

Embedding Emotions in the Metaverse: The Emotive Keywords for Augmented Reality Mobile Library Application

Nik Azlina Nik Ahmad¹, Munaisyah Abdullah², Ahmad Iqbal Hakim Suhaimi³, Anitawati Mohd Lokman^{4*}

Universiti Kuala Lumpur, Software Engineering Section

Malaysian Institute of Information Technology, Kuala Lumpur, Malaysia^{1,2}

College of Computing, Informatics and Mathematics, Universiti Teknologi MARA, Shah Alam, Malaysia^{3,4}

Abstract—The emergence of the metaverse, marked by the seamless integration of augmented reality (AR) applications across various sectors is driving a profound transformation in the digital landscape. As we delve into the digital realm of the metaverse, just like other applications, it unfolds as an equally captivating canvas for emotional exploration, where a comprehensive understanding of human emotion for better user experience (UX) is vital. Although the efforts to investigate emotions within the metaverse are in progress, however there is a notable absence of extensive research that examines the user's emotional experiences which incorporates a tailored set of keywords specifically for designing user interface (UI) products within this context, resulting in a substantial void in this particular domain. Therefore, the objective of this research is to synthesise and validate an extensive array of emotive keywords explicitly tailored for AR-based Mobile Library Application (MLA) design. This endeavor involves an exhaustive review of literature and a rigorous validation process, encompassing input from both linguistic and technical experts in the field. The result is an explicit collection of sixty emotive keywords that will significantly contribute to the metaverse realm by adding a layer of emotional depth to enrich the AR-based MLA experience. These findings offer valuable guidance for practitioners and researchers, advancing the landscape of MLA interface design and ultimately boosting UX in the educational sector.

Keywords—Affective engineering; emotional design; human factor; Kansei engineering; metaverse library; mobile augmented reality; user experience

I. INTRODUCTION

In the evolving landscape of app design, the value of comprehending human emotions remains paramount. These emotions underpin the very essence of user experiences (UX) and the connections we forge with digital interfaces. As we venture into the metaverse; a realm that offers limitless possibilities and unprecedented interactivity, it becomes abundantly clear that comprehending and embedding human emotions is the key to developing engaging immersive experiences. In this digital frontier, where reality and imagination converge, the complex landscape of the metaverse rings us to explore the depth of human perception, leading us to new perspectives in app design; the emotional design.

The field of emotive design has a strong connection to Kansei Engineering (KE) [1], a methodology originating from the domain of emotional design research to efficiently navigate

the various emotions that individuals may experience throughout their interaction with a product. In the field of affective engineering, KE is widely recognized as a dynamic methodology that effectively interprets implicit emotions and transforms them into tangible attributes for products [2]. This unique ability refreshes the product design process by seamlessly integrating consumer emotions with innovation. These products, which have been carefully calibrated to elicit an emotional response, easily trigger a deep bond between the consumer and the product, thus engage their interest. KE relies on domain-specific lexical terminologies known as "Kansei Words" (KW), which often referred to as "emotive keywords" [3]. These KW's function as communicative pathways, reflecting the users' emotional experiences and perceptions as they engage with diverse product designs [4]. Each emotive keyword is carefully constructed to portray the subtle emotional reactions that consumers feel towards a particular product.

In an era characterized by the rapid rise of metaverse technology, the need of integrating emotive design principles becomes evident. The digital environment is a source for innovation, holding a wide range of apps, each with the ability to evoke distinct emotions and deeply engage users. However, it begs the question of how thoroughly the previous research have investigated the field of emotional design, providing pertinent information for the continuous improvement in this research context. Has this been sufficiently addressed by prior research?

