`

Volume XI Issue 3 Year 2026 | Page 730-741 | ISSN: 2527-9866
Received: ***22-05-2026*** | *Revised:* ***10-06-2026*** | *Accepted:* ***25-07-2026***

Needs Analysis of a 360° Virtual Tour as Campus Information Medium at STTNF Using PIECES

Annisa Nurul Nabilah[1], Jemiro Kasih[2]
[1,2]Program Studi Sistem Informasi, Sekolah Tinggi Teknologi Terpadu Nurul Fikri, Indonesia
e-mail: anni22193si@student.nurulfikri.ac.id [1], jemiro.kasih@nurulfikri.ac.id [2]
*Correspondence: jemiro.kasih@nurulfikri.ac.id

Abstract: *This study aims to analyze the system requirements for developing a 360° Virtual Tour as a campus information medium for Nurul Fikri Integrated Technology College (STTNF) using the PIECES model, comprising Performance, Information, Economy, Control, Efficiency, and Service dimensions. A descriptive qualitative approach was employed, with data collected through observation, semi-structured interviews, and documentation involving 15 informants consisting of prospective students, active students, and New Student Admission Team representatives. Data were analyzed through transcription, coding, categorization, technique triangulation, mapping into the PIECES dimensions, and requirements formulation. The credibility of the findings was strengthened through member checking. The findings reveal that existing campus information media at STTNF remain static and non-interactive, limiting users from obtaining a comprehensive overview of the campus environment. Based on the PIECES analysis, 23 functional requirements and 22 non-functional requirements were formulated, with information completeness, navigation support, and system performance emerging as the primary user priorities. An initial use case diagram was developed to translate the validated requirements into a preliminary system model. This study contributes a validated and user-centered requirements specification for campus-based 360° Virtual Tour development using the PIECES model, distinguishing itself from prior studies that focused predominantly on implementation and usability evaluation by emphasizing requirements elicitation prior to system development in higher education institutions.*

Keywords: *360° Virtual Tour, Requirements Analysis, PIECES Model, Campus Information Media, Information System.*

1. INTRODUCTION

The development of information and communication technology has transformed how educational institutions deliver information through digital media. One increasingly adopted technology is the 360° Virtual Tour, which simulates a location through panoramic images to provide a complete visualization of an environment without requiring physical presence [1]. In higher education, it has been used as an interactive medium to introduce campus facilities and academic environments to prospective students [2], and has been shown effective in helping users gain better understanding through explorable visualizations [3].

Nurul Fikri Integrated Technology College (STTNF) is a private higher education institution focused on information technology. Based on PDDIKTI data for the 2025 odd semester, STTNF offers three active undergraduate programs with approximately 2,577 enrolled students. Despite this, STTNF lacks a 360° Virtual Tour system built on structured user requirements analysis. Campus information still relies on a website, social media, and brochures, all of which are static in nature. Consequently, prospective students cannot obtain a comprehensive overview of the campus environment prior to an on-site visit, reducing the effectiveness of digital promotion and remote information access.

Requirements analysis is a crucial stage to ensure the resulting system reflects user and stakeholder needs [4], as developing without it risks misalignment with actual expectations [5]. The PIECES model, comprising Performance, Information, Economy, Control, Efficiency, and Service, provides a structured framework for identifying these aspects comprehensively [6].

Previous studies on 360° Virtual Tours in higher education have focused on specific development stages rather than requirements engineering. Cardona et al. [7] reviewed virtual tour technologies but focused on classification and characteristics rather than requirements analysis. Wibowo et al. [8] evaluated usability via SUS after implementation, without prior structured elicitation. Andri et al. [9] examined virtual campus navigation but concentrated on orientation outcomes. Collectively, these studies confirm that structured requirements analysis as a foundation for 360° Virtual Tour development remains underexplored, particularly in higher education institutions in developing countries, and that the PIECES model has not previously been applied as a requirements elicitation framework for Virtual Tours in this context.

