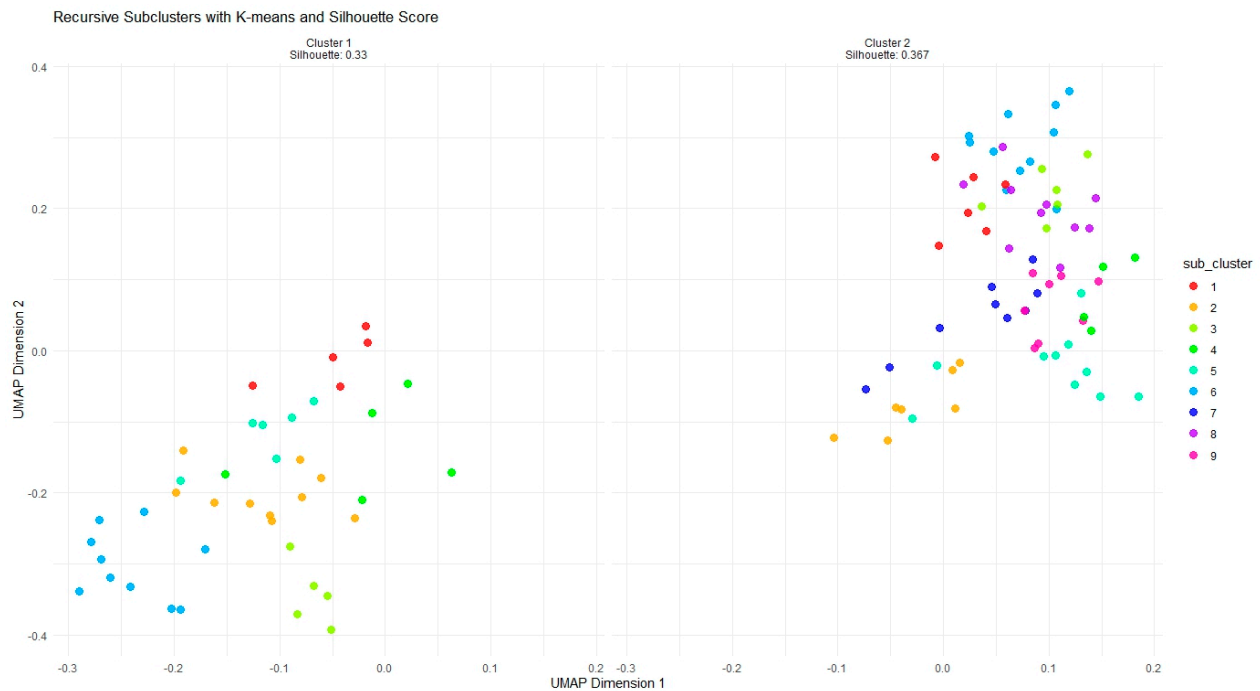


Figure 10. Visualization of first-level and second-level recursive subclusters generated with k-means clustering, including corresponding silhouette scores.

Figure 9 compares the standard clustering metrics (Calinski–Harabasz Index, Davies–Bouldin Index, and WSS) to determine the optimal number of subclusters within each primary cluster. The metrics indicate stable solutions in regard to subclusters six and nine, ensuring thematic interpretability, while maintaining the statistical rigor. The second-level clustering produced clearly defined thematic groupings, significantly enhancing the interpretability of qualitative insights derived from the focus group.

Sub-cluster Validation and Justification

To ensure the robustness and interpretability of the second-level clustering, the same validation approach used for the first level was applied. The optimal number of subclusters was determined through the WSS, DBI, CHI, and silhouette scores, providing an objective assessment of the internal cohesion and separation. Furthermore, the representative sentences closest to each subcluster centroid were manually examined to verify the thematic clarity and relevance. This combined quantitative and qualitative validation ensured that the subclusters presented here provide an accurate and nuanced representation of the thematic structure within the focus group data.

Cluster 1—The Role of Virtual Reality in the Wine Sector and Communication was further divided into six clearly interpretable subthemes, as follows:

Subcluster 1.1—Informational Enrichment through VR: The participants emphasized VR’s potential for delivering engaging communication on complex geological, climatic, and viticultural information. VR was highlighted as a superior alternative to static maps, with notable potential in B2B contexts for educating distributors, sommeliers, and sales representatives.

Subcluster 1.2—VR as an Immersive Consumer Tool: The discussions highlighted the emotional impact of VR, underscoring its effectiveness in recreating historical settings or transporting consumers into wineries and vineyards. The participants referenced existing successful implementations, such as immersive VR presentations used in Switzerland to showcase Amarone wines.

Subcluster 1.3—Historical Identity and Authenticity: Concerns were expressed regarding VR’s potential to dilute or normalize the historical authenticity and prestige

of heritage wine brands. The participants stressed the critical balance required between innovative VR approaches and preserving the integrity of traditional wine narratives.

Subcluster 1.4—Innovation vs. Audience Perception: The stakeholders indicated that some traditional wineries might perceive VR as misaligned with their established identity. Recommendations included cautious and selective deployment of VR in controlled scenarios, avoiding its overuse or the replacement of authentic vineyard experiences.

Subcluster 1.5—Interactive Educational Experiences: The participants suggested immersive VR scenarios akin to interactive simulations (e.g., “Jurassic Park” style), as effective educational tools to engage B2B audiences, thereby enriching distributor training programs and enhancing learning outcomes.

Subcluster 1.6—Global Markets and Diverse Perceptions: The discussions revealed significant market-dependent variability, noting a stronger acceptance of VR in the United States and China compared to more conservative European markets. Concerns were raised about possible negative perceptions among certain traditional consumers, who may view extensive VR use as detrimental to brand authenticity.

Table 1 summarizes the dominant themes and representative quotes emerging from Cluster 1.

Table 1. Emerging themes and representative quotes from Cluster 1.