Undoubtedly, research focusing on emotions within the metaverse has gained considerable attention from scholars. However, most of these studies tend to focus on usability challenge [5]–[8], characteristics [9], key issues [10], or solely on the developmental aspects [11]–[13]. Within the domain of KE, a number of research initiatives have delved into Kansei studies, exploring keywords and producing sets of appropriate KWs for particular application categories. However, these endeavors often maintain a broad perspective, exemplified by [14], which presented a comprehensive compilation of more than 800 keywords that are relevant to IT-based products in general. Conversely, alternative research endeavors concentrate their attention on specific categories of applications, such as web-based [15], [16] or mobile-based applications [17], [18]. Nevertheless, their investigations primarily centered around conventional application types. Despite the fact that [19] attempted to cover innovative products by examining keywords for pervasive applications, their study still broad in scope, as it

encompassed a wide range of current technologies, including augmented reality and virtual reality applications in their entirety. Surprisingly, scholarly investigations have uncovered the absence of precise design guidelines for shaping the augmented reality-based mobile library application (ARMLA) experience within the metaverse. To date, no existing study has yet offered a comprehensive compilation of meticulously tailored *Kansei* emotive keywords specifically designed for this purpose. This gap underscores a significant deficiency in this particular domain. Therefore, this study intends to bridge the gap by methodically synthesizing and evaluating an extensive list of emotional keywords particularly devised for the ARMLA, thereby addressing the following research question (RQ):

RQ: What are the essential emotional requirements or the most pertinent emotive keywords for designing an engaging library application in the metaverse environment?

II. LITERATURE BACKGROUND

A. The Vital Role of Emotions in Metaverse Product Design

The metaverse stands as an expanding frontier that opens doors to increasingly intricate experiences. The metaverse is a dimension that exists beyond reality, establishing a connection between the actual and digital realms. It emerges from a combination of numerous technologies that blend together with the ability to expand the physical world through augmented reality (AR) and virtual reality (VR) [20] offering a fully dynamic and immersive virtual environment [21]. The application of the metaverse extends across diverse sectors, including education for innovative libraries [22], [23], enhanced campus and classroom experiences [24]–[26], retail to elevate shopping experiences [27], [28], games for revolutionary entertainment [29], [30], and the medical field to enhance healthcare [31], [32]. It is expected to be applied in an even broader range of sectors in the future.

As this notion gaining momentum and drawing significant interest from scholars, industries, and society at large, it underscores the pressing need for improvement. Design, in particular, emerges as an essential driver for its ongoing evolution. Scholarly investigations have highlighted the impacts of innovation failures, which often stem from the inability to satisfy user needs and preferences [33], [34]. As pertinent technologies keep evolving, the study of emotion assessment has emerged as a prominent research area. This is primarily motivated by its wide ranging applications and the complex emotional dynamics that unfold in interactions between users and device interfaces. Consequently, it becomes clear that grasping the human factors and emotions that contribute to establishing a connection with technological inventions is crucial [35], [36].

B. Effective Emotion Elicitation using Kansei Engineering

Before embarking into the intricate domain of user emotions, it is important to understand how to conduct an in-depth user

research to effectively elicit user emotions in response to innovative products. Emotional research is strongly tied to affective engineering, a field that is closely associated with the Kansei Engineering (KE). Originally pioneered in Japan by Professor Mitsuo Nagamachi [37], KE has transcended the traditional confines of product design, bringing about a transformative shift in how we perceive and interact with objects and technology. This method places a significant emphasis on the emotional dimension within the design process by capturing the user's emotional responses, which are subsequently translated into tangible product attributes. Kansei which translates to "emotions," is the core of KE process. The process leads to the categorization of user emotions as Kansei words (KWs), representing emotive keywords that encapsulate their feelings and perceptions regarding specific product design [38], [39]. These KWs manifest as adjectives [2] like attractive, happy, fun, frustrated, or bored, allowing for a precise characterization of the UX. KE emphasizes how design improvements may elevate user satisfaction and human-device interactions. These encompass variety of fields like web-based user interface [15], [16], mobile app [18], robotic [40], [41], and pervasive or ubiquitous product designs [19].