This study therefore aims to: (1) identify problems and limitations of existing campus information media at STTNF; (2) identify system requirements for a 360° Virtual Tour across the six PIECES dimensions; and (3) formulate functional and non-functional requirement specifications.

2. LITERATURE REVIEW

A.360° Virtual Tour

A 360° Virtual Tour is a digital media technology based on Virtual Reality Photography (VRP) that enables users to interactively explore environments through panoramic displays [10]. Its primary advantage is creating spatial presence, the psychological sensation of being situated within a visualized environment [11]. Virtual Tours are classified by type of world (real or simulated), level of immersion (non-immersive, semi-immersive, fully immersive), and capture time (pre-captured or real-time) [7]. In higher education, panorama photography-based approaches are widely used for their relatively low implementation cost and capacity to produce realistic, interactive visualizations [10]. Despite growing adoption, existing studies have predominantly emphasized implementation, technological classification, and usability evaluation, while comparatively limited attention has been given to systematic user requirements identification prior to development [7], [8], [9]. This gap highlights the need for structured requirements analysis to ensure Virtual Tour systems align with actual user needs and institutional objectives before development begins [12].

B. System Requirements Analysis

System requirements analysis focuses on identifying, analyzing, and documenting user requirements and organizational needs, determining the scope, objectives, and constraints of a system to be developed [4]. The output of this process is a requirements specification covering functional and non-functional requirements, which serves as the foundation for system design [13]. For immersive and VR-based systems, this process is particularly complex: Karre and Reddy [14] demonstrated that VR requirements elicitation requires detailed specification of scene elements, interaction behaviors, and system constraints beyond conventional software. A user-centered perspective is equally essential; Kartini et al. [15] confirmed that the User-Centered Design (UCD) approach effectively identifies requirements for VR platforms in educational contexts, producing measurably improved usability outcomes.

C.PIECES Model

The PIECES model is an information system analysis framework that identifies problems, opportunities, and development directions across six dimensions: Performance (system speed and stability), Information (quality and completeness), Economy (cost and time efficiency), Control (security and access control), Efficiency (navigation ease and operational efficiency), and Service (quality of user services) [6], [16]. Compared to alternative approaches such as SWOT analysis, Design Thinking, User Story Mapping, and ISO/IEC 25010, PIECES is distinguished by its ability to simultaneously capture technical, informational, economic, governance, usability, and service dimensions, enabling both functional and non-functional requirements to be elicited in a balanced and comprehensive manner [6], [16], [17]. Although PIECES has been applied in diverse information system contexts [16], [17], its application to campus-based Virtual Tour requirements elicitation has not previously been documented. This study therefore applies PIECES as a structured elicitation framework to identify and formulate requirements for a 360° Virtual Tour system at STTNF.

3. METHODS

This study employed a descriptive qualitative approach. Data were collected through observation of existing campus information media (official website, Instagram, TikTok, YouTube, and PMB brochures), semi-structured interviews guided by the PIECES dimensions, and documentation review. The study involved 15 informants selected through purposive sampling: 5 prospective students, 8 active STTNF students, and 2 PMB team representatives (Table I). Prospective students were selected to represent variation in geographic origin, educational background, and study interest. All participants provided informed consent covering study purpose, voluntary participation, and data confidentiality prior to data collection.

Table 1. Distribution of Research Informants

Informant Group	Number	Code
Prospective Students (CM)	5 persons	N1, N2, N3, N4, N5
Active Students (MA)	8 persons	N6, N7, N8, N9, N10, N11, N12, N13
PMB Team	2 persons	N14, N15
Total	15 persons	N1–N15

Note: CM = Prospective Students; MA = Active Students; PMB = New Student Admission Team.

Data collection continued until informational saturation was reached; saturation was observed beginning from the twelfth interview, with interviews N13–N15 confirming previously identified themes [18]. Before interviews, informants were shown examples of 360° Virtual Tour systems from other higher education institutions as visual references.