Subcluster	Emergent Themes	Representative Quotes
1.1 Informational Enrichment	Engaging communication, superior alternative to static maps.	“Imagine interactive mapping, data on elevations, soils, temperature ranges, all of which would usually have to be read in a boring brochure.”
1.2 VR as an Immersive Consumer Tool	Emotional impact, historical recreations, consumer immersion	“I was especially impressed by the aesthetic impact, such as the suspended hall with a view of the estates.”
1.3 Historical Identity and Authenticity	Risk of diluting brand authenticity, balance innovation with tradition	“Doing an Antinori experience where a progenitor from the 1300s recounts the care of the vineyard and the transformation of the land could be intriguing, but it has to be evaluated if it is in line with the values of the brand and if it doesn’t risk being forced.”
1.4 Innovation vs. Audience Perception	Misalignment with traditional identities, selective deployment of VR	“Instead of simply showing them a video, we could give them a visor: that way, without ever having set foot in the company, they could ‘live’ our estates.”
1.5 Interactive Educational Experiences	Interactive simulations for B2B education, engaging learning tools	“Through immersive maps and graphs, you can better convey the terrain, soil conformation, and exposure of the vineyards, making everything clearer and more convincing.”
1.6 Global Markets and Diverse Perceptions	Market-dependent acceptance, conservative attitudes in Europe, positive reception in US and China	“China and the United States, for example, may be more receptive than European countries, where perhaps an underlying snobbery dominates and geographic proximity easily allows for a real trip to the winery.”

Cluster 2—Limitations and Alternatives to Virtual Reality was further segmented into nine distinct subthemes, as follows:

Subcluster 2.1—Effects on User Perception: The participants acknowledged VR's capacity for focused learning due to the immersive headset experience, although they highlighted the potential for discomfort, thus recommending careful user consideration, particularly for geographically distant markets.

Subcluster 2.2—Physical and Cognitive Limitations: Issues were identified related to headset discomfort, complexity, and cognitive overload, creating barriers between the user and authentic experiences, thereby limiting VR's usability and adoption.

Subcluster 2.3—Augmented Reality vs. Virtual Reality: Augmented reality (AR) emerged as a preferred alternative due to its ability to maintain the user's interaction with real-world contexts, enhancing rather than isolating them from reality.

Subcluster 2.4—Technology and Market Perception: The participants expressed concerns that VR might appear overly technical, impersonal, or emotionally distant compared to traditional educational methods, thus better suited for B2B rather than consumer-oriented experiences.

Subcluster 2.5—Information Overload Risks: The discussions highlighted the potential for excessive technology use to overwhelm and confuse users, emphasizing the importance of clearly defining the target audiences before investing extensively in immersive technologies.

Subcluster 2.6—Complementary Role of VR: It was strongly recommended that VR should complement rather than replace real-life experiences, particularly beneficial in regard to B2B educational contexts, corporate events, or targeted market presentations.

Subcluster 2.7—Contexts of VR Utility: The utility of VR was primarily recognized within training contexts for importers, distributors, and sales agents, rather than for broad public applications, strengthening wine knowledge through the use of interactive learning tools.

Subcluster 2.8—Current Technological Limitations: High visual expectations were identified as a challenge for VR technology, as the current graphical capability of such technology often falls short of users' expectations compared to high-definition videos or immersive projection environments, thus prompting the consideration of alternative technologies.

Subcluster 2.9—VR Cannot Replace Authentic Experiences: The participants emphasized the fundamental limitation of VR in fully substituting real-world experiences, concluding that VR is effective as a tool for deepening the understanding of educational content, but fails if perceived as an experiential replacement.

Table 2 presents the key themes and the selected quotes identified in Cluster 2.

Table 2. Emerging themes and representative quotes from Cluster 2.

Subcluster	Emergent Themes	Representative Quotes
2.1 Effects on User Perception	Focused learning potential, user discomfort, and practical usability concerns	"Those using the viewer are forced to pay attention, avoiding distractions typical of other tools."
2.2 Physical and Cognitive Limitations	Headset discomfort, cognitive overload, usability barriers	"At the same time, I found it a bit uncomfortable: you need to focus on your balance."
2.3 Augmented Reality vs. Virtual Reality	Preference for AR, interaction with real-world contexts	"Augmented reality, on the other hand, allows the real experience to be enriched with digital content, leaving the perception of context intact."

Table 2. *Cont.*

Subcluster	Emergent Themes	Representative Quotes
2.4 Technology and Market Perception	Perceived as overly technical, suited better to B2B contexts	“In short, as it stands, VR may not be perfect, but with the right content and a well-defined purpose, it could prove to be a powerful tool for training and communication in B2B.”
2.5 Information Overload Risks	Risk of overwhelming users, need for clear target audience	“Therefore, the target audience must be taken into account.”
2.6 Complementary Role of VR	VR complementing real-life experiences, targeted educational and corporate uses	“In conclusion, VR can be a powerful educational tool, especially in the B2B arena, but it is not designed to replace the real experience nor to generate stronger emotions than a good narrative video or a vineyard visit.”
2.7 Contexts of VR Utility	B2B training contexts, specific applications for importers and distributors	“It could be useful for our importers, agents or distributors (B2B) to train and inform those who then have to present products to consumers.”
2.8 Current Technological Limitations	Graphical and technological shortcomings, preference for alternative high-definition technologies	“Often the use of the viewer returns a lower definition than the latest generation of TVs, and this can disappoint expectations.”
2.9 VR Cannot Replace Authentic Experiences	Limitation in replacing real-world experiences, VR as educational enhancement only	“However, the fact always remains that if a person is already in the suit, he or she can see and touch the real thing.”

The Supplementary Materials accompanying this paper provide detailed results from the recursive clustering procedure, including all the focus group sentences, their respective cluster assignments, and the distance from the second-level cluster centroids.

4.2.3. Conclusions from Second-Level Clustering

The detailed analysis of the second-level clustering clearly highlights the nuanced perspectives within each major thematic domain. The first primary cluster demonstrated VR’s considerable potential as an educational and communicative tool in regard to B2B wine training, underscored by careful consideration of brand authenticity and market-specific perceptions. Conversely, the second primary cluster reinforced VR’s inherent limitations, recommending complementary alternatives, such as augmented reality, immersive video technology, and traditional sensory-rich approaches, as more appropriate tools for consumer engagement and experience authenticity.

These findings offer critical insights for strategic planning in regard to deploying immersive technologies effectively within the wine industry, balancing innovation with tradition, technological sophistication with user acceptance, and enhancing wine education without compromising brand authenticity and heritage.

5. Discussion

This section discusses the main findings from the study in relation to the existing literature, addressing both the theoretical and practical implications. The discussion is structured to position the results within the broader body of research on the use of VR applications in regard to professional training and the wine industry, to reflect on the

achievements in terms of the research objectives, and to consider the study's limitations and directions for future research.

