



## **Design and Development of a Web-Based Virtual UNU Yogyakarta Campus Tour System to Improve Information Accessibility**

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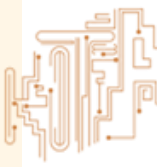
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### **Abstract**

Universitas Nahdlatul Ulama (UNU) Yogyakarta has long depended on static 2D photographs and scattered social media content to convey campus conditions – a method that consistently falls short of giving prospective students any real spatial understanding of the campus environment. For students outside Yogyakarta, this means making enrollment decisions based on incomplete visual fragments. This study addresses that gap by designing and building a web-based 360° Virtual Tour system using the Prototyping development method. The system adopts a decoupled architecture: Django REST Framework handles backend data operations, while Next.js – paired with the React Photo Sphere Viewer library – drives the panoramic front-end display. Black Box functional testing confirmed that all eight tested features operated without error. User Acceptance Testing (UAT) conducted with 66 respondents produced a feasibility score of 83.0%, classified as "Very Feasible." The highest-rated indicator was Real Campus Representation at 4.44 out of 5.00, confirming that users found the system's depiction of campus space genuinely accurate. The system offers a self-managed, cost-conscious alternative to vendor-dependent tour platforms, with clear implications for how smaller institutions can reclaim control over their own digital presence.

**Keywords:** Virtual Tour; Django REST Framework; Next.js; Prototyping; Information Accessibility; Higher Education Marketing.



## 1. Introduction

Higher education institutions are under real pressure to rethink how they present themselves online. The post-pandemic period did not create this problem – it simply made it impossible to ignore. Indonesia alone recorded 4,356 active higher education institutions as of 2023 (Ministry of Education, Culture, Research, and Technology RI, 2023), all competing for the attention of prospective students who no longer wait for campus open days. They search, scroll, and form judgments within minutes. Digital transformation in Indonesian universities has accelerated sharply in recent years (Kambau, 2024), yet the shift in communication strategy has not kept pace. Many institutions, including Universitas Nahdlatul Ulama (UNU) Yogyakarta, still rely on static photographs, printed brochures, and two-dimensional floor plans as their primary visual tools – media that flatten depth and strip away any sense of scale or spatial relationship. UNU Yogyakarta is a nine-story building with layered spatial complexity. Representing that environment through a handful of cropped photos is not just inadequate; it actively misleads. Interviews with the Admissions Office confirmed that prospective students from outside the Special Region of Yogyakarta reported genuine difficulty forming a reliable picture of campus facilities from social media content alone. The result is a form of information asymmetry – local students can visit and verify; distant students cannot. That gap has measurable consequences: research shows that interactive digital media can raise prospective student engagement by as much as 67% (Concept3D, 2024), which means the cost of relying on static visuals is not merely aesthetic.

The 360-degree virtual tour addresses this problem directly. By linking panoramic images through navigational hotspots, users can move through a space, control their viewing angle, and build a spatial understanding that no photograph can replicate. Prior work by Riyadi and Nurhaida (2022) demonstrated that panoramic virtual tour applications improve spatial awareness and support more confident user decision-making. More recently, Yusuf *et al.* (2025) validated similar findings in a metaverse-based campus tour context, confirming that immersive spatial media consistently outperforms static alternatives in user experience metrics. Virtual campus tours have also been recognized as a strategic marketing tool for higher education institutions seeking to reach geographically dispersed audiences (Noetic Marketer, 2024). The technology, in other words, is proven. What remains underdeveloped – particularly within the Indonesian higher education context – is the custom-built, institution-managed version of it. Most available solutions run on proprietary third-party platforms: expensive to license, difficult to modify, and entirely dependent on external vendors for content updates. When a new lab opens or a floor is renovated, institutions using these platforms must wait for someone else to act. Beyond the practical inconvenience, it means institutions lose authorship over their own representation. Academic research on independently developed virtual tour systems within Indonesian universities is also sparse, and studies that pair technical development with empirical user acceptance evaluation are rarer still.