Data analysis proceeded through: (1) transcription and reduction; (2) inductive coding and categorization; (3) technique triangulation [19]; (4) mapping validated findings to PIECES dimensions; (5) requirements analysis; and (6) formulation of functional and non-functional requirements. Each interview statement was assigned an initial descriptive code, grouped into broader requirement categories, and then mapped to the corresponding PIECES dimension. For example, statements about loading speed were coded as loading-time tolerance, categorized under system access speed, and mapped to the Performance dimension. In total, 74 requirement themes were identified across the six dimensions. Requirements were retained only when evidence from at least two data sources demonstrated consistency; discrepancies were further examined until a consistent interpretation was achieved. To ensure coding consistency and reduce interpretation bias, codes were assigned by the first researcher and reviewed by the second, with ambiguities resolved through consensus. The complete workflow is illustrated in Figure 1.

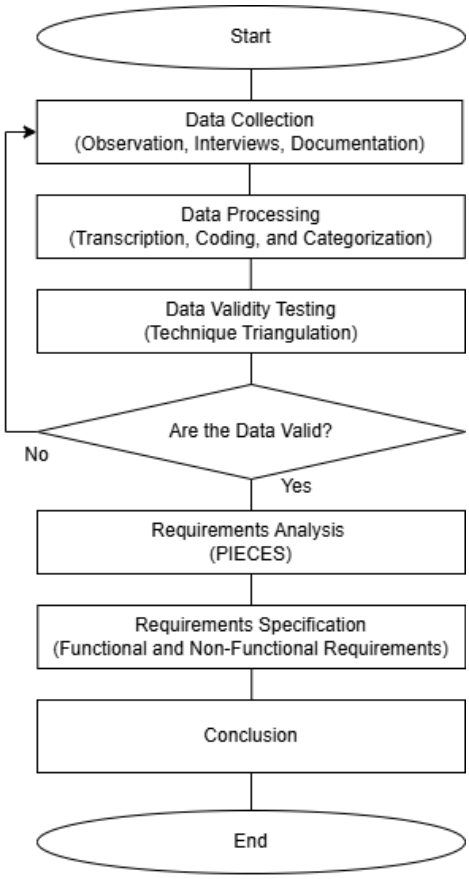

Figure 1. Research Workflow

4. RESULTS AND DISCUSSION

A. Results of the Observation of Campus Information Media

Observation conducted in 2025 confirmed that existing STTNF campus information media remain static and non-interactive. The website presents facility photographs with limited viewing angles and no building layout map (Figure 2). Across all observed platforms, content consistently prioritizes program and scholarship promotion over spatial or facility visualization: TikTok and YouTube room-tour content exists but is outdated (2023) and lacks facility detail, while the PMB brochure contains no facility visuals at all. None of these channels supports interactive or navigational exploration of the campus environment, confirming the absence of any interactive medium, such as a 360° Virtual Tour, that enables independent visual exploration of the campus environment by prospective students.

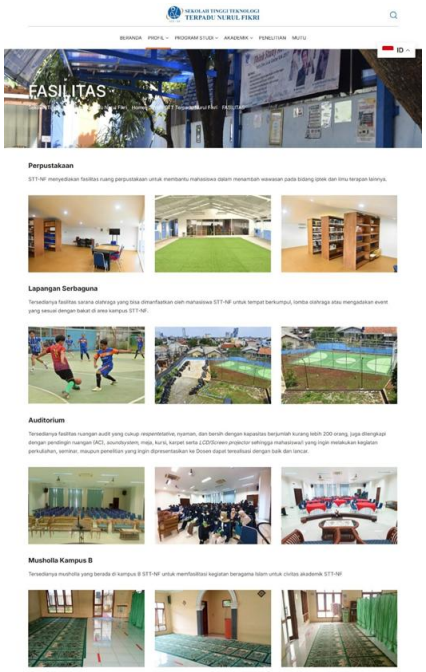

Figure 2. Facilities Page of the STTNF Website

B. Results of Requirements Analysis Based on the PIECES Dimensions

Based on interviews with 15 informants mapped to the six PIECES dimensions, the following findings were obtained:

1. Performance Dimension

All informant groups identified loading speed as critical, with an ideal tolerance of no more than 2–3 seconds. A prospective student noted: "The maximum loading time tolerance should be no more than two seconds, because if it takes too long it becomes uncomfortable" (N1). Additional expectations include multi-user stability during peak admission periods, smartphone compatibility, and usability under unstable connectivity. These expectations reflect the geographic diversity of STTNF's prospective student base. These findings yielded six non-functional requirements (KNF01–KNF06); no functional requirements were derived, as the identified needs pertain to system quality attributes rather than discrete features.