In particular, the first part of the discussion examines how the present findings align with, extend, or add nuance to existing contributions regarding the use of VR in regard to B2B sales training, wine education, and customer experience management. This is followed by a detailed reflection on how each of the study's research objectives has been addressed, focusing on the design principles, methodological contributions, and stakeholder insights emerging from the iterative development and evaluation process.

Subsequently, the discussion identifies key limitations of the study and proposes future research avenues to enhance the robustness, generalizability, and practical relevance of VR-based training solutions in regard to the international wine industry and beyond. Finally, the chapter outlines several practical implications for industry stakeholders, providing actionable guidance for the effective adoption and strategic integration of immersive technologies in B2B sales training programs.

5.1. Positioning the Findings Within the Literature

The findings from this study align with and extend several strands within the existing literature on VR applications in regard to both sales training and the wine industry. In line with the study by Baceviciute et al. [12], our results confirm that VR-based training enhances knowledge retention, engagement, and self-efficacy in professional learning contexts. Moreover, consistent with the studies by Wieland et al. [5] and Klico [13], this study reinforces the role of immersive technologies in improving B2B customer experiences and supporting sales force development.

At the same time, this research advances prior work by addressing a notable gap in the literature: while existing studies on VR in regard to wine education have largely focused on consumer-facing applications, such as wine tourism (Sousa et al. [1]; Wen and Leung [3]) and sensory learning (Torrico et al. [6]; Moonen et al. [2]), few have examined the specific needs of B2B international sales teams in the premium wine sector. By developing a stakeholder-driven, narrative-centered training application, this study provides empirical insights into how VR can be used to communicate terroir, brand heritage, and technical expertise in B2B contexts, complementing the trends identified by Mattiacci and Bruni [8] regarding the evolving demands in regard to sales capabilities in the wine industry.

Furthermore, the stakeholder feedback regarding market-specific differences in VR acceptance echoes prior findings on the cultural and contextual variability of technology adoption in wine marketing (Deng et al. [16]). The emphasis on complementarity between VR and traditional experiential methods also resonates with Beverland's [10] relational perspective on wine sales, underscoring the importance of maintaining authenticity and emotional resonance in regard to customer relationships.

In this way, the present study not only corroborates, but also adds nuance and extends the existing literature, offering a more comprehensive understanding of how VR can be strategically integrated into premium wine B2B sales training.

5.2. Research Objectives

Regarding the first research objective, the results highlight how the iterative, stakeholder-driven approach effectively identified and refined key design features, essential for a virtual reality (VR) application specifically aimed at training the international B2B sales force of a global wine brand. The systematic application of the Scrum framework, encompassing vision formulation, Product Backlog development, sprint planning, iterative sprint execution, and regular stakeholder reviews enabled continuous alignment of the

technical development with the specific training needs of sales representatives engaged in global markets.

The core training needs of the sales force were explicitly articulated by the stakeholders, including marketing experts, communication specialists, and international sales personnel, from the initial phase of vision formulation and Product Backlog definition. This collaborative approach identified the necessity of communicating complex terroir, historical heritage, and product differentiation information clearly and engagingly. The essential features identified included structured immersive storytelling, interactive digital maps that highlighted geographical and pedological characteristics, and realistic depictions of viticultural and cellar processes. By grounding the development in these targeted educational objectives, the resulting VR application directly addresses critical knowledge gaps commonly experienced by B2B sales representatives operating in diverse international contexts. During the subsequent phases of sprint planning and sprint execution, iterative development allowed the team to incrementally implement and refine these core features based on continuous stakeholder feedback. For example, detailed sprint planning sessions facilitated prioritization of specific training scenarios, such as vineyard management activities, cellar operations, and interactive 3D visualizations of the estates. Regular stakeholder interactions during these sprints ensured that the VR scenarios remained educationally relevant and directly applicable to the practical tasks required of the sales representatives in regard to their market interactions. Incremental development provided stakeholders with frequent opportunities to validate the realism, interactivity, and accuracy of the content, all of which are essential for effective training outcomes.

A distinctive outcome of the iterative Scrum process was the structured, consequential storytelling within the VR application, effectively communicating brand values, tradition, and technical information, essential for sales force education. By systematically presenting distinct terroir attributes and the unique features of each estate (Pèppoli, Tignanello, and Badia a Passignano), the VR training tool directly addresses the B2B sales representatives' need to articulate product differentiation convincingly to international buyers. Regular stakeholder feedback underscored the significance of these structured narratives for improving both the understanding and retention of critical sales arguments in regard to international markets.

Finally, the sprint review and systematic qualitative evaluation through the use of structured focus groups validated the educational effectiveness of the VR solution. The feedback from the sales and marketing stakeholders clearly indicated the potential of the application to significantly enhance the quality and effectiveness of training for international B2B markets. The application was perceived as particularly beneficial for educating distributors, importers, and sales agents, enabling them to more effectively communicate brand heritage, product authenticity, and detailed terroir-driven characteristics to diverse international clientele.

In conclusion, employing the iterative Scrum methodology allowed the development team to identify, prioritize, and continuously refine essential VR application features, explicitly targeted toward enhancing B2B sales force education. This approach not only facilitated the effective transfer of complex educational content, but also enhanced sales representatives' ability to clearly articulate brand identity and differentiate product offerings in regard to the competitive international wine market.

The second research objective was to systematically analyze stakeholders' perceptions of the strengths, limitations, and potential alternatives to using VR for international B2B training in the wine industry. The results obtained from the structured qualitative evaluation, conducted through the use of focus groups involving marketing, communications, and international sales representatives, and analyzed using NLP embedding vectors and

recursive clustering, provided detailed insights into these dimensions. The first primary thematic cluster revealed significant acknowledgment of VR's strengths and opportunities within the wine industry, especially for its capacity to deliver compelling, interactive, and highly informative training experiences. The stakeholders underlined VR's unique potential to communicate complex, technical content, such as geological, pedological, climatic, and viticultural characteristics of the terroir, more effectively than traditional static presentations. The interactive and immersive features were particularly valued in the context of distributor, importer, and sales force training, wherein engagement with and retention of detailed technical knowledge are critical. Moreover, the stakeholders pointed out that VR offers clear advantages in regard to providing consistent, accurate educational content globally, which is crucial for the delivery of standardized training across international markets.