This study responds to both gaps. A custom web-based 360-degree virtual campus tour system was designed and built for UNU Yogyakarta using the Prototyping method (Pressman & Maxim, 2014), with Django REST Framework handling backend services (Django Software Foundation, 2024) and Next.js managing frontend visualization (Vaghela, 2024). The architecture was chosen



specifically to give the institution direct control over content management – no vendor dependency, no developer required for routine updates. Accessibility standards outlined by W3C (2024) were also considered in the interface design to ensure the system remains usable across a broad range of devices and user conditions. System evaluation was carried out through Black Box functional testing and User Acceptance Testing (UAT) involving 66 respondents, producing both technical validation and user-side evidence of the system's practical value. The contribution here is not just a working product – it is a replicable model for how smaller institutions can build and own their digital campus presence without surrendering control to external platforms.

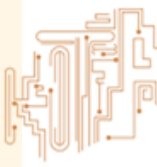
## 2. Theoretical Framework

### 2.1 Virtual Tour Systems and Information Accessibility

A virtual tour system is a digital application that allows users to explore physical environments remotely through 360-degree panoramic images linked by navigational controls. The key distinction from static photographs or conventional video is user agency – the ability to rotate, zoom, and move between spaces at will. This matters because spatial understanding is not simply about seeing a room; it is about grasping how spaces relate to each other, how large a corridor actually feels, whether a study area is genuinely usable or merely staged for a camera. Riyadi and Nurhaida (2022) demonstrated that panoramic virtual tour applications measurably improve users' spatial awareness and perception of realism compared to conventional visual media. In the higher education context, this translates directly into a more honest representation of campus conditions – one that prospective students, particularly those who cannot visit in person, can use to make informed enrollment decisions. When that representation is absent or inadequate, information inequality follows: students with geographic access to a campus can verify what they see online; those without it cannot. Virtual tour systems are one of the more practical tools for closing that gap (Concept3D, 2024; Noetic Marketer, 2024).

### 2.2 Web-Based Development Architecture

A browser-based delivery model removes the installation barrier entirely. A prospective student on a mobile phone in East Java can access the same campus tour as someone sitting in a campus library – no download required, no platform restriction. This accessibility advantage is why a web-based approach was chosen over a native mobile application, and it aligns with the accessibility principles outlined in the Web Content Accessibility Guidelines (W3C, 2024), which emphasize broad device compatibility and low-friction access as baseline design requirements. The system uses a decoupled architecture, separating backend logic from frontend presentation. Django REST Framework (DRF) was selected for the backend. Built on Python, DRF provides structured API management, built-in authentication, and a well-documented admin interface – qualities that matter when non-technical staff need to manage content without developer involvement (Django Software Foundation, 2024). For the frontend, Next.js was chosen for its Server-Side Rendering (SSR) capability, which reduces initial load time for image-heavy pages and improves search engine visibility – both relevant concerns for a visually demanding application serving users on variable mobile connections



(Vaghela, 2024). Paired with the React Photo Sphere Viewer library, Next.js delivers full-screen panoramic rendering with fluid user interaction. This separation of concerns is not merely a technical preference; it is what makes the system maintainable and updatable by the institution itself, rather than dependent on a vendor's schedule.

### 2.3 Prototyping Method in System Development

The Prototyping method is a software development approach built around iterative design and continuous user feedback (Pressman & Maxim, 2014). For a virtual tour system, this is the appropriate choice – not because other methods are inadequate, but because the quality of a spatial experience is genuinely difficult to evaluate from a specification document or a static wireframe. A prototype that users can actually navigate reveals usability problems that no design review would catch: a hotspot placed at an awkward angle, a transition that disorients rather than guides, an info panel that obscures the view it is meant to describe. The iterative cycle of build, test, and refine surfaces these issues early, before they become costly to fix. Pressman and Maxim (2014) note that prototyping reduces development risk precisely by compressing the feedback loop between design decisions and user response – a principle that applies with particular force to systems where the experience itself is the primary output.