2. Information Dimension

Informants consistently identified content gaps: detailed room data, campus layout visualization, accessibility information, and a centralized platform. One active student noted: "The most difficult information to find is the detail of rooms and classroom conditions, such as the floor location of each room and its capacity" (N7). Seven functional requirements (KF01–KF07) and four non-functional requirements (KNF07–KNF10) were formulated, making this the dimension with the highest functional requirement count.

3. Economy Dimension

The Economy dimension generated the fewest functional requirements (KF08–KF10), reflecting users' pragmatic expectation: the Virtual Tour primarily substitutes for physical visits rather than serving as a cost-reduction tool per se. This distinction has design implications. Economy-related requirements should not drive core feature prioritization.

4. Control Dimension

Users indicated that private areas should be excluded from the tour, while integration with official institutional platforms and use of official logos and domains are essential for building trust. A mechanism for reporting inaccurate information and coordinated content management are also required. Four functional requirements (KF11–KF14) and two non-functional requirements (KNF14–KNF15) were derived, addressing content governance and institutional trust.

5. Efficiency Dimension

Users prioritize intuitive navigation: an interactive campus map, location search by name or category, shortcuts to key areas, directional guidance, tutorials for new users, and clear room labels. Six functional requirements (KF15–KF20) and three non-functional requirements (KNF16–KNF18) were formulated, reflecting the centrality of interface intuitiveness as a user priority.

6. Service Dimension

Users require an FAQ feature, direct communication services, and a user feedback feature. A PMB team representative stated: "When explaining to prospective students, especially those from outside the city, we usually only convey information verbally or through a profile video, and there has been no visual evidence that can be shown in detail" (N14), underscoring the institutional need for an information channel independent of staff availability. Three functional requirements (KF21–KF23) and four non-functional requirements (KNF19–KNF22) were formulated.

C.Formulation of Functional Requirements

Requirement priorities were determined based on frequency of occurrence across informant groups and consistency of triangulation evidence. Requirements identified by multiple stakeholder groups and supported by observational or documentary evidence were classified as High priority; those with more limited occurrence as Medium or Low.

Table 2. Functional Requirements of the 360° Virtual Tour System

Code	Functional Requirement	PIECES Dimension	Source	Priority
KF01	Provide complete campus facility information (name, function, facilities, capacity)	Information	W+O+D	High
KF02	Provide clear facility location information with directions to rooms	Information	W+O+D	High
KF03	Provide additional room information (operating hours, facility condition)	Information	W+O	Medium
KF04	Provide comprehensive visual campus layout information	Information	W+O+D	Medium
KF05	Provide interactive visual displays of campus facilities	Information	W+O	Low
KF06	Provide campus accessibility information (wheelchair paths, special access)	Information	W	Low
KF07	Provide a centralized integrated campus information platform	Information	W+O+D	Low
KF08	Provide online Virtual Tour access without direct visits	Economy	W+O+D	Medium
KF09	Reduce dependence on direct communication with PMB staff	Economy	W+O	Low
KF10	Enable out-of-town users to access campus information online	Economy	W+O+D	Medium
KF11	Restrict display of private areas/information	Control	W+O	High
KF12	Integrate with official platforms and display official campus identity	Control	W+O+D	High
KF13	Provide a feature for reporting inaccurate information	Control	W	Low

KF14	Provide structured content management across organizational units	Control	W	Low
KF15	Provide an interactive campus map with building and facility markers	Efficiency	W+O	High
KF16	Provide room/location search by name or category	Efficiency	W+O	High
KF17	Provide directions between campus locations	Efficiency	W+O	Medium
KF18	Provide shortcuts/quick access to important locations	Efficiency	W+O	Medium
KF19	Provide guides/tutorials for new users	Efficiency	W+O	Medium
KF20	Provide clear labels/markers for each room and facility	Efficiency	W+O	Low
KF21	Provide an FAQ feature	Service	W+O+D	Medium
KF22	Provide direct communication services (chat/contact person)	Service	W	Low
KF23	Provide a user feedback feature	Service	W	Low

Note: W = Interview; O = Observation; D = Documentation.