Conversely, the analysis of the second thematic cluster clearly identified key perceived limitations and boundaries in regard to the widespread adoption of VR across various contexts. Stakeholders consistently stressed the inherent limitations of virtual experiences compared to authentic vineyard or cellar visits. The physical discomfort of prolonged headset use, potential cognitive fatigue, and the possible emotional disconnection from traditional wine experiences were recurrently identified. Additionally, stakeholders emphasized significant market-dependent variability, highlighting that consumer acceptance and business perceptions of VR vary notably across global markets. European audiences were described as more conservative, raising concerns about authenticity and brand integrity when traditional sensory-rich experiences are replaced with technologically mediated experiences.

Importantly, stakeholders proposed and evaluated potential complementary or alternative technologies that may overcome some limitations of fully immersive VR experiences. Notable among these alternatives were augmented reality (AR) solutions, immersive projection rooms ("immersive rooms"), and high-definition multimedia experiences, featuring large screens or advanced audiovisual effects. Such technologies were seen as offering comparable educational effectiveness, potentially reducing discomfort and enhancing the overall acceptance among different user groups.

In summary, the analytical results underscore VR's potential as a powerful educational tool in international B2B contexts, highlighting its strengths in regard to delivering immersive, interactive, and globally consistent training experiences. Simultaneously, stakeholders clearly outlined practical limitations and market-specific acceptance challenges, emphasizing that successful deployment requires complementary, rather than substitutive, strategies. This nuanced understanding supports the importance of informed strategic choices, balancing innovative technological integration with traditional wine experiences to maximize effectiveness and acceptance in diverse international contexts.

The third research objective examined the effectiveness of the NLP-based analytical methodology applied in this study for systematically identifying and interpreting thematic insights from stakeholder feedback. The study aimed to continuously improve the VR training application. The advanced analytical approach, which combined NLP embeddings generated through OpenAI's 'text-embedding-ada-002' model, dimensionality reduction via UMAP and hierarchical recursive k-means clustering, proved to be highly effective in transforming qualitative data into structured, interpretable themes. The embedding-based NLP methodology demonstrated significant advantages over traditional qualitative analysis approaches (e.g., manual coding or classic topic modelling), notably in capturing the nuanced, contextually rich, and semantically accurate dimensions of the stakeholder perceptions. By translating textual data into semantic vector representations, the method retained critical context and meaning, enabling deeper thematic granularity and more

accurate interpretation of complex stakeholder feedback. Furthermore, dimensionality reduction through the use of UMAP facilitated clear visualizations of the semantic groupings, thereby enhancing the interpretability of thematic clusters.

The recursive clustering approach further reinforced the effectiveness of this analytical methodology. Through iterative clustering, the analysis successfully delineated both broad thematic domains and detailed subthemes. For example, the initial clusters clearly separated general attitudes toward VR adoption into supportive and critical dimensions, while subsequent recursive clustering revealed nuanced perceptions, such as specific educational strengths of VR, concerns related to brand authenticity, and market-specific acceptance issues. Such detailed thematic insights would be challenging to identify using conventional qualitative methodologies alone, underscoring the value of the NLP-based approach.

Additionally, the methodology proved valuable for rapidly and systematically integrating stakeholder feedback into actionable insights for iterative product development. By objectively quantifying the semantic patterns in qualitative feedback, the method effectively supported the Scrum-based iterative process, guiding developers to prioritize relevant enhancements and strategically refine the training content based on validated stakeholder perspectives.

Overall, the results confirmed that the NLP-based analytical approach employed in this study provides a powerful, objective, and effective method for systematically extracting thematic insights from stakeholder feedback. Its capability to identify detailed semantic nuances supports data-driven decision making, continuous improvement, and strategic refinement of VR-based training solutions in complex international B2B sales contexts.

5.3. Limits of the Work and Future Research

Despite its contributions, this study has several limitations that should be considered when interpreting its findings. Firstly, the selection of Marchesi Antinori as a case study, characterized by its substantial size, rich history, and emphasis on tradition, may restrict the applicability of the results to the wider wine industry. Antinori's strong reliance on tradition and authenticity uniquely positions it among large-scale, heritage-driven wine enterprises. Consequently, the stakeholder skepticism identified towards VR adoption for direct consumer interactions (B2C) may reflect organizational and cultural contexts rather than universally applicable perceptions. Indeed, the prior literature provides evidence that immersive VR experiences can be positively received by consumers in various wine tourism contexts, especially when enhanced by elements of social presence and environmental realism [7].

Secondly, the qualitative evaluation conducted via the focus group only involved internal stakeholders, specifically marketing, communication, and international sales representatives. To achieve broader validity, future research could include a more diverse range of external stakeholders, such as international distributors, importers, sommeliers, and end consumers. This would provide a more comprehensive evaluation and validate the findings beyond organizational boundaries.

Additionally, the study did not include a formal usability evaluation of the VR application, thus limiting the insights on interface intuitiveness, user friendliness, and ease of use. Future research should incorporate structured usability assessments, such as usability testing protocols or standardized usability scales, to ensure the effectiveness and practicality of the training application from the user perspective.

Furthermore, while the NLP-based analytical approach offered significant advantages in regard to systematically extracting thematic insights from stakeholder feedback, the results are dependent on specific computational choices and embedding models. Compara-

tive studies employing alternative embedding techniques, advanced transformer-based models, or supervised analytical methods could further validate and potentially enhance the thematic accuracy and interpretability.

Moreover, due to the brief evaluation period, the long-term impact of the VR training application remains unclear, including sustained user engagement, knowledge retention, and effectiveness in real-world sales contexts. Therefore, future longitudinal research is necessary to provide comprehensive insights into long-term training outcomes and market impacts.

In addition, it is important to acknowledge that the use of a relatively small, internal company sample within the focus group may limit the generalizability of the study's findings. While the participants were purposefully selected to represent diverse internal perspectives relevant to the VR application's intended use context, the sample size and internal company focus inherently restrict the breadth of the external validity. Therefore, future research should consider incorporating a broader range of external stakeholders, including distributors, importers, and end users, to enhance the generalizability and robustness of the insights obtained.

Lastly, the stakeholder feedback highlighted interest in exploring complementary technologies, such as augmented reality (AR), immersive projection environments, and high-definition interactive videos. Comparative studies examining these alternative technologies could provide valuable insights into their relative effectiveness, acceptance, and potential integration within international B2B sales training programs.

Addressing these limitations through broader stakeholder engagement, formal usability evaluations, comparative technology analyses, and longitudinal assessments would enhance the robustness and generalizability of future research findings, guiding more effective implementation of immersive training solutions across diverse contexts in the wine industry.