### 2.4 User Acceptance

User acceptance determines whether a technically functional system actually gets used. In virtual tour applications, acceptance is shaped by several factors: image clarity, interface legibility, navigation comfort, system responsiveness, and – perhaps most critically – how accurately the system represents the real environment. A tour that looks polished but feels artificial will not help a prospective student make a decision. User Acceptance Testing (UAT) using structured Likert-scale questionnaires provides a systematic way to measure these perceptions across a representative user group, rather than relying on informal feedback. Yusuf *et al.* (2025) found that high acceptance scores in campus tour applications consistently correlate with perceived spatial realism and smooth navigation performance – findings that directly informed the selection of evaluation indicators used in this study.

## 3. Methodology

### 3.1 Research Design

This study follows an applied research design, centered on building and evaluating a functional information system. The Prototyping method was selected as the development model because virtual tour systems are inherently visual and experiential – their quality cannot be reliably assessed from a specification document alone. Only when users actually navigate a working prototype do problems with spatial flow, hotspot placement, and interface legibility become apparent. This iterative build-test-refine cycle is what makes Prototyping the appropriate fit here, rather than a linear development model that defers user feedback until late in the process (Pressman & Maxim, 2014).



### 3.2 Prototyping Development Stages

System development followed five sequential Prototyping stages. In the Communication stage, requirements were identified through direct discussions with campus management and the Admissions Office. Priority features were established at this point: 360-degree panoramic navigation, hotspot-based movement between locations, and contextual facility information accessible through embedded info icons. The Quick Plan stage translated these requirements into system flow diagrams using Unified Modeling Language (UML) – specifically Use Case and Activity Diagrams – alongside an Entity Relationship Diagram (ERD) to define the database structure. During Modeling Quick Design, wireframes were produced to define layout, navigation hierarchy, and information placement. The objective was to confirm that the interface would be legible and navigable before any code was written, reducing the risk of costly redesign later. Construction of the Prototype then moved into full implementation: the backend was built using Django REST Framework with PostgreSQL for database management, while the frontend was developed in Next.js and paired with the React Photo Sphere Viewer library for panoramic rendering. Finally, the Deployment and Feedback stage involved releasing the prototype to a user group for evaluation. Feedback gathered at this stage informed the final round of refinements before formal testing commenced.

### 3.3 Data Collection

Visual data were obtained by capturing 360-degree panoramic images at 16 strategic campus locations. Images were taken using Single-shot HDR techniques to maintain consistent visual quality across varying lighting conditions – a practical necessity in a nine-story building where natural light differs significantly between floors and room types. User evaluation data were collected through a structured questionnaire administered during the UAT phase. Respondents were drawn from prospective users, including students and members of the general public, totaling 66 participants. The questionnaire applied a five-point Likert scale (1–5) to measure perceptions across usability, visual quality, and overall system feasibility.

### 3.4 System Testing and Evaluation

Evaluation was conducted through two methods. Black Box functional testing assessed system behavior without inspecting internal code, focusing on observable outputs across eight test scenarios: URL access, panorama loading, hotspot navigation, zoom behavior, sidebar navigation, info pop-up display, panorama transitions, and admin dashboard content management. Each scenario was assessed against expected output to determine whether the function performed as specified. User Acceptance Testing (UAT) measured the system's feasibility and acceptability from the user's perspective. Ten evaluation indicators were assessed: image clarity, UI design quality, transition comfort, information readability, asset loading speed, campus representation accuracy, and interest in visiting or enrolling. Feasibility percentage was calculated using quantitative descriptive analysis – dividing the total actual score by the maximum ideal score – to produce a single comparable figure against established feasibility thresholds.



## 4. Results and Discussion

### 4.1 Results

#### 4.1.1 System Implementation

The UNU Yogyakarta Virtual Campus Tour was built as a fully web-based application covering 16 campus locations across the building's nine floors. The decoupled architecture delivered on its core promise: the backend and frontend operate independently, which means updates to content do not require changes to application code, and frontend rendering performance is not constrained by backend processing load. The backend, built on Django REST Framework with PostgreSQL, handles all structured data – location records, panoramic image paths, hotspot coordinates, and facility descriptions – and exposes them through a REST API. The frontend, developed in Next.js and paired with the React Photo Sphere Viewer library, consumes that API to render full-screen 360-degree panoramic views. Next.js's server-side rendering handles the initial page load efficiently, which matters given that 92.4% of UAT respondents accessed the system via mobile devices – connections where load time directly affects whether a user stays or leaves.

#### 4.1.2 Visitor Interface

The visitor-facing interface presents a full-screen panoramic view as its primary element. Three interaction mechanisms are available to users. Hotspot navigation uses arrow-shaped markers embedded within each scene to move between locations, replicating the experience of walking through the building. An info icon ("i") appears at contextually relevant points within each panorama, opening a panel with facility details when selected. A collapsible sidebar menu lists all 16 locations, allowing users to jump directly to any space without following a sequential path. Together, these features give users genuine control over how they explore the campus – which is precisely what distinguishes this format from a pre-recorded walkthrough video.

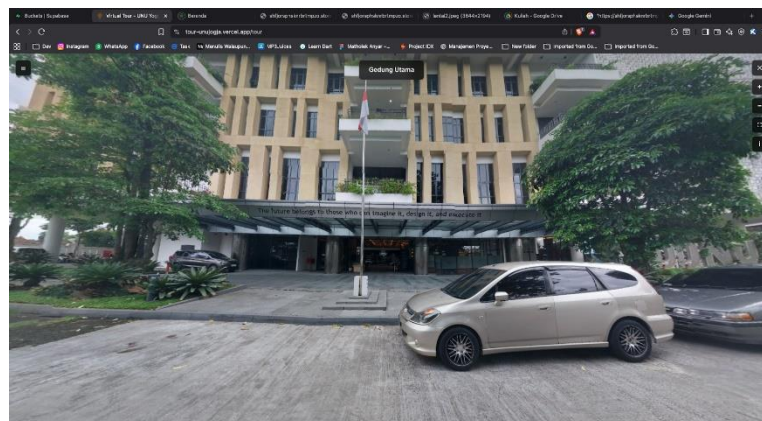


Figure 1. Virtual Tour Interface Display (Viewer)

#### 4.1.3 Admin Dashboard

The admin interface, built on a modified Django Admin base, allows public relations staff to manage all content without touching the codebase. New locations can be added, panoramic images uploaded, and descriptive text edited through a standard web form. This is not a minor convenience – it is the feature



that determines whether the system remains current six months after launch or quietly becomes outdated. Institutions that depend on vendor platforms for every content update tend to let their tours go stale precisely because the update process requires external coordination. This system removes that dependency entirely.

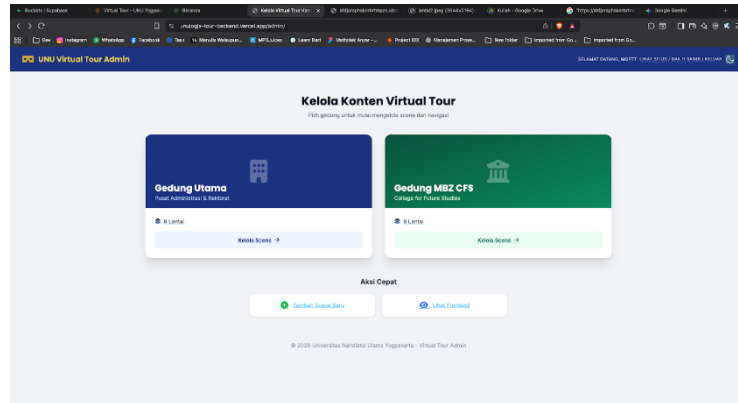


Figure 2. Admin Dashboard Page for Content Management

#### 4.1.4 Functional Testing Results (Black Box)

Black Box testing covered eight functional scenarios: URL access, panorama loading, hotspot interaction, zoom behavior, sidebar navigation, info pop-up display, panorama transitions, and admin dashboard content management. All eight scenarios returned valid results – each function performed according to its specification, with no logical errors detected. The system is technically ready for deployment.