D.Formulation of Non-Functional Requirements

Table 3. Non-Functional Requirements of the 360° Virtual Tour System

Code	Non-Functional Requirement	PIECES Dimension	Source	Priority
KNF01	Loading time no more than 3 seconds under normal connection conditions	Performance	W+O+D	High
KNF02	Stable and accessible during increased user traffic	Performance	W+O	Medium
KNF03	Display visuals with clear and sharp resolution	Performance	W+O	Medium
KNF04	Accessible smoothly across various devices, especially smartphones	Performance	W+O	Medium
KNF05	Remain usable under unstable internet conditions	Performance	W+O	Medium
KNF06	Responsive when moving between locations in the Virtual Tour	Performance	W+O	Medium
KNF07	Accurate information consistent with actual campus conditions	Information	W+D	Medium
KNF08	Information updated regularly with update timestamps	Information	W+D	Medium
KNF09	Information language is clear, simple, and understandable	Information	W	Low
KNF10	Additional information does not obstruct the main Virtual Tour display	Information	W+O	Low
KNF11	System shall provide self-service information access that operates without requiring direct assistance from PMB staff	Economy	W+O+D	Low
KNF12	Consider efficient use of institutional resources	Economy	W	Low
KNF13	Designed flexibly for updates without complete redevelopment	Economy	W	Low
KNF14	Information consistent with other official campus platforms	Control	W+O+D	Low
KNF15	Content complies with institutional policies and regulations	Control	W+D	Low
KNF16	Navigation is simple and intuitive between locations	Efficiency	W+O	Medium
KNF17	Interface is simple and easy to use without special training	Efficiency	W+O+D	High
KNF18	Additional information displayed progressively through on-click mechanisms	Efficiency	W+O	Low

KNF19	Attractive interface reflecting the professional image of the campus	Service	W+O	Low
KNF20	Responsive information services independent of staff availability	Service	W+O+D	Low
KNF21	Easy access to information services through online media	Service	W+O+D	Medium
KNF22	Usable consistently by various user groups	Service	W+O	Medium

Note: W = Interview; O = Observation; D = Documentation.

Requirement sources annotated in Tables II and III reveal a meaningful pattern: requirements supported by three data sources (W+O+D) consistently correspond to High or Medium priority, while single-source requirements (W only) tend to reflect more specific, lower-priority needs. This alignment confirms that triangulation functions not merely as a procedural validation step but as a de facto priority signal. This finding may inform future PIECES-based requirements studies.

A member checking process was conducted with three representative informants (N2, N7, N14), one from each stakeholder group. All three confirmed that the formulated requirements accurately reflected their expressed needs. Minor wording clarifications were made to KF03 and KNF09 to better reflect the informants' original expressions.

Based on interview theme frequency, Information (19 themes), Efficiency (17 themes), and Performance (13 themes) were classified as high-priority dimensions; Control (10 themes) as medium priority; and Economy (8 themes) and Service (7 themes) as lower-priority dimensions. Of the 45 identified requirements, 8 were classified as High priority, 17 as Medium, and 20 as Low, indicating that the initial development phase should focus primarily on information completeness, navigation support, access control, and system performance.

E. Initial System Design

Based on the validated functional requirements, an initial use case diagram (Figure 3) was developed to represent user-system interactions. The system involves two primary actors: Visitor and PMB Administrator. Visitors can explore the 360° Virtual Tour, access facility information, search locations, view the campus map, access FAQs, submit feedback, and contact the admission team. The PMB Administrator manages facility information, virtual tour content, FAQs, and user feedback. This diagram provides a preliminary representation of the system scope and confirms that the formulated requirements are sufficiently detailed to support subsequent design and development activities.