5.4. Practical Implications

This research has several practical implications for practitioners and managers in the wine industry, particularly about the effective implementation of immersive virtual reality (VR) technologies in regard to international B2B sales force training. Firstly, the structured, iterative development process demonstrated here, guided by active stakeholder participation and iterative refinement, represents a practical and effective framework for ensuring alignment between technological innovations and educational objectives. Companies looking to improve their sales force training programs using immersive technologies should adopt similar iterative methodologies, ensuring continual stakeholder involvement and integrating feedback to optimize the relevance and usability of the content, and the overall effectiveness of the training.

Secondly, the detailed findings regarding the strengths and limitations of VR offer concrete guidance on the strategic deployment of immersive technologies. Practitioners should recognize that VR can effectively communicate complex technical information, heritage storytelling, and terroir-specific details, particularly in structured educational contexts for distributors, importers, and sales representatives. However, they should also consider the identified limitations, notably user discomfort and the potential perception of VR as overly technical or impersonal. Accordingly, VR applications should be carefully targeted towards specific educational goals and clearly defined market segments, rather than replacing traditional experiential practices wholesale.

Furthermore, this study highlights the importance of tailoring immersive technological solutions to diverse international markets. Practical insights gained from stakeholder feedback suggest that the acceptance of VR varies across geographic regions, with higher

levels of acceptance in markets such as the United States and China, and more conservative attitudes in Europe. Managers should, therefore, strategically adapt immersive solutions and content delivery to the cultural preferences, acceptance levels, and specific expectations of their target markets.

As this study is based on a single-case analysis centered on Marchesi Antinori, a highly resourced, heritage-driven, premium wine producer, certain findings may reflect characteristics specific to large-scale, internationally recognised wineries, with strong brand narratives and substantial investment capacity. The emphasis on immersive storytelling, the integration of historical and terroir-based content, and stakeholder-driven iterative development may be particularly applicable to producers operating in the premium or super-premium segments of the wine market.

However, smaller producers or those in different geographic markets may face practical constraints when adopting similar VR-based training solutions, such as limited resources for content production or reduced access to technical expertise. Nevertheless, many of the design principles identified in this study, such as the importance of narrative coherence, stakeholder engagement, and brand identity alignment, could be adapted for more modest contexts or different cultural markets. This could be achieved through lighter weight immersive formats, such as augmented reality or 360° video, or collaborative industry initiatives.

Future research could explore how such adaptations might be implemented in smaller scale wineries or emerging wine regions, thereby extending the applicability of the present findings.

Finally, the analytical approach demonstrated here, which is based on NLP embedding techniques, provides practitioners with a robust, objective method to systematically analyze qualitative feedback from stakeholders. Companies seeking continuous improvement and data-driven decision making in regard to product development and training programs could adopt similar NLP-based analytical methods. These approaches allow organizations to quickly and objectively identify user insights, strengths, limitations, and areas for improvement, thus improving the organization's responsiveness and strategic decision making.

Beyond the specific context of the wine industry, the findings from this study also offer insights that are relevant to the broader landscape of digital transformation in luxury and heritage-based sectors. Industries such as haute couture, fine art, jewelry, and high-end hospitality face similar challenges in balancing technological innovation with the preservation of brand authenticity, craftsmanship, and cultural narratives. In these domains, immersive technologies, such as VR and AR, are increasingly being explored as tools for enhancing the customer experience, supporting storytelling, and enabling new forms of engagement, while maintaining the emotional and symbolic value of heritage products [36]. The present study reinforces the importance of adopting iterative, stakeholder-driven approaches to ensure that immersive solutions are culturally aligned and perceived as authentic, a principle that can inform digital innovation strategies across other sectors, where brand heritage and emotional resonance are key drivers of customer value.

6. Conclusions

This study provides valuable insights into the emerging field of immersive technology use for international B2B sales force training, with a particular focus on the premium wine industry. Adopting a distinctive, iterative, stakeholder-driven development methodology enabled this research to effectively identify and validate the key design features necessary for communicating brand heritage, terroir-specific details, and product knowledge clearly through virtual reality (VR). A notable aspect of the study's originality lies in its integration

of advanced natural language processing (NLP) embedding techniques, combined with recursive clustering analyses, which systematically transformed qualitative stakeholder feedback into actionable insights for continuous improvement. Furthermore, by openly acknowledging the strengths of VR and critically evaluating its limitations, this study highlights the need for complementary technological solutions, thereby providing robust and nuanced guidance for industry practitioners. The methodological and analytical frameworks proposed offer substantial practical value, equipping wine businesses with effective, data-driven strategies for optimizing immersive technologies within international market training initiatives.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/jtaer20020146/s1>. Detailed results of the recursive clustering procedure, including all focus group sentences, their respective cluster assignments, and the distance from second-level cluster centroids.

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Institutional Review Board Statement: This study involved a focus group with internal company stakeholders (marketing, sales, and communication staff). All participants were adults, participated voluntarily, and provided informed consent. No sensitive personal data or health-related information was collected. According to institutional and national guidelines, ethical approval was not required as the study did not fall under the scope of biomedical research as defined by the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are contained within the Supplementary Materials.

Conflicts of Interest: The authors declare that there are no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

B2B	Business to Business
CRM	Customer Relationship Management
ICVR	Immersive Collaborative Virtual Reality
LDA	Latent Dirichlet Allocation
NLP	Natural language processing
UMAP	Uniform Manifold Approximation and Projection
VR	Virtual reality

Appendix A NLP and Clustering Methods: Technical Details

The analytical procedure employed in this study integrates sophisticated techniques, namely natural language processing (NLP), embedding methodologies, dimensionality reduction, and cluster analysis, to systematically uncover and interpret meaningful thematic patterns from qualitative textual data.

The decision to adopt an embedding-based approach instead of traditional topic modeling techniques, such as Latent Dirichlet Allocation (LDA) [37], is grounded on several theoretical and methodological advantages. While LDA is a widely employed probabilistic method that identifies latent topics within large textual corpora, based on statistical distributions of words, it inherently assumes a bag-of-words structure, thus

disregarding contextual semantics and word order. Conversely, embedding-based methods retain the contextual and semantic richness by considering the relationships among the words and their positioning within sentences, thereby offering greater interpretative depth and semantic accuracy [38]. Consequently, embedding-based NLP analysis provides a more nuanced and detailed representation of complex thematic structures, which is particularly beneficial in regard to analyzing qualitative data, where subtle meanings and semantic relationships significantly influence interpretative accuracy.