C. Metaverse Library

Recent years have witnessed a surge in scholarly interest surrounding the metaverse and its applications in the context of libraries. This spike is particularly evident in the thorough exploration of AR technology's immense potential within library services known as ARMLA. Their findings not only underscored the ability of AR technology to enhance the library experience but also revealed its capacity to provide captivating virtual tours of library spaces [42], [43], thereby increasing patron engagement [44]. In tandem, [45] have delved into the metaverse's potential to revolutionize library data storage and retrieval, as well as provide better reading environment [13], shedding light on its transformative potential. Similarly, [23], [46], [47] strongly emphasized the imperative need of libraries to embrace the metaverse in order to meet the demands of a digitally connected society. This is further supported by [21], [48], who argued that libraries should not fall behind, but rather be proactive and continue to evolve in order to stay aligned with the changing technological landscape and growing user expectations. By taking this proactive move to embrace the metaverse, libraries will remain relevant and accessible as vital gateways to information and knowledge in the modern era, while also having the ability to evoke profound emotional connections through enhanced interactive experiences.

III. METHODOLOGY

This part describes the methodologies and procedures employed to synthesize the *Kansei* Words (KWs), commonly referred to as emotive keywords, tailored for the metaverse library context known as ARMLA. This study follows a systematic approach divided into three main phases, as outlined in Fig. 1 and elaborated upon in the subsequent sections.

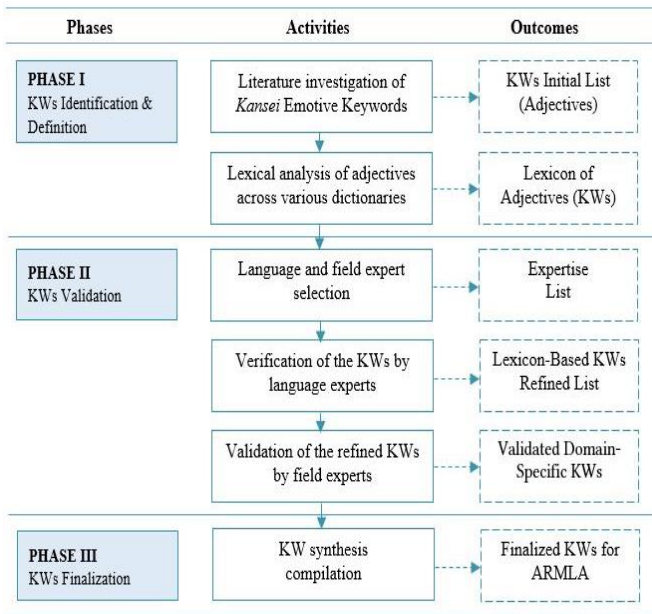


Fig. 1. Validation procedures for ARMLA emotive keywords

A. Phase I

This study initiated with a comprehensive investigation of relevant scholarly works, aiming to identify emotive keywords that could be extracted from prior literature or research discussions centered around user emotions in the context of AR libraries within the metaverse. This included investigating users' emotional responses as they viewed, used, engaged, and interacted with such applications. An extensive review examined 224 scholarly articles and discovered 184 adjectives (emotive keywords or KWs) from searches across six databases including ScienceDirect, ACM, Taylor and Francis, IEEE, Springer, and Emerald, laying the groundwork for identifying crucial keywords that significantly impact the emotional UX in this digital landscape. The collected keywords underwent lexical analysis across diverse dictionaries in order to ascertain their precise definitions. This methodical approach helps to prevent conceptual deviations and contributes to a thorough and comprehensive understanding of the emotional aspects in the context of AR libraries within the metaverse.

B. Phase II

According to [49], [50], The selection of experts is a critical step in the validation procedure since it has an immediate influence on the accuracy and reliability of the results. Consequently, this phase focused on identifying the professional experts to actively participate in the validation process. As suggested by [51], experts in research can be chosen based on various criteria, such as their educational background, professional experience, familiarity with the subject matter, and their ability to provide valuable insights. In alignment with this objective, the research has laid out the following criteria for expert selection:

- 1) Having relevant practical, academic, or research experience in the field under evaluation.
- 2) Possess a minimum of five years of professional / work experience pertinent to the field of study.

3) Demonstrate willingness and availability to participate in the study.