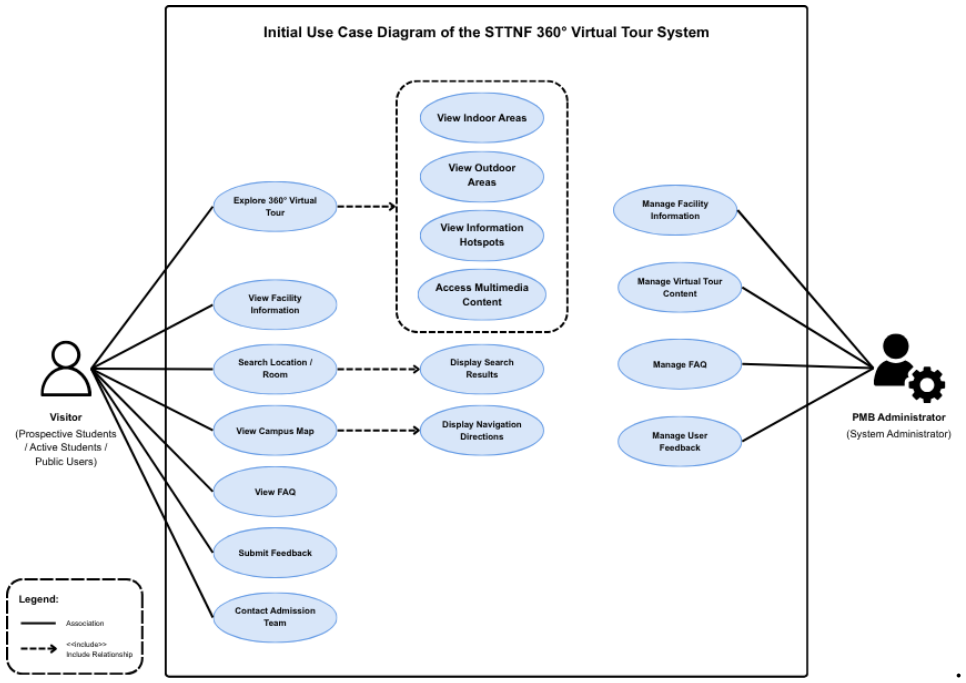

Figure 3. Initial Use Case Diagram of the Proposed 360° Virtual Tour System

The Information and Efficiency dimensions generated the highest number of functional requirements (7 and 6 respectively), indicating that users perceive the core problem not as a technical deficiency but as a content and completeness gap, namely the inability of current media to convey a comprehensive representation of the campus environment. This is consistent with Samala et al. [10], who argued that in campus-based Virtual Tour applications, informational richness is more determinative of user satisfaction than technological sophistication. The high volume of Efficiency requirements (KF15–KF20) further suggests that usability-centered design is critical for Virtual Tour systems intended for first-time users such as prospective students, reinforcing Kartini et al.'s [15] findings on UCD-driven design improvements.

The Performance dimension dominates the non-functional requirements (KNF01–KNF06), confirming that system success is measured not only by available features but also by technical quality. Notably, smartphone compatibility and low-bandwidth tolerance emerged as primary concerns, aligning with Yusuf et al.'s [20] findings in the Indonesian higher education context and underscoring the importance of context-sensitive design. The Economy dimension generated the fewest requirements (KF08–KF10), reflecting the pragmatic expectation that the Virtual Tour serves as a substitute for physical visits rather than a cost-saving tool. This distinction has practical implications for development prioritization: Economy requirements (KF08–KF10) should be treated as baseline assumptions rather than differentiating features, freeing development resources to concentrate on Information and Efficiency requirements where user expectations are highest.