Initially, the textual corpus T was segmented into sentences $S = \{s_1, s_2, \dots, s_n\}$, enabling granular semantic analysis [39].

Subsequently, each sentence was converted into numerical vector $\mathbf{e}_i \in \mathbb{R}^d$ representations, using embedding algorithms provided by OpenAI's "text-embedding-ada-002" model, with $d = 1536$. Formally, this process can be expressed as:

$$\mathbf{e}_i = \text{EmbeddingModel}(s_i), \mathbf{e}_i \in \mathbb{R}^{1536}$$

The concept of embeddings originates from NLP, where words, sentences, or entire documents are mapped into high-dimensional numerical vector spaces, preserving the semantic relationships and contextual nuances present within the text [38,40]. Embeddings are generated by deep learning models trained on large-scale textual datasets, enabling the capturing of rich semantic and syntactic information through the positional relationships between vectors. In other words, sentences that share similar meanings tend to have embedding vectors positioned close together in the vector space, while semantically distant sentences occupy separate regions.

The decision to adopt OpenAI's embedding model ("text-embedding-ada-002") rather than other well-established language models, like BERT [38], Word2Vec [40], GloVe [41], or FastText [42], is supported by specific methodological considerations. While models such as Word2Vec, GloVe, and FastText effectively capture semantic relationships among individual words through static embeddings, they lack deep contextual sensitivity and cannot fully represent sentence-level semantics. BERT and similar transformer-based models provide context-sensitive embeddings, capable of capturing rich linguistic nuances; however, these models can become computationally expensive and challenging to fine tune without substantial domain-specific data [38].

Due to the high dimensionality of embedding vectors, the Uniform Manifold Approximation and Projection (UMAP) technique was applied for dimensionality reduction, condensing embeddings into lower dimensional representations $\mathbf{u}_i$, while preserving their intrinsic semantic relationships.

$$\mathbf{u}_i = \text{UMAP}(\mathbf{e}_i), \mathbf{u}_i \in \mathbb{R}^m, m \ll d$$

UMAP effectively maintains the original data structure, enabling a meaningful interpretation of clustered thematic patterns. While traditional methods, such as Principal Component Analysis (PCA), rely on linear transformations and assume that data structures can be effectively represented in a linear, orthogonal subspace [43], textual embeddings typically embody complex, non-linear semantic relationships [44]). PCA's linear assumptions may inadequately capture these intricate data patterns, resulting in potential information loss and oversimplification of the data's semantic structure. Therefore, Uniform Manifold Approximation and Projection (UMAP) was preferred due to its ability to model the non-linear and high-dimensional structure of textual embeddings more effectively. UMAP achieves dimensionality reduction by constructing a high-dimensional graph representation of the data and optimizing it into a lower dimensional manifold that preserves both local and global data structures, thus offering improved semantic interpretability compared

to PCA [44]. Consequently, employing UMAP in this study allowed for a richer and more nuanced representation of sentence embeddings, enhancing the clustering accuracy and interpretability of the resulting thematic clusters.

Following dimensionality reduction, the k-means clustering algorithm, a form of unsupervised machine learning, was used to identify naturally occurring thematic groupings. K-means partitions the data into k clusters $C = \{C_1, C_2, \dots, C_k\}$, minimizing the within-cluster variance:

$$\operatorname{argmin}_C \sum_{j=1}^k \sum_{\mathbf{u}_i \in C} \|\mathbf{u}_i - \boldsymbol{\mu}_j\|^2 \quad (\text{A1})$$

where $\boldsymbol{\mu}_j$ denotes the centroid of cluster C_j .

The optimal number of clusters (k^*) was determined using multiple validation metrics, selected for their complementary strengths in assessing clustering quality from different perspectives. Specifically, the Within-Cluster Sum of Squares (WSS) was used to measure cluster compactness and to support the “elbow method” in identifying the optimal number of clusters. The Davies–Bouldin Index (DBI) provided a combined evaluation of intra-cluster similarity and inter-cluster separation, where lower values indicate better defined clusters. The Calinski–Harabasz Index (CHI) quantified the ratio of between-cluster dispersion to within-cluster dispersion, with higher values suggesting more distinct clustering structures. In addition, silhouette scores were applied as an intuitive measure of how well each data point fits within its assigned cluster, further supporting the interpretability of the results. The combined use of these metrics enabled a balanced and robust validation of the clustering outcomes in regard to both first-level and second-level recursive clustering.

A summary of these validation metrics, their purpose, interpretation, and application within this study is presented in Table A1.

Table A1. Summary of clustering validation metrics: purpose, interpretation, and application in this study.

Metric	Purpose	Interpretation
Within-cluster Sum of Squares (WSS)	Assesses cluster compactness and supports the elbow method	Lower WSS suggests more compact clusters
Davies–Bouldin Index (DBI)	Evaluates intra-cluster similarity vs. inter-cluster separation	Lower DBI indicates better defined clusters
Calinski–Harabasz Index (CHI)	Measures between-cluster vs. within-cluster dispersion	Higher CHI suggests more distinct clusters
Silhouette Score	Assesses how well each data point fits its cluster	Higher silhouette score indicates better cluster assignment

The WSS measuring the internal cluster cohesion, computed as:

$$\text{WSS} = \operatorname{argmin}_C \sum_{j=1}^k \sum_{\mathbf{u}_i \in C} \|\mathbf{u}_i - \boldsymbol{\mu}_j\|^2, \quad k^* = \operatorname{argmin}_k \text{WSS}(k) \quad (\text{A2})$$

The DBI measures compactness and separation between clusters [45]:

$$\text{DBI} = \frac{1}{k} \sum_{j=1}^k \max_{l \neq j} \left(\frac{\sigma_j + \sigma_l}{\|\boldsymbol{\mu}_j - \boldsymbol{\mu}_l\|} \right), \quad k^* = \operatorname{argmin}_k \text{DBI}(k) \quad (\text{A3})$$

The CHI evaluates clustering quality by assessing the ratio of between-cluster variance to within-cluster variance [46]:

$$\text{CHI} = \frac{\text{Between-cluster variance}}{\text{Within-cluster variance}} \times \frac{(n-k)}{(k-1)}, \quad k^* = \operatorname{argmax}_k \text{CHI}(k) \quad (\text{A4})$$

The silhouette method further assessed cluster cohesion and separation, thus providing robust validation of the cluster structure [47,48]:

$$S(i) = \frac{b(i) - a(i)}{\max\{a(i), b(i)\}}, \bar{S} = \frac{1}{n} \sum_{i=1}^n S(i), k^* = \operatorname{argmax}_k \bar{S}(k) \quad (\text{A5})$$

with $a(i)$ being the average intra-cluster distance and $b(i)$ being the minimum average distance to points in other clusters.