In order to guarantee a thorough and extensive evaluation of the *Kansei* emotional keywords, two groups of panelists have been formed. Each consisting of three language experts (designated as experts 1-3) and three field experts (designated as experts 4-6), as depicted in Table I.

TABLE I. PANEL OF EXPERTS FOR KANSEI EMOTIVE KEYWORDS ASSESSMENT

Expert ID	Expertise / Field Experts	Years of Experience
Expert 1	Language (Linguistics and English Language Studies)	8
Expert 2	Language (Linguistics and English Language Studies)	11
Expert 3	Language (Teaching English as a Second Language)	7
Expert 4	Technical (UX)	9
Expert 5	Technical (AR)	8
Expert 6	Domain Experts (Librarian)	19

Interaction with these experts was conducted via email conversations and physical meetings. Throughout these interactions, comprehensive guidelines were provided to enhance and validate the adjectives/ keywords that effectively represent the diverse emotions experienced by users within the ARMLA context.

The responsibilities of the language experts included ensuring the linguistic accuracy, validating the usage and context of adjectives, and confirming their definitions and meanings in the study context. This is particularly significant since the KWs predominantly supposed to be in adjective forms.

On the other hand, considering this research is related to AR-based mobile applications, it is imperative to engage field experts in the assessment process as well. This procedure is integral in ensuring that the chosen keywords effectively encompass the key aspects within the context of this research, in which the field experts carefully refined and recommended the most suitable emotive keywords for the AR-based mobile application in the library setting. Gaining insights from the technical and domain experts who possess advanced knowledge and skills in this domain can greatly assist in evaluating the relevance of keywords within the study's context.

C. Phase III

This final phase entails drawing expert opinion as a valuable source to compile an extensive collection of pertinent emotional keywords into a structured list, which we refer to as the finalized KWs for the ARMLA. The finalization process ensures that the chosen keywords effectively encapsulate the key aspects and user experiences within the study context.

IV. RESULTS AND DISCUSSIONS

This section discusses the research findings, shedding light on significant discoveries across three pivotal phases, all of which concentrate on the identification of emotional keywords that precisely align with the context of augmented reality library

applications within the metaverse setting, in order to address the stated RQ.

A. KWs Identification and Definition

This section presents research findings on user emotions in AR libraries within the metaverse. From an initial pool of 224 papers, the collection was refined through relevance screening and duplicate removal, resulting in 158 studies; 70.5% of the initial set. A thorough full-text evaluation of these studies facilitated the extraction of pertinent emotional keywords. Notably, 21 articles were omitted from the analysis owing to inadequate coverage of the emotional experiences topic or because they did not align with the research's main emphasis. Refer to Fig. 2 for a visual depiction of the process involved in extracting emotional keywords from the database.

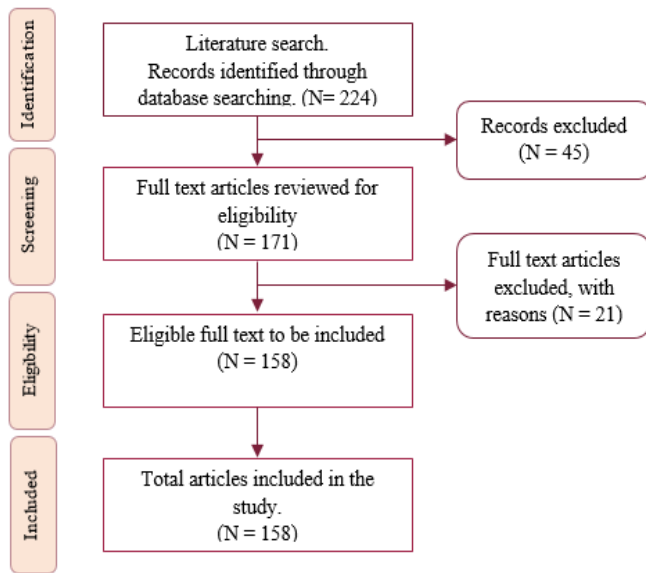


Fig. 2. The procedure and results of extracting emotive keywords from the database

Following the aforementioned procedure, this analysis has identified 184 emotive keywords (referred to as the KWs initial list) in their adjectival form across 158 research publications. The subsequent phase involved in-depth exploration of adjective lexicons sourced from various dictionaries, providing a profound grasp of the contextual intricacies of these lexical elements. The outcome is a lexicon of 184 adjectives, complete with definitions and meanings, which will serve as the experts' point of reference in their review.