The application of PIECES proved capable of identifying system requirements more comprehensively than conventional analytical approaches, simultaneously capturing technical performance, content quality, economic efficiency, governance, usability, and service quality [6], [16], [17]. Unlike prior studies focused on implementation and post-development evaluation [7], [8], [9], this study demonstrates that structured pre-development requirements analysis produces a more targeted and user-centered specification. This finding suggests that institutions planning similar systems should invest in structured elicitation before committing to development tools or platforms, as the requirements profile, particularly the dominance of Information and Efficiency needs, directly constrains technology selection and feature scoping decisions. The initial use case

diagram further strengthens the practical contribution of the study by translating the validated requirements into a preliminary conceptual model that can directly support subsequent design and implementation activities.

4. CONCLUSIONS

This study applied the PIECES model as a structured requirements elicitation framework to identify the needs for a 360° Virtual Tour system at STTNF. Existing campus information media were found to be static and non-interactive, unable to support independent spatial exploration by prospective students. Through interviews, observations, documentation analysis, triangulation, and member checking, 23 functional requirements and 22 non-functional requirements were formulated, with information completeness, navigation support, and system performance identified as primary user priorities. An initial use case diagram was developed to translate these validated requirements into a preliminary system model, strengthening the study's practical contribution. The validated requirements specification provides a direct foundation for user-centered design and development of the proposed system, and may assist other higher education institutions in planning comparable Virtual Tour implementations. Future research should extend this work by designing, prototyping, and evaluating the proposed system, using instruments such as the System Usability Scale (SUS) or the Technology Acceptance Model (TAM) to assess usability, user acceptance, and overall effectiveness.

References

[1] J. Rodríguez, M. I. Lamas, and L. Castro-Santos, "Scientific Advances and Applications of 360 Tours in the XXI Century," *Societies*, vol. 15, no. 74, pp. 1–26, 2025, doi: 10.3390/soc15040074.

[2] P. Kurniawan, N. Ifadianto, and A. C. Nugroho, "Web-Based Interactive Virtual Tour as an Information Media and Introduction to Post-Pandemic Lecture Buildings at Universitas Lampung," *J. Eng. Sci. Res.*, vol. 4, no. 2, pp. 94–99, 2022, doi: https://doi.org/10.23960/jesr.v4i2.115.

[3] M. N. Raihan and I. G. L. P. E. Prismana, "Implementasi Sistem Virtual Tour E-Panorama Sebagai Media Informasi dan Pengenalan Gedung Jurusan Teknik Informatika Universitas Negeri Surabaya," *J. Informatics Comput. Sci.*, vol. 5, no. 03, pp. 291–303, 2024, doi: https://doi.org/10.26740/jinacs.v5n03.p291-303.

[4] F. Zakaria and E. Utami, "An Analysis of Requirement Engineering and Techniques: A Literature Review," *Int. J. Res. Appl. Technol.*, vol. 4, no. 1, pp. 48–59, 2024, doi: 10.34010/injuratech.v4i1.13731.

[5] A. C. Puspitaningrum and E. S. Sintiya, "Teknik Elisitasi Kebutuhan Perangkat Lunak: Literatur Review," *J. Sist. Inf.*, vol. 8, no. 1, 2022, doi: 10.19109/jusifo.v8i1.11569.

[6] B. L. Nafiisa, Jaswadi, and L. Djajanto, "PIECES Framework for Information System Needs Analysis using Website-based Appsheet: A Technopreneurship Digitalization Solution in Indonesia," *East Asian J. Multidiscip. Res.*, vol. 3, no. 7, pp. 2407–2418, 2024, doi: 10.55927/eajmr.v3i7.9563.

[7] H. Cardona, C. Lara-alvarez, E. F. Parra-González, and K. Villalba-Condori, "Virtual Tours to Facilities for Educational Purposes: A Review," *TEM J.*, vol. 12, no. 3, pp. 1725–1731, 2023, doi: 10.18421/TEM123-55.

[8] N. C. Wibowo, T. Lathif, M. Suryanto, F. Annas, and M. Billah, "Evaluating the Usability of Virtual Tour Application Using the System Usability Scale (SUS) Method," *Int. J. Comput. Netw. Secur. Inf. Syst. (IJCONSIST).*, vol. 3, no. 2, pp. 1–7, 2022, doi: https://doi.org/10.33005/ijconsist.v3i2.65.

[9] R. C. Andri, R. Oktaviati, and H. Wijaya, "Penerapan Jelajah Kampus Virtual dalam Meningkatkan Pengalaman Orientasi Mahasiswa Kelas Karyawan Jakarta Global University," *J. Teknol. Inf. dan Multimed.*, vol. 6, no. 2, pp. 196–207, 2024, doi: 10.35746/jtim.v6i2.583.

[10] A. D. Samala, M. Ricci, C. J. A. Rueda, L. Bojic, F. Ranuharja, and W. Agustiarmi, "Exploring Campus through Web-Based Immersive Adventures Using Virtual Reality Photography: A Low-Cost Virtual Tour Experience," *Int. J. Online Biomed. Eng.*, vol. 20, no. 1, pp. 104–127, 2024, doi: 10.3991/ijoe.v20i01.44339.

[11] R. B. F. Jr, "Immersive capability and spatial presence in virtual reality photo-based tours:

implications for distance education," *Asian Assoc. Open Univ. J.*, vol. 18, no. 3, pp. 201–217, 2023, doi: 10.1108/AAOUJ-12-2022-0171.

[12] N. P. L. Santiari, I. G. A. Dananjaya, and I. G. S. Rahayuda, "Design of a 360 Degree Virtual Tour System: Introduction to Tanah Wuk Tourism Objects for Promotion in Digital Business," *@is Best Account. Inf. Syst. Inf. Technol. Bus. Enterp.*, vol. 8, no. 1, pp. 76–90, 2023, doi: https://doi.org/10.34010/aisthebest.v8i1.9915 Design.

[13] C. Dongmo, "A Review of Non-Functional Requirements Analysis Throughout the SDLC," *Computers*, vol. 13, no. 12, p. 308, 2024, doi: 10.3390/computers13120308.

[14] S. A. Karre and Y. R. Reddy, "Model-based approach for specifying requirements of virtual reality software products," *Front. Virtual Real.*, vol. 5, pp. 1–30, 2024, doi: https://doi.org/10.3389/frvir.2024.1471579.

[15] K. S. Kartini, I. M. M. Yusa, I. N. W. Adnyana, and I. N. T. A. Putra, "Usability Evaluation of Virtual Reality Metaverse Lab Using Usability Testing With the User-Centered Design Approach," *Int. J. Eng. Sci. Inf. Technol.*, vol. 5, no. 4, pp. 597–606, 2025, doi: https://doi.org/10.52088/ijesty.v5i4.1497.

[16] M. K. Argaputri, N. R. Fadlilah, H. Setyowati, and M. A. Yaqin, "Analisis Model PIECES dalam Perancangan Sistem Informasi Meeting Proyek Menggunakan Metode FAST," *Ilk. J. Comput. Sci. Appl. Informatics*, vol. 5, no. 1, pp. 59–70, 2023, doi: 10.28926/ilkomnika.v5i1.418.

[17] S. Ramadhani, N. Eltivia, and N. I. Riwajanti, "Analisis Kebutuhan Pengguna dalam Perancangan Akuntansi Kost Sistem Informasi Menggunakan Kerangka PIECES," *J. Ekon. dan Bisnis Digit.*, vol. 3, no. 2, pp. 269–282, 2024, doi: 10.55927/ministal.v3i2.8982.

[18] M. Hennink and B. N. Kaiser, "Sample sizes for saturation in qualitative research: A systematic review of empirical tests," *Soc. Sci. Med.*, vol. 292, p. 114523, 2022, doi: 10.1016/j.socscimed.2021.114523.

[19] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*, 3rd ed. Bandung, Indonesia: Alfabeta, 2021.

[20] A. Yusuf, R. FITRI, and P. W. PRASETYO, "Metaverse-Based Virtual Campus Tour for Higher Education: Insights from Development to User Experience Validation," *J. Metaverse*, vol. 6, no. 1, pp. 1–25, 2026, doi: https://doi.org/10.57019/jmv.1770621.