Additionally, the analysis was enriched through the use of a recursive clustering approach, allowing primary clusters to undergo further clustering iterations and revealing finer thematic nuances. Representative sentences, selected due to their proximity to cluster centroids, provided clarity and facilitated precise thematic interpretations [39].

After determining the optimal clustering, the procedure was recursively applied to each primary cluster to uncover more detailed thematic structures:

$$C_j^{(sub)} = \text{k-means}(U_i), U_j \subseteq U, j \in \{1, \dots, k^*\} \quad (\text{A6})$$

Finally, the representative sentences for each cluster were identified by measuring the distances between each embedding vector $\mathbf{u}_i$ and the cluster centroids $\boldsymbol{\mu}_j$:

$$\text{Representative}(C_i) = \left\{ s_i \mid \mathbf{u}_i \in C_j, \|\mathbf{u}_i - \boldsymbol{\mu}_j\| \rightarrow \min \right\} \quad (\text{A7})$$

Hence, the embedding-based analytical procedure implemented in this research combines the theoretical strengths of deep semantic representation as a result of advanced NLP techniques with rigorous statistical clustering methods. It provides a more contextually informed and semantically nuanced analysis compared to traditional topic modelling methods, enabling the gathering of richer interpretative insights from qualitative textual data.

In order to provide full transparency and reproducibility, the key analytical parameters used for embedding, dimensionality reduction, and clustering are summarized in Table A2.

Table A2. Analytical parameters used for embedding, dimensionality reduction (UMAP), and clustering (k-means).

Component	Parameter/Setting	Value
Embedding model	Embedding model used	text-embedding-ada-002
	Number of embedding dimensions	1536
UMAP dimensionality reduction	Number of neighbors	15
	Minimum distance	0.1
	Similarity metric	Euclidean
	Number of components	60
K-means clustering	Cluster initialization method	k-means++
	Number of clusters	Selected via validation (Table 1)
	Number of initializations	10
	Maximum number of iterations	300
	Random state for reproducibility	42
Clustering validation metrics	Validation metrics used	WSS, DBI, CHI, silhouette score

References

1. Sousa, N.; Alén, E.; Losada, N.; Melo, M. Virtual reality in wine tourism: Immersive experiences for promoting travel destinations. *J. Vacat. Mark.* **2024**. [CrossRef]
2. Moonen, N.; Heller, J.; Hilken, T.; Han, D.-I.D.; Mahr, D. Immersion or social presence? Investigating the effect of virtual reality immersive environments on sommelier learning experiences. *J. Wine Res.* **2024**, *35*, 101–118. [CrossRef]
3. Wen, H.; Leung, X.Y. Virtual wine tours and wine tasting: The influence of offline and online embodiment integration on wine purchase decisions. *Tour. Manag.* **2021**, *83*, 104250. [CrossRef]
4. Boyd, D.E.; Koles, B. Virtual reality and its impact on B2B marketing: A value-in-use perspective. *J. Bus. Res.* **2019**, *100*, 590–598. [CrossRef]
5. Wieland, D.A.; Ivens, B.S.; Kutschma, E.; Rauschnabel, P.A. Augmented and virtual reality in managing B2B customer experiences. *Ind. Mark. Manag.* **2024**, *119*, 193–205. [CrossRef]
6. Torrico, D.D.; Han, Y.; Sharma, C.; Fuentes, S.; Viejo, C.G.; Dunshea, F.R. Effects of context and virtual reality environments on the wine tasting experience, acceptability, and emotional responses of consumers. *Foods* **2020**, *9*, 191. [CrossRef]
7. Deng, D.S.; Seo, S.; Harrington, R.J.; Martin, D. When virtual others are with me: Exploring the influence of social presence in virtual reality wine tourism experiences. *Int. J. Wine Bus. Res.* **2024**, *36*, 548–571. [CrossRef]
8. Mattiacci, A.; Bruni, A.; Magno, F.; Cassia, F. Sales capabilities in the wine industry: An analysis of the current scenario and emerging trends. *Br. Food J.* **2019**, *121*, 3380–3395. [CrossRef]
9. Gultek, M.M.; Dodd, T.H.; Guydosh, R.M. Attitudes towards wine-service training and its influence on restaurant wine sales. *Int. J. Hosp. Manag.* **2006**, *25*, 432–446. [CrossRef]
10. Beverland, M. Are salespeople relationship oriented? (And do they need to be?) A study based on the New Zealand wine industry. *Int. J. Wine Mark.* **1999**, *11*, 47–64. [CrossRef]
11. Benson-Rea, M.; Woodfield, P.; Brodie, R.J.; Lewis, N. Sustainability in strategy: Maintaining a premium position for New Zealand wine. In Proceedings of the 6th AWBR International Conference, Bordeaux, France, 9–10 June 2011.
12. Baceviciute, S.; Cordoba, A.L.; Wismer, P.; Jensen, T.V.; Klausen, M.; Makransky, G. Investigating the value of immersive virtual reality tools for organizational training: An applied international study in the biotech industry. *J. Comput. Assist. Learn.* **2022**, *38*, 470–487. [CrossRef]
13. Klico, A. How using virtual reality can improve B2B marketing. In *BH Ekonomski Forum*; Ekonomski Fakultet-Univerzitet u Zenici: Zenica, Bosnia, 2022; pp. 27–40.
14. Bamberger, B.; Reinartz, W.; Ulaga, W. Navigating the future of B2B marketing: The transformative impact of the industrial metaverse. *J. Bus. Res.* **2025**, *188*, 115057. [CrossRef]
15. Freina, L.; Ott, M. A literature review on immersive virtual reality in education: State of the art and perspectives. In Proceedings of the International Scientific Conference Elearning and Software for Education, Bucharest, Romania, 23–24 April 2015; Volume 1, pp. 10–1007.
16. Wilson, A. Utilizing Advanced Technology in Salesforce to Enhance CRM and Problem Solving. *Management (IJCRM)* **2024**, *3*, 1–11.
17. Schwaber, K.; Beedle, M. *Agile Software Development with Scrum*; Prentice Hall: Hoboken, NJ, USA, 2002.
18. Schwaber, K.; Sutherland, J. The Scrum Guide 2020: The Definitive Guide to Scrum: The Rules of the Game. Available online: <https://scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-US.pdf> (accessed on 1 June 2024).
19. Rubin, K.S. *Essential Scrum: A Practical Guide to the Most Popular Agile Process*; Addison-Wesley: Boston, MA, USA, 2012.
20. Royce, W.W. Managing the Development of Large Software Systems. *Proc. IEEE Wescon* **1970**, *26*, 328–338.
21. Petersen, K.; Wohlin, C.; Baca, D. The waterfall model in large-scale development. In *Product-Focused Software Process Improvement*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 386–400.
22. Moe, N.B.; Dingsøyr, T.; Dybå, T. A teamwork model for understanding an agile team: A case study of a Scrum project. *Inf. Softw. Technol.* **2010**, *52*, 480–491. [CrossRef]
23. Lei, H.; Ganjeizadeh, F.; Jayachandran, P.K.; Ozcan, P. A statistical analysis of the effects of Scrum and Kanban on software development projects. *Robot. Comput. Manuf.* **2017**, *43*, 59–67. [CrossRef]
24. Ahmad, M.O.; Markkula, J.; Oivo, M. Kanban in software development: A systematic literature review. In Proceedings of the 2013 39th Euromicro Conference on Software Engineering and Advanced Applications, Santander, Spain, 4–6 September 2013; pp. 9–16.
25. Highsmith, J. *Agile Project Management: Creating Innovative Products*; Addison-Wesley Professional: Boston, MA, USA, 2009.
26. Pichler, R. *Agile Product Management with Scrum: Creating Products that Customers Love*; Addison-Wesley: Boston, MA, USA, 2010.
27. Schwaber, K. *Agile Project Management with Scrum*; Microsoft Press: Redmond, WA, USA, 2004.
28. Sutherland, J.; Schwaber, K. The Scrum Guide 2013: The Definitive Guide to Scrum: The Rules of the Game. Available online: <https://scrumguides.org/docs/scrumguide/v1/Scrum-Guide-US.pdf> (accessed on 1 June 2024).
29. Cohn, M. *User Stories Applied: For Agile Software Development*; Addison-Wesley: Boston, MA, USA, 2004.