#### 4.1.5 User Acceptance Testing (UAT) Results

UAT was completed by 66 respondents, with 92.4% accessing the system through mobile devices. Ten indicators were assessed using a five-point Likert scale. Table 1 presents the summarized scores for the primary indicators:

Table 1. UAT Questionnaire Result Summary

Code	Assessment Indicator	Avg. Score	Category
P1	Image Clarity (Visual)	4.23	Very Good
P2	User Interface Design (UI)	4.24	Very Good
P3	Transition Comfort	3.88	Good
P6	Info Feature Readability	4.36	Very Good
P7	Asset Loading Speed	3.97	Good
P9	Real Campus Representation	4.44	Very Good
P10	Interest in Visiting/Enrolling	4.30	Very Good
–	Overall Average	4.15	Very Good

The total actual score of 2,739 against a maximum possible score of 3,300 yields a feasibility percentage of 83.0%, placing the system in the "Very Feasible" category. The highest-scoring indicator – Real Campus Representation at 4.44 – is also the most meaningful one. If users do not believe the tour accurately reflects the actual campus, the system's entire purpose collapses. The fact that this indicator scored above image clarity, UI design, and information readability suggests the system succeeds where it most needs to. The two lowest scores, Transition Comfort (3.88) and Asset Loading Speed (3.97), remain within the



"Good" range but warrant attention. Both are directly tied to mobile network conditions and device processing capacity – factors that panorama compression strategies and lazy-loading techniques could address without sacrificing visual quality.

#### 4.2 Discussion

Taken together, the Black Box and UAT results confirm that the system works as intended – both technically and from the user's perspective. The 83.0% feasibility score from a general user population, not a controlled lab group, carries genuine weight. These are the kinds of users the system will actually serve. The decoupled architecture proved to be the right structural choice. Separating backend data management from frontend rendering allowed each layer to be optimized independently. Next.js handled asset delivery efficiently enough that load performance, despite being the lowest-rated indicator, still cleared the "Good" threshold – a reasonable outcome for a panoramic image application running on mobile connections. The admin dashboard's no-code content management model directly addresses the institutional autonomy problem identified in the introduction. A system that requires a developer for every content update is not a sustainable solution for a mid-sized institution with limited IT resources. This one does not.

The high score on Real Campus Representation (4.44) aligns with findings from Riyadi and Nurhaida (2022) and Yusuf *et al.* (2025), both of whom found that panoramic and spatially immersive media consistently outperform static alternatives in user perception of realism. For prospective students who cannot visit UNU Yogyakarta in person, that score is the most direct evidence that the system closes the information gap it was built to address. One limitation worth stating plainly: the system was tested at a single institution with a defined building configuration. Scalability – to additional floors, multiple buildings, or satellite campuses – has not been evaluated and should be treated as an open question for future work.

### 5. Conclusion

This study produced a functional, user-validated web-based Virtual Campus Tour system for UNU Yogyakarta, built using the Prototyping method with a decoupled architecture – Django REST Framework on the backend, Next.js on the frontend. The architecture gave the institution something that vendor-dependent platforms rarely offer: direct, independent control over content. Public relations staff can add locations, upload panoramic images, and edit facility descriptions without developer involvement, which is what makes the system viable beyond its initial launch. Black Box testing confirmed 100% functional validity across all eight tested scenarios. UAT results from 66 respondents placed the system at 83.0% feasibility – classified as "Very Feasible" – with Real Campus Representation scoring highest at 4.44 out of 5.00. For prospective students who cannot visit in person, that score is the clearest evidence that the system does what it was built to do: give distant students a spatially accurate, honest picture of the campus before they commit to an enrollment decision. Two areas remain open for improvement. Transition Comfort (3.88) and Asset Loading Speed (3.97), while still rated "Good," reflect the real constraints of serving a mobile-dominant user



base on variable network connections. Panorama compression and lazy-loading strategies are the most direct paths to improvement here. Beyond performance, future development should consider adding real-time interactive features – guided tour modes or embedded live chat – to move the system from passive exploration toward genuine two-way engagement. Scalability across multiple buildings or campuses also remains untested and represents the most significant boundary of the current work.

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