B. KWs Validation

In the second phase, a comprehensive collection of 184 emotive keywords, each accompanied by their respective definitions and meanings, underwent verification by three language experts (referred to as experts 1-3). The objective of this verification was to ensure the utmost precision and accuracy in the nuances of these keywords, including their meanings and correct usage as adjectives. After a meticulous verification process, the team of experts recommended eliminating nine words owing to the improper usage of adjectives and suggested rephrasing two keywords. As a result, this process produced 175 refined emotive keywords in total. Notable examples among

these keywords include 'attractive,' 'boring,' 'unclear,' 'messy,' and 'responsive'. The final result of this phase is a carefully curated lexicon-based list of 175 refined keywords, serving as a valuable resource for the study. The complete list of these 175 keywords can be found in the prior research [19].

Equipped with these 175 meticulously refined lexicons, they were presented to a panel of field experts, comprising two technical experts and one domain expert, for further assessment. This time, the assessment was more specific, geared to address the nuances within the ARMLA domain. This process plays a crucial role in ensuring that the selected keywords effectively capture the essential aspects within the context of this research. Leveraging their technical expertise and domain-specific knowledge, the field experts meticulously refined and recommended the most appropriate emotive keywords for the AR-based mobile application in the library setting. Gaining insights from the technical and domain experts who possess advanced knowledge and skills in this domain significantly enhances the evaluation of relevance of keywords within the study's context.

This procedure adheres to the guidelines outlined by [52] for determining the selection of keywords based on expert validation. According to these guidelines, when reaching a consensus, the opinion of the majority holds the utmost importance. In the scope of this research, the results exclusively encompassed keywords that received agreement of at least two experts, signifying the majority agreement for inclusion. In light of feedback from experts, the selection or exclusion of keywords by the experts was influenced by whether the terms accurately represent the design or lean more towards describing the functional aspects of the application, such as the keywords "efficient" and "effective". Another justification was a misalignment between the terminology and the practical encounters produced by fast-paced, dynamic AR mobile applications. This mismatch is exemplified by keywords such as "relaxing" and "sad." Table II displays a representative sample of emotive keywords selected and discarded by experts during the validation process.

TABLE II. SAMPLE OF SELECTED AND EXCLUDED EMOTIVE KEYWORDS

Field Experts	Expert 4	Expert 5	Expert 6
No. of KWs Selected	51	54	55
Sample of Selected KWs	Appealing, Fresh, Messy, Unclear	Interesting, Modern, Outdated, Simple	Appealing, Crowded, Messy, Simple
Sample of Excluded KWs	Calm, Clunky, Efficient, Static	Aroused, Inspiring, Relaxing, Sad	Effective, Inflexible, Relaxing, Sad

During the expert validation process, a consensus was reached among three experts, resulting in a final selection of 60 keywords. Expert 4, Expert 5, and Expert 6 individually chose 51, 54, and 55 keywords, respectively. Significantly, there were instances where two or more experts agreed on the same keywords, leading to their inclusion in the study. These collective decisions, which represented majority consensus,

formed the basis for the inclusion of the selected keywords in the study.

C. KWs Finalization

In the concluding phase, a significant understanding of the emotional dimensions of user experience within ARMLA have been gained, providing a conclusive solution to the RQ at hand. In this phase, a complete set of sixty emotive keywords, deemed pertinent to the research context is presented in Table III.