30. Brooke, J. SUS: A quick and dirty usability scale. In *Usability Evaluation in Industry*; Jordan, P.W., Thomas, B., Weerdmeester, B.A., McClelland, I.L., Eds.; Taylor & Francis: Milton Park, UK, 1996; pp. 189–194.
31. Lewis, J.R. IBM Computer Usability Satisfaction Questionnaires: Psychometric evaluation and instructions for use. *Int. J. Hum. Comput. Interact.* **1995**, *7*, 57–78. [\[CrossRef\]](#)
32. Jerald, J. *The VR Book: Human-Centered Design for Virtual Reality*; Morgan & Claypool Publishers: San Rafael, CA, USA, 2015.
33. Morgan, D.L. *Focus Groups as Qualitative Research*, 2nd ed.; Sage Publications: Thousand Oaks, CA, USA, 1997.
34. Krueger, R.A.; Casey, M.A. *Focus Groups: A Practical Guide for Applied Research*, 5th ed.; Sage Publications: Thousand Oaks, CA, USA, 2015.
35. Stewart, D.W.; Shamdasani, P.N. *Focus Groups: Theory and Practice*, 3rd ed.; Sage Publications: Thousand Oaks, CA, USA, 2014.
36. Bonetti, F.; Warnaby, G.; Quinn, L. Augmented reality and virtual reality in physical and online retailing: A review, synthesis and research agenda. In *Augmented Reality and Virtual Reality: Empowering Human, Place and Business*; Springer: Cham, Switzerland, 2018; pp. 119–132.
37. Blei, D.M.; Ng, A.Y.; Jordan, M.I. Latent Dirichlet Allocation. *J. Mach. Learn. Res.* **2003**, *3*, 993–1022.
38. Devlin, J.; Chang, M.W.; Lee, K.; Toutanova, K. BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. *arXiv* **2019**, arXiv:1810.04805.
39. Silge, J.; Robinson, D. *Text Mining with R: A Tidy Approach*; O'Reilly Media, Inc.: Sebastopol, CA, USA, 2017.
40. Mikolov, T.; Chen, K.; Corrado, G.; Dean, J. Efficient estimation of word representations in vector space. *arXiv* **2013**, arXiv:1301.3781.
41. Pennington, J.; Socher, R.; Manning, C.D. GloVe: Global Vectors for Word Representation. In Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP), Doha, Qatar, 25–29 October 2014; pp. 1532–1543.
42. Joulin, A.; Grave, E.; Bojanowski, P.; Mikolov, T. Bag of Tricks for Efficient Text Classification. *arXiv* **2017**, arXiv:1607.01759.
43. Jolliffe, I.T.; Cadima, J. Principal component analysis: A review and recent developments. *Philos. Trans. R. Soc. A Math. Phys. Eng. Sci.* **2016**, *374*, 20150202. [\[CrossRef\]](#) [\[PubMed\]](#)
44. McInnes, L.; Healy, J.; Melville, J. UMAP: Uniform Manifold Approximation and Projection for Dimension Reduction. *arXiv* **2018**, arXiv:1802.03426.
45. Davies, D.L.; Bouldin, D.W. A cluster separation measure. *IEEE Trans. Pattern Anal. Mach. Intell.* **1979**, *1*, 224–227. [\[CrossRef\]](#)
46. Calinski, T.; Harabasz, J. A dendrite method for cluster analysis. *Commun. Stat.* **1974**, *3*, 1–27.
47. Rousseeuw, P.J. Silhouettes: A Graphical Aid to the Interpretation and Validation of Cluster Analysis. *J. Comput. Appl. Math.* **1987**, *20*, 53–65. [\[CrossRef\]](#)
48. Petukhova, A.; Matos-Carvalho, J.P.; Fachada, N. Text clustering with large language model embeddings. *Int. J. Cogn. Comput. Eng.* **2025**, *6*, 100–108. [\[CrossRef\]](#)

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