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Development of a Mobile Application for Standardized Asset Naming to Enhance Workflow Efficiency in Healthcare Construction Projects

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Abstract

Efficient asset management is critical to the success of complex construction projects, especially in healthcare environments where accuracy, coordination, and regulatory compliance are paramount. This study presents the development of a standardized digital asset naming system designed to address persistent issues such as inconsistent identification, disorganized documentation, and communication breakdowns among stakeholders. Using a mixed-methods approach, the research combines quantitative survey data with qualitative insights from construction professionals to inform the system's design and validate its effectiveness. The project involved designing a mobile application that enables users to systematically input asset data, attach optional photographs, and generate structured PDF reports. Deployment at the Sunway Ipoh Medical Centre project demonstrated measurable improvements in workflow efficiency and data accuracy. Feedback from end-users highlighted the application's practicality and usability. It is recommended that future developments include Building Information Modeling (BIM) integration, customizable naming templates, and geolocation tagging to enhance system flexibility and scalability.

Keywords: Standardized Asset Naming, Construction Asset Management, Mobile Application, Workflow Efficiency, PDF Documentation

Introduction

The construction industry plays a pivotal role in shaping urban infrastructure and advancing sustainable development. To meet growing demands for quality, traceability, and timely project delivery, leading firms such as Sunway Construction Group Berhad (SunCon) are increasingly adopting digital tools to enhance operational efficiency across all project phases. SunCon is widely recognized for its multidisciplinary expertise in general construction, infrastructure, and MEP (Mechanical, Electrical, and Plumbing) works, as well as its strategic

commitment to environmental goals like reducing carbon emissions and minimizing construction waste.

One of SunCon's major healthcare developments, the Sunway Ipoh Medical Centre (SMCI), exemplifies a complex construction environment that requires precise asset tracking and strict adherence to stringent healthcare standards. In such settings, the accuracy of asset management is not merely an operational goal but a critical component of ensuring patient safety and long-term facility performance. Manual asset management methods have been shown to result in inconsistent naming conventions, tracking errors, and communication breakdowns that can delay inspections and compromise quality. These challenges are magnified in healthcare projects due to the sophisticated MEP systems and specialized equipment involved.

In response, this study introduces a standardized digital asset naming system designed to streamline the identification and documentation of MEP and architectural components. The primary aim is to address common inefficiencies, improve stakeholder coordination, and enhance overall construction efficiency. Specifically, the study seeks to identify key challenges in existing asset management practices, develop a mobile-based solution for standardized naming, and validate its effectiveness through real-world application at the SMCI site.

Problem Statement

Inconsistent and unstructured asset naming remains a persistent challenge in construction projects, undermining efforts to ensure accurate identification, tracking, and documentation throughout the project lifecycle. These inefficiencies are particularly detrimental in complex builds such as healthcare facilities, where the precision and reliability of asset management are directly linked to regulatory compliance, safety, and long-term functional performance.

Current practices, which often rely on spreadsheets or manual paper-based records, are prone to human error, miscommunication, and significant delays, especially during critical inspection, verification, and project handover phases. The absence of a standardized naming convention leads to duplicated efforts, compromised traceability, and difficulties in managing essential Mechanical, Electrical, and Plumbing (MEP) installations. This disconnect not only hampers operational efficiency during the construction phase but also creates long-term challenges for facility maintenance and lifecycle asset management. A digital, standardized solution is therefore required to resolve these systemic inefficiencies and foster improved coordination among project stakeholders.

Literature Review

This study is built upon three key pillars in the existing literature: challenges in traditional construction asset management, the importance of standardization, and the role of digital technology in modernizing industry practices.

Challenges in Traditional Asset Management

Conventional asset management practices in the construction industry, often relying on manual methods like spreadsheets and paper logbooks, are notoriously inefficient and error-prone. These methods lack a consistent data structure, making it difficult to maintain traceability and accuracy throughout the project lifecycle (Attencia & Mattos, 2022). Chong and Low (2005) emphasize that poor asset identification and documentation during the construction stage can lead to defects that are difficult to manage during the occupancy stage, thereby increasing long-term maintenance costs. Issues such as duplicate asset names, vague identifiers, and fragmented records frequently result in delays, costly rework, and ineffective communication between project teams.

