

MULTIMEDIA DEVELOPMENT LIFE CYCLE (MDLC)-BASED DESIGN OF A VIRTUAL TOUR FOR SCHOOL LIBRARIES

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ABSTRACT

User education and library promotion in schools still takes a largely manual form and is managed during the student orientation only (MPLS). Today, this approach is outdated and has little sustainability. With the view to solving this problem, a Virtual Library was set up on the basis of Virtual Reality (VR) technology and the Multimedia Development Life Cycle (MDLC) approach. The system allows one to navigate in the school library in an interactive and autonomous way. The process was six-step MDLC phases, including concept, design, gathering of material, assembly, testing, and distribution. Design was done using storyboards and conceptualization was carried out using interviews and observations. 3D objects were done in blender and Canva, and assembly was done in 3D Homestyler and Panoee. Blackbox Testing using Equivalence Partitioning was used in the system and there was a 100 percent functional validity. The performance of networks was also checked out through CBN Speedtest, which shows that a solid internet is necessary to facilitate smooth discovery. The User Acceptance Testing (UAT) reported 92 percent approval rate which implies that the system is quite feasible and is user-friendly and it is within the users expectations. The end product was available through an access link, which made the product to be made available with ease to both students and teachers. This innovation of the Virtual Library offers a new, resourceful, and viable means of orienting and marketing a library within the digital world.

Keywords: *user education, virtual tour, virtual reality, MDLC, Blackbox Testing, school library*

1. INTRODUCTION

In today's digital era, libraries as a gateway to knowledge, must adapt to the rapid flow of information and the emergence of new technologies (Serghides et al., 2024). The advancement of *virtual reality* (VR) technology has begun to be utilized in the library sector to digitally introduce library environments and support exhibitions or competitions through virtual tours. This technology can serve as an effective medium for showcasing the conditions and layout of school libraries through immersive VR-based tours (Setiawan et al., 2023). Virtual reality offers users the impression of being physically present in the environment, making it an ideal tool for introducing specific spaces or objects (Fitrianto et al., 2022). VR-based digital mapping can also increase user

engagement in exploring different areas within the library (Bahtiar, 2020). User education can be packaged more engagingly through interactive methods, ensuring the information is delivered more effectively. Such innovations can enhance students' motivation and ease in understanding new material, particularly among younger users (Intaniasari et al., 2022).

In practice, school libraries often conduct user education only once a year during the student orientation program (MPLS). As a result, the reach of this activity remains limited and has not yet been implemented sustainably or continuously. Based on observations and interviews, several challenges have been identified, including the lack of technological infrastructure, limited human resources, and a student behavior pattern that tends to be more centered on smartphone usage in their daily routines. This situation indicates the need for a more innovative approach that aligns with the digital habits of today's younger generation (Suparmini, 2024).

This study aims to design and develop a library virtual tour for school libraries. This innovation is an alternative medium to support user education and library promotion efforts, offering a more interactive and accessible experience for users, especially students. The development process follows the Multimedia Development Life Cycle (MDLC) method, which consists of six phases: concept, design, material collection, production, testing, and distribution (Nugroho, 2024). In the concept phase, librarians were strategic partners in identifying user information needs and mapping the library service areas to be visualized digitally. Through structured interviews and in-depth discussions, initial data were gathered to determine key areas within the library that should be featured in the virtual tour and relevant informational content to be delivered to users (Kiy, 2019).

The next production stage involved creating 3D objects using Blender, utilizing modeling and texturing techniques (Syty et al., 2024). Graphic design elements were developed using Canva to support visually engaging and communicative content. The virtual objects were assembled within a digital spatial layout using 3D Homestyler and finally integrated into a 360-degree virtual tour via the Panoee platform. At this stage, previously designed information was embedded into the tour interface as part of a content delivery strategy to enrich the user's experience while navigating the library services and facilities online (Serghides et al., 2024).

Subsequently, the system underwent a twofold testing process. First, Blackbox Testing using the *Equivalence Partitioning* technique was implemented to evaluate the functionality of navigation features and overall interactivity within the virtual tour (Geil, 2025). A total of 29 test case scenarios were executed to ensure that all system components operated as expected. Second, network performance testing was conducted using the Speedtest application to assess how internet connection quality influences the user experience when accessing the virtual tour.

2. LITERATURE REVIEW

Several previous studies have explored the development of virtual reality (VR) applications to support information services in educational settings. A study by Aulia et al. (2023), titled "*Design and Development of a Library Layout Information Application Based on Virtual Reality*," focused on creating a VR-based application aimed at helping users easily navigate and understand the library's layout, services, and facilities. Another study, "*Designing an Immersive Virtual Reality Campus Tour*," examined virtual tours as an effective promotional medium for disseminating information to prospective university students. Meanwhile, Setiawan et al. (2023), in their work

entitled *“Implementation of Virtual Tour Using Image Stitching as an Introduction Media of SMPN 1 Karangobar to New Students,”* highlighted the use of virtual tours as a tool for introducing the school environment to new students.

3. METHODS

In the development process of this virtual tour, the Multimedia Development Life Cycle (MDLC) method was used, which consists of six stages: concept, design, material collection, development, testing, and distribution. The workflow in this study refers to the development model proposed by Sutopo, which is a modification of Luther’s method (Binanto, 2010).

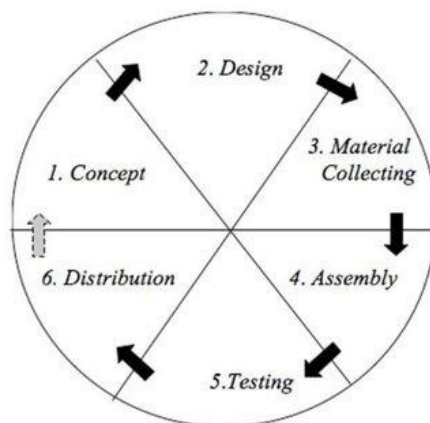


Figure 1. Multimedia Development Life Cycle (MDLC) Method (Binanto, 2010)

This study adopts a Research and Development (R&D) approach, which aims to explore information and data in order to develop, validate, and test the effectiveness of the developed library virtual tour product (Sugiyono, 2020). The research process refers to the Regulation of the Head of the National Library of the Republic of Indonesia Number 4 of 2024, particularly regarding school library service standards and spatial arrangements. The stages of this research follow a systematic flow based on the R&D approach and the Multimedia Development Life Cycle (MDLC) model, which includes: concept, design, material collection, development, testing, and distribution.

In the concept stage, data collection was carried out using two methods: observation and interviews. Observation was used to record in detail the library’s physical environment and the users’ activities (Hasanah, 2017). Structured interviews were conducted with librarians and relevant staff to identify user needs and priority service areas to be visualized in the virtual tour (Romdona et al., 2025).

The design stage was created by creating a storyboard as a navigation guide between rooms and for placing visual information. This storyboard helps organize the sequence of displays and the interactivity between spaces in the virtual tour. In the material collecting stage, visual data were gathered in the form of room photos, documentation of furniture and equipment, and service information elements. This process is essential to ensure that the 3D visualizations correspond with the actual conditions of the library. These data also serve as the foundation for creating three-dimensional (3D) object models and informative graphic designs that enhance the user experience.

The development stage involved creating 3D objects using the Blender application through

modeling and texturing processes (Syty et al., 2024). Additional visual elements such as icons, labels, and narrations were designed using Canva. All objects and information elements were then moved to the next stage. In the assembly stage, the 3D objects were assembled using 3D Homestyler to form the virtual room layout. Subsequently, all elements were compiled using the Panoee platform to produce an interactive 360° virtual tour. The previously designed information was embedded into the tour pages to enrich the user experience when exploring the library's facilities.

The testing stage was carried out using three approaches. First, Blackbox Testing with the Equivalence Partitioning technique was used to test the system's functionality. This test involved 29 test scenarios (test cases), which were divided into equivalent input groups to observe whether the output met the expected results (Budiarto & R.L., 2022). The test results were analyzed using valid and invalid percentages based on formulas from Santi et al. (2022). Second, a network speed test was conducted using the Speedtest application to assess how much the internet connection quality affects the user experience when accessing the virtual tour. Third, User Acceptance Testing (UAT) was conducted to determine the level of user acceptance of the developed system.

4. RESULT AND DISCUSSION

a. Concept Stage

Based on the interview results, several user needs were identified, including the necessity for innovation in implementing user education and library promotion activities. To facilitate the identification process, the following concept table was created.

Table 1. Design and Development Concept

No.	Parameter	Description	Implementation Details
1	Title	Library Virtual Tour in the School Library	Developed as a web-based VR experience accessible via a link, integrated into school media
2	Objective	To develop an innovative method for implementing user education and promoting the library	Aims to replace one-time orientations with an ongoing, engaging virtual alternative
3	End Users	Students, teachers, school staff, and the general public	Accessible through browsers on mobile and desktop devices without the need for VR headsets
4	Virtual Object	Virtual tour of the library area	Interactive 360° view of rooms, collections, and facilities using hotspots and navigation
5	Input	360-degree panoramic photos rendered during the assembly stage to illustrate library spaces	Captured using panoramic cameras or 3D tools, then edited and imported into VR platforms

6	Output	360-degree virtual tour showcasing various areas of the library	Final product hosted online via Panoee or similar platform, shareable through a direct link
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The concept stage is used to refine the ideas to be developed based on the user needs assessment findings, which will be further elaborated in the next phase, product design.

b. Design Stage

To facilitate the design process, a storyboard table was created to define the boundaries of the rooms to be displayed and to structure the navigation flow within the pages of the Galas Library Virtual Tour (Prasetyo et al., 2021).

Table 2. Design storyboard

Scene No.	Scene Title	Description	Visual Elements	User Interaction	Tools Used
1	Circulation service area	Information about borrowing, returning, and membership	videos, background images, navigation directions	Click the “Tour link” to enter the virtual library	Homestyler, Canva, Panoee
2	Reference Area	Display seating area and reference collection zone	360° photo of lobby, directional arrows	Click arrows to explore other sections	Homestyler, Canva, Panoee
3	Multimedia service area	Area with computers, internet access, and online resources	Icons or animations showing computer usage	Info panel appears on click for digital services	Homestyler, Canva, Panoee
4	Reading Area	Features seating areas and supporting facilities	interactive objects, and navigation	Rotate view, zoom in/out	Homestyler, Canva, Panoee
5	Head of Library Room area	Head of Library workspace for administration and services	interactive objects, and navigation	Info panel appears on clickfor the library head room	Homestyler, Canva, Panoee
6	Book Collection area	Shelves categorized by subject or genre	Labeled sections, search tips as text bubbles	Click hotspot for details about the collection	Homestyler, Canva, Panoee

7	Biography & Antique Collection Zone	Presents biographies of figures and antique collections for cultural education	Hotspots with text, icons, info pop-ups	Hover or click hotspot for information display	Homestyler, Canva, Panoee
8	Reading Area	Features seating areas and supporting facilities	interactive objects, and navigation	Rotate view, zoom in/out	Homestyler, Canva, Panoee
9.	Warehouse area	a place to store inactive collections, archives, and library support equipment.	Hotspots with text, icons, info pop-ups	Info panel appears when clicked for warehouse area	Homestyler, Canva, Panoee

The library has seven main areas: circulation, reference, multimedia, floor-seating reading, head librarian's room, book collection shelves, and storage. To provide a clearer overview of the facilities in each area, the researcher added two additional pages to the virtual tour: one showcasing the biography book collection and antique items, and another specifically dedicated to the floor-seating reading area.

c. Material Collection Stage



Figure 2. Material Collection (representation)

The *material collecting* stage in the development of a library virtual tour serves as a critical phase that bridges conceptual design and multimedia-based digital implementation. At this stage, developers are responsible for gathering various types of materials required as the primary source for the modeling and virtual space assembly process. These materials include visual data, physical documentation, and contextual information relevant to the functions and structure of the library services. The goal is to produce three-dimensional (3D) digital models that not only resemble the physical layout but also convey the meaning and purpose of each visualized element.

Visual data collection was conducted through direct documentation using 360-degree panoramic photography techniques across all areas of the library. Focus areas included the circulation desk, reference section, multimedia room, reading lounge, book collection racks, and storage rooms.

This documentation was carried out comprehensively by considering spatial composition, lighting conditions, and user eye-level perspectives. Such attention ensures that the 3D reconstruction does not suffer from visual distortion and provides an immersive exploratory experience. The captured images served as the primary references for modeling objects in Blender and arranging the layout in 3D Homestyler.

In addition to the visual aspect, this stage also involved inventorying all furniture and library service facilities. Objects such as circulation desks, book racks, computers, information boards, and decorative elements were recorded in detail based on their dimensions, colors, materials, and functional roles. This data collection supports the creation of accurate digital objects while maintaining the integrity between physical and digital spaces. Supplementary information such as service descriptions, usage guidelines, and educational narratives was also prepared in the form of text content and icons, which would later be embedded into the virtual tour system as interactive elements.

The entire material collecting process was conducted in accordance with the regulations outlined in the Head of the National Library Regulation No. 4 of 2024, particularly regarding service standards and school library spatial design. This ensures that the layout and navigation flow in the virtual tour are not only visually appealing but also aligned with ideal and functional library service principles. The outcomes of this phase include a collection of raw media files, detailed descriptions of objects and services, and interactive information scripts ready for integration into the next stage. Therefore, material collecting is not merely a visual asset gathering activity but a strategic content curation process aimed at creating a representative, educational, and user-oriented library virtual tour.

d. Development Stage



Figure 3. Development Stage (representation)

The development stage serves as the core phase of implementation in the creation of a library virtual tour, where all previously gathered visual assets, informational content, and interactive designs are assembled into a complete digital product. This process begins with the modeling and texturing of three-dimensional (3D) objects using Blender software. At this point, items such as bookshelves, service desks, computers, chairs, posters, and architectural room elements are carefully reconstructed based on the visual documentation collected during the material collecting stage. Each object is developed not only for aesthetic accuracy but also with attention to spatial proportions to

create a realistic and immersive digital environment.

Once the 3D objects are completed, the development proceeds with digital space layout assembly using the 3D Homestyler application. This tool facilitates the arrangement of the room layout to mirror the actual structure of the library. All objects are positioned to reflect their real-life placement, ensuring spatial accuracy. The visual elements are then exported into the Panoee platform, which serves as the main system for transforming digital spaces into interactive 360-degree virtual tours. Panoee enables integration of panoramic images, navigation points, hotspots, and other interactive elements into a single, user-friendly interface.

During this stage, all supporting information such as service descriptions, navigation icons, social media links, and space usage instructions are embedded in the form of interactive overlays. Icons, text labels, and other visual elements are designed using Canva to ensure visual consistency and clarity. These contents are strategically placed at key points throughout the virtual tour, allowing users to access relevant information while exploring specific areas. For example, in the multimedia room, icons provide descriptions of video playback services, while in the circulation area, social media icons guide users to the library's online platforms.

The development process concludes with a series of internal functional tests to ensure that all elements are properly connected, navigation flows smoothly, and informational content is displayed completely. Reviews are conducted by the development team in collaboration with library staff to assess whether the virtual tour aligns with library service contexts and meets the usability needs of the intended users. Thus, the development stage not only results in a visually rich digital product but also creates an educational, accessible, and user-centered exploratory experience that supports both user education and the online promotion of library services.

e. Testing Phase

1) Blackbox Testing

Blackbox testing was employed in the virtual tour system's testing phase by designing 29 test scenarios. The testing results revealed that all scenarios passed successfully, indicating that the system functions as intended and meets the predefined requirements.

$$Test\ Case\ Valid = \left(\frac{29}{29}\right) \times 100 = 100\%$$

All navigation features and icons in the virtual tour functioned properly, achieving a 100% success rate in the test case evaluation.

2) Internet Speed Testing

Internet speed testing revealed that internet access can significantly affect the virtual tour experience. Based on data from three informants, the network usage during the virtual tour was recorded as follows.

Tabel 3. Speedtest CBN

Testing on Informants (IF)	Speedtest CBN					
	Download (Mbps)	Upload (Mbps)	Ping (ms)	Jitter (ms)	Server	IP
IF-1	45.2	49.4	17	7	X1	66.96.233.56
IF-2	1.3	0.7	30	96	X2	180.248.47.60
IF-3	21.2	7.3	38	12	Y1	114.125.102.204

Testing on website access speed indicated that performance is highly influenced by the type of network used. Network X1 delivered the most optimal results with a download speed of 45.2 Mbps and low latency (17 ms), ensuring a smooth virtual exploration experience. In contrast, network X2 showed less supportive performance with a high jitter of up to 96 ms, which may cause delays in the virtual tour display. These findings highlight that a stable and high-speed internet connection is essential to support the effective implementation of online virtual tours.

3) User Acceptance Testing (UAT)

UAT was conducted with 10 respondents, consisting of students and librarians, to evaluate the Library Virtual Tour product based on four main indicators: usability, clarity of visuals and navigation, relevance of informational content, and overall user satisfaction with the system. Each indicator was assessed using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Table 4. User Acceptance Testing (UAT)

No	Respondents	Usability	Visual & Navigasi	Content	Satisfaction	Total Score
1	R1	5	5	4	5	19
2	R2	4	5	5	5	19
3	R3	5	4	4	5	18
4	R4	4	5	4	4	17
5	R5	5	5	5	5	20
6	R6	4	4	4	4	16
7	R7	5	5	4	5	19
8	R8	4	4	5	4	17
9	R9	5	5	5	5	20
10	R10	5	4	5	5	19
Total		46	46	45	47	184

Maximum possible score:

- 10 respondents × 4 indicators × maximum score (5) = 200
- Actual score obtained: 184
- UAT success percentage:

$$UAT \text{ Percentage} = \left(\frac{184}{200} \right) \times 100 = 92\%$$

The User Acceptance Testing (UAT) results show a user acceptance rate of 92%, indicating that the virtual tour product is considered highly feasible and well-received by end users. This score reinforces the system's validity as an effective digital-based educational and promotional tool for the library (Qois, 2021).

4) Distribution Stage

Based on the development results, the library virtual tour has been successfully built and functions well according to its initial objectives. Testing results show that all features run smoothly, indicating that the product is feasible. The outcome of this research will be handed over to the library via a virtual tour access link. This link can be shared with students and teachers as a digital medium for learning and promoting library services, enabling broader and more sustainable utilization.

5. CONCLUSION

The design and development of the library virtual tour in the School Library have been successfully carried out using the Multimedia Development Life Cycle (MDLC) method. Each stage of the method was systematically implemented, beginning with the concept phase, which referred to the indicators of the Regulation of the Head of the National Library Number 4 of 2024, up to the distribution stage, where the final product was handed over to the library. The tour flow was designed using a storyboard, while 3D objects were created using Blender and assembled into 360° panoramas using 3D Homestyler. Visual information was designed using Canva and integrated into the Panoee platform to produce an interactive and informative virtual tour. Functionality testing using the black box method showed that all 29 scenarios ran successfully, indicating that the product met technical and operational standards. Furthermore, network speed testing highlighted the importance of a stable internet connection to ensure smooth access to the virtual tour.

The User Acceptance Testing (UAT) results also demonstrated that the virtual tour product received a user acceptance rate of 92%, reflecting high levels of satisfaction and usability from the perspectives of students and librarians as end users. Therefore, the developed product is feasible as an innovative medium to support the implementation of user education and promote library services digitally and sustainably.

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