TABLE III. THE KANSEI EMOTIVE KEYWORDS FOR AUGMENTED REALITY MOBILE LIBRARY APPLICATION

No.	Kansei Words (KW _s)	No.	Kansei Words (KW _s)	No.	Kansei Words (KW _s)
1	Appealing	21	Elegant	41	Modern
2	Attractive	22	Engaged	42	Neat
3	Balanced	23	Enjoyable	43	New
4	Boring	24	Exciting	44	Nice
5	Bright	25	Fanciful	45	Organized
6	Cheerful	26	Fascinating	46	Outdated
7	Clean	27	Fresh	47	Precise
8	Clear	28	Friendly	48	Prestigious
9	Cluttered	29	Fun	49	Professional
10	Colorful	30	Guided	50	Realistic
11	Complicated	31	Harmonious	51	Satisfactory
12	Comprehensible	32	Helpful	52	Simple
13	Concise	33	Inconsistent	53	Soft
14	Confusing	34	Informative	54	Sophisticated
15	Consistent	35	Interactive	55	Straightforward
16	Cool	36	Interesting	56	Trendy
17	Creative	37	Joyful	57	Unclear
18	Crowded	38	Latest	58	Understandable
19	Dull	39	Messy	59	Up-to-date
20	Easy	40	Minimalist	60	Vibrant

These finalized keywords (referred to as synthesized KW_s for ARMLA) which were meticulously compiled from prior validation procedures, offer a comprehensive overview of *Kansei* words that have successfully passed rigorous expert validation. These keywords can be concluded as the most pertinent emotive elements essential for designing an engaging library application within the metaverse environment, effectively addressing the user's emotional requirements in paving the way for an immersive experience.

Intended as a guide for designers, this set of emotive keywords can be used as references throughout the creation of the metaverse library. Embedding these emotive elements into UI design could potentially elicit the required emotional response, thereby fostering a rich and engaging user interaction experience. Serving as a crucial resource, this comprehensive compilation of emotive keywords contributes to further research and advancements in the ARMLA domain, enabling the creation of more emotionally engaging UX in the metaverse environment.

It is also learned that the applicability of emotions extends beyond positive emotions. Both positive and negative emotions

are accounted in this study, as evident in Table III. Consistent with findings from other research [35], [53], [54], our study reaffirms the importance of embracing a broad and diverse spectrum of emotions, as it reflects the real-world diversity of user responses and their emotional requirements. By acknowledging and addressing negative emotional experiences, designers can identify pain points and areas for improvement, leading to more robust and user-centric designs that improve the overall UX in the metaverse, thus preventing potential user dissatisfaction and frustration. The inclusion of both positive and negative emotions in innovative products is important because it acknowledges the complexity of user reactions and allows a more nuanced understanding of emotional engagement in ARMLA.

V. CONCLUSION

In an effort to elevate the emotional level and UX within the metaverse environment, this study embarked on a comprehensive journey to synthesize *Kansei* words that effectively capture the emotive dimensions essential for ARMLA. The validation procedure was meticulously carried out, with a panel of experts taking on a pivotal role, harnessing their expertise and domain-specific knowledge to assess and validate the applicability of the KW_s, resulting in the identification of 60 *Kansei* emotive words for ARMLA. The ARMLA synthesized keywords redefine the new way to configure users' emotional perceptions in this specialized domain, providing practitioners with valuable guidance in creating application designs that match the user affective needs. This research makes a significant contribution to the metaverse landscape by adding a layer of emotional depth to enrich the ARMLA experience, filling the critical gaps in the affective engineering field. These significant findings revolutionize the design of AR applications, placing emotional resonance at the forefront of innovation in this cutting-edge field.

The primary limitation of this study lies in its exclusive concentration on the metaverse dimension within the AR library context. It is crucial to acknowledge that *Kansei* Engineering research demands a domain-specific approach for its KW_s investigation. Consequently, it is imperative to recognize that the insights derived from this research may not be entirely applicable to other scopes or domains. To comprehensively grasp the relevant emotional nuances in other areas, a dedicated research effort tailored to those specific domains becomes a necessity for ensuring the robustness and applicability of the findings.

In the future, the strategic application of this set of emotive keywords is expected to provide valuable guidance for the development of ARMLA prototype with the aim of enhancing the emotional UX. This process may include a thorough retrospective statistical analysis, focused on the validation of the most significant emotive keywords in the specific domain of the metaverse.

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