The Importance of Standardization in Construction Documentation

To overcome these challenges, standardization has been identified as a critical factor. Standardized protocols ensure that all stakeholders use the same conventions, thereby improving clarity and reducing ambiguity. Abdul-Rahman et al. (2014) assert that standardized documentation improves operational efficiency by reducing redundant processes. This is further supported by Aziz et al. (2023), who state that standardized protocols are essential for enhancing overall construction efficiency. In the context of complex MEP and healthcare projects, a standardized naming system is paramount to ensure every component can be accurately identified, tracked, and maintained, as discussed by Ramli and Ibrahim (2021).

The Role of Digital Technology and Mobile Applications

The advent of digital technologies offers a potent solution to the limitations of manual methods. Digital platforms and mobile applications enable real-time data collection, centralized storage, and the automation of documentation processes. Attencia and Mattos (2022) note that the adoption of digital technologies for asset management can significantly improve data accuracy and facilitate coordination between on-site and office-based teams. Furthermore, Yeoh et al. (2021) highlight how innovative firms like Sunway Construction Group Berhad leverage digital tools to drive project efficiency. The development of a mobile application specifically designed for standardized asset naming is, therefore, a logical step to bridge the gap between current practices and industry needs.

This literature review confirms that while the problem of asset management is well-identified, a practical and user-friendly digital solution focused specifically on standardizing asset naming on construction sites is needed. This study aims to fill that gap by developing and validating a mobile application designed for this purpose.

Methodology

The development of the asset naming application followed a structured, multi-phase methodology to ensure both technical robustness and practical relevance in a real-world construction environment. The process commenced with problem identification through comprehensive data collection. Primary data were gathered from literature reviews, on-site observations, and stakeholder interviews, while secondary data were collected via structured

surveys distributed to construction professionals. This mixed-methods approach provided critical insights into the limitations of existing asset management practices and informed the design requirements of the proposed system.

The subsequent phase focused on system design, which involved defining the application's user interface (UI), user experience (UX), system architecture, and cloud-based database structure. This phase laid the technical foundation for development, utilizing Flutter for cross-platform UI implementation and Firebase for real-time data storage and synchronization. Core features, including structured asset data entry, optional image capture, and automated PDF reporting, were prioritized to address the core challenges identified.

Once the initial prototype was developed, the system underwent iterative testing cycles. Preliminary user feedback guided initial refinements before proceeding to expert-level testing, where seasoned construction professionals evaluated the system's performance and usability in a live project setting. Insights gathered during this phase led to targeted improvements in usability, functionality, and overall system performance, ensuring the final product was aligned with on-site workflow demands. The complete methodology workflow is summarized in Figure 1.

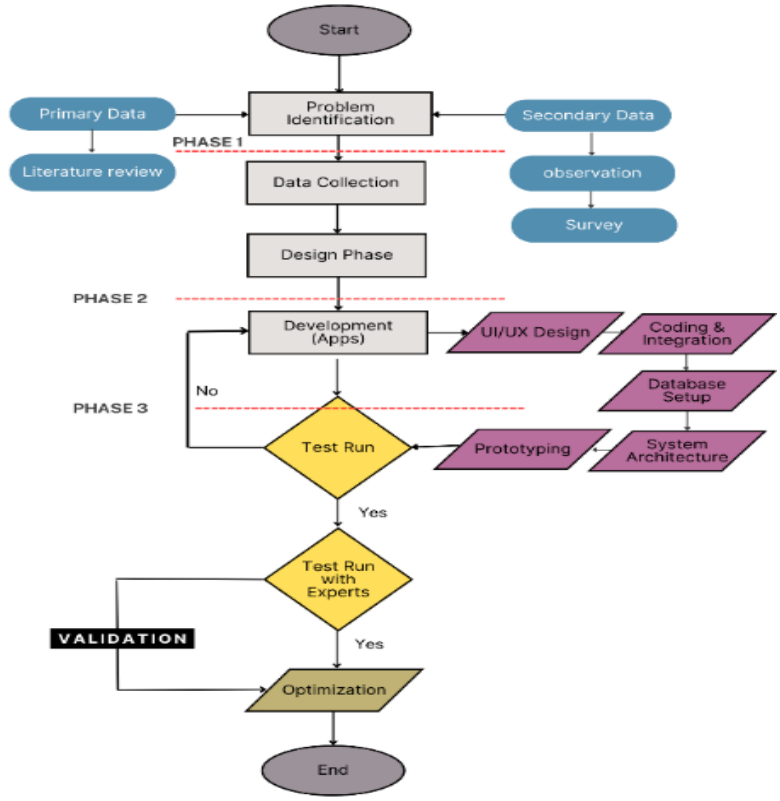

Figure 1: Structured development process for the asset naming application.

Research Design

The research design phase established a structured framework for developing a standardized digital asset naming system tailored to the asset management needs of complex

construction projects, with a focus on enhancing traceability, consistency, and communication. This phase began with a comprehensive assessment of existing practices, which identified key inefficiencies such as inconsistent naming conventions, duplicated asset identifiers, and a lack of traceable documentation across the asset lifecycle.

To address these challenges, a mixed-method approach was employed, combining site observations, structured interviews with project engineers and facility managers, and quantitative surveys to collect data on current processes, pain points, and user expectations. Insights from relevant literature reinforced the critical need for systematic asset naming. For instance, Abdul-Rahman et al. (2014) highlight that standardized documentation improves operational efficiency by reducing redundant processes, while Chong and Low (2005) emphasize the value of aligning asset naming structures with stakeholder needs to improve coordination and minimize communication breakdowns.

Drawing on these findings, the study focused on gathering detailed stakeholder input to define key naming attributes, such as location-based identifiers, unique alphanumeric codes, and asset categories tied to specific lifecycle stages. Based on the data collected, the design phase outlined the core requirements for the system, including categorization by asset type and location, integration capabilities with existing asset management tools, and support for automated report generation. The research identified target users—such as facility managers, site supervisors, and MEP engineers—to ensure that the system's design directly responds to on-site operational demands. The phase concluded with the creation of a detailed implementation roadmap, including technical specifications, resource planning, and development timelines, which formed the foundation for the subsequent application development and validation stages.

Data Collection

This study employed a systematic data collection strategy to identify key issues in current asset naming practices and to assess the feasibility of implementing a standardized digital solution. Initial site observations in active construction and facility management environments revealed significant inefficiencies, including inconsistent naming conventions, difficulty in locating assets, and poor coordination during inspection and maintenance tasks. These gaps in asset traceability underscored the urgent need for a more structured and consistent naming system.

To gain deeper insights, interviews were conducted with facility managers, project engineers, and site supervisors, all of whom highlighted persistent challenges with manual documentation methods. Common concerns included duplicated asset names, vague identifiers, and poor alignment across different departments, which frequently led to communication breakdowns and costly rework. Their input also helped define key requirements for a future-proof naming protocol: namely, clarity, scalability, and seamless integration with digital asset management systems.

In addition to this qualitative feedback, a structured online questionnaire was distributed to 20 professionals involved in asset management across various construction roles. The aim was to quantitatively validate the observed challenges and collect feedback on the limitations experienced when using manual methods such as spreadsheets or logbooks. The results confirmed widespread dissatisfaction with current practices and indicated a strong willingness among respondents to adopt a digital asset naming application that could improve accuracy, efficiency, and project coordination.

Development Phase

The development phase focused on translating the research insights into a functional mobile application designed to improve asset naming and documentation in construction projects. Built using the Flutter framework for multi-device compatibility and Firebase for cloud-based data storage, the application allows users to input structured asset data, categorize components, and generate standardized PDF reports. To enhance asset verification during inspections, support for optional photo attachments was also included.

The user interface was intentionally designed for simplicity and ease of use, featuring dropdown fields and search functions to streamline asset entry and retrieval. The backend database was structured to support hierarchical naming formats, enabling a clear and logical linkage between assets, their categories, and their physical locations. Finally, automated reporting tools were implemented to reduce the manual documentation workload and support consistent, accurate record-keeping throughout the entire project lifecycle.

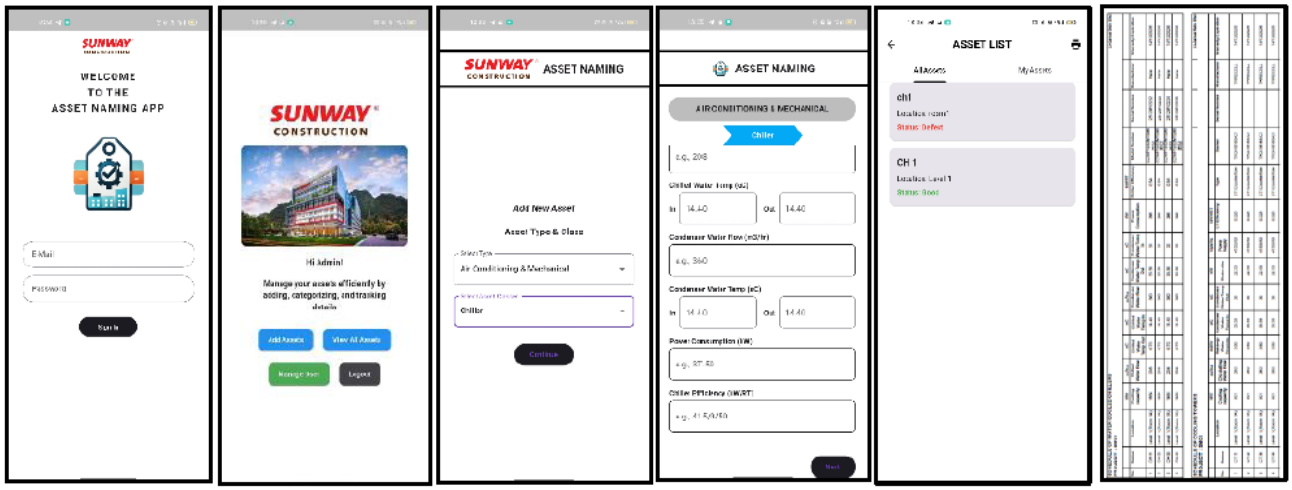

Figure 2: Asset Naming App Overview.

Testing and Validation

The application underwent rigorous internal alpha testing to evaluate its core functionalities, including asset entry, naming consistency, categorization, and PDF report generation. This initial phase was crucial for ensuring system stability by identifying and resolving technical bugs and usability issues.

Following this, a beta testing phase was conducted with 20 industry professionals, including site supervisors and QAQC (Quality Assurance/Quality Control) personnel. These users tested the application in real-world project settings and provided structured feedback on its performance and practicality. The insights gained from this phase led to targeted improvements in the data input flow, interface clarity, and report formatting. Final adjustments were made to ensure the application aligned seamlessly with actual on-site workflows. A final internal review confirmed the app's readiness for deployment as a practical tool for improving asset documentation, standardization, and traceability in demanding construction environments.

Results and Analysis

This chapter presents the findings from the implementation and testing of the standardized digital asset naming system at the Sunway Medical Centre Ipoh project. The data is presented through expert feedback gathered during validation and a quantitative comparison against manual methods. Key performance metrics include usability, time efficiency, and data consistency.

Expert Feedback and User Validation

The application was evaluated through a structured validation process involving expert testing and direct user feedback. During a test run, the deputy MEP manager emphasized the importance of maintaining a simple and intuitive interface, noting that ease of use is essential for adoption in fast-paced construction environments. The MEP manager provided additional feedback, recommending the inclusion of location-based references to improve clarity and better align the asset naming convention with existing site documentation workflows.

Further validation was conducted through a post-implementation survey involving 20 professionals actively engaged in MEP coordination and QAQC processes. The structured questionnaire assessed the application's performance in terms of usability, accuracy, and workflow integration. The responses reflected a high level of satisfaction with the system, particularly in its ability to streamline asset naming, reduce documentation errors, and improve coordination across different teams. Users noted significant improvements in clarity and speed when compared to manual methods and expressed a strong interest in adopting the application for future projects.

Performance Comparison and Efficiency Gains

A comparative analysis was conducted to evaluate the effectiveness of the proposed asset naming application against the conventional manual method, which primarily relied on spreadsheets. Key performance indicators assessed included usability, clarity of information, error reduction, and time efficiency. The evaluation was based on feedback from 20 respondents who used a 5-point Likert scale to rate both methods.

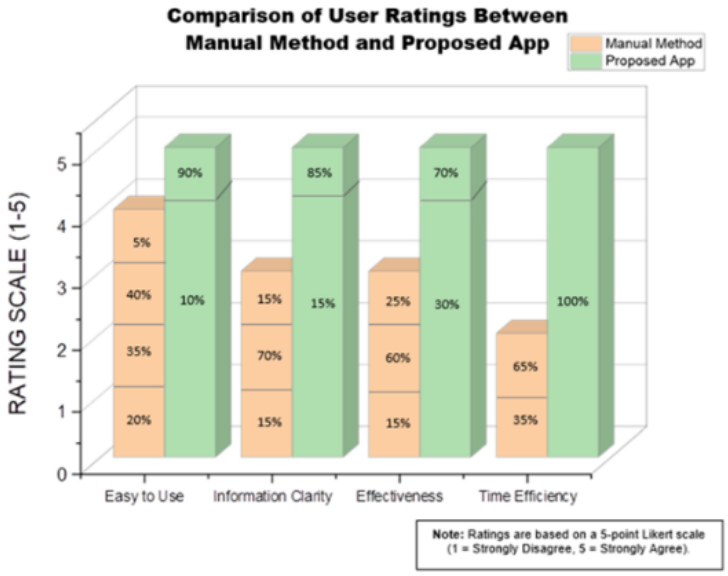

Figure 3: Consolidated Comparison of User Ratings Across Key Dimensions.

Figure 3 presents the consolidated user ratings across these key dimensions. The results clearly indicate that the proposed application significantly outperformed the manual method in all categories. In particular, users rated the application substantially higher for its ease of use, data clarity, and operational efficiency. In contrast, the manual method received mostly neutral or negative ratings, reflecting its inherent limitations in terms of speed and accuracy.

Table 1
Comparison between manual method and proposed method

Aspect	Before (Manual Method)	After (Proposed App)
Naming Format	Inconsistent and duplicated names	Standardized format, auto-generated
Input Method	Manual entry via Microsoft Excel	Automated input via mobile interface
Time Taken per Asset	3–5 minutes	Less than 3 minutes
Traceability	Difficult to track updates	Centralized database, real-time access
Error Rate	High, prone to duplication/errors	Reduced through validation rules
Accessibility	Files stored locally on user devices	Cloud-based, accessible from anywhere
Coordination	Manual referencing and cross-checks	Instant sharing and structured records

Further analysis, as summarized in Table 1, highlights the performance differences before and after the implementation of the application. For instance, asset identification and documentation tasks that previously took between three to five minutes per asset using Excel

were consistently completed in under three minutes with the app. The structured input fields, integrated search functions, and automated PDF reporting all contributed to this notable efficiency gain. The app also minimized errors by enforcing standardized naming formats, which in turn improved traceability and overall data quality.

Discussion

The findings from this study provide strong evidence for the value of digital solutions in enhancing construction asset management, especially in complex, coordination-heavy environments like healthcare projects. This section interprets the results presented, discusses their implications, and acknowledges the limitations of the study.

Interpretation of Findings

The successful implementation of the standardized asset naming protocol led to measurable improvements in data consistency, task efficiency, and stakeholder communication. The overwhelmingly positive feedback from MEP and QAQC professionals underscores the system's practical value. Features such as predefined categories and structured data input directly addressed the core problem of inconsistent naming, significantly reducing data entry errors and improving record accuracy. The quantitative data, showing a reduction in task completion time from over three minutes to under three minutes per asset, confirms a tangible increase in workflow efficiency. This demonstrates that a well-designed, user-centric mobile application can effectively replace error-prone manual processes, aligning with the industry's broader push towards digitalization.

Limitations and Future Research

Despite the positive outcomes, certain limitations were identified during the study. The application was deployed on a single project site, and while the results were promising, broader testing across multiple project types and scales is needed to fully assess the system's scalability and cross-project performance. Additionally, the current Firebase-based architecture may require adaptation to meet stricter data security or localization policies that may be present in other corporate or government projects. These limitations provide a clear roadmap for future research, which should focus on validating the system in diverse construction environments and exploring more robust backend solutions.

Conclusion

This study successfully addressed key challenges in asset identification and documentation within the complex environment of healthcare construction, particularly concerning MEP and architectural components. The research was guided by three core objectives: identifying inefficiencies in manual asset management, developing a standardized digital naming system, and validating its effectiveness in a real-world project setting—all of which were successfully achieved. The investigation confirmed that conventional manual methods are plagued by inconsistent naming, a lack of standardization, and time-consuming tracking, all of which contribute to project delays and miscommunication.

In response, a mobile application was developed to streamline the asset naming process through the use of structured input fields, dropdown categories, photo attachments, and automated PDF reporting. The application was tested by industry professionals in an active healthcare construction project and received overwhelmingly positive feedback for its usability, speed, and significant contribution to standardizing asset documentation workflows.

Future Recommendations

To further enhance the functionality and scalability of the proposed asset naming system, several improvements are recommended. These enhancements are aimed at strengthening the system's integration with broader construction management workflows and increasing its adaptability across different project environments. The top three suggestions are as follows:

- Integration with BIM or Project Management Platforms: Enable a seamless connection with Building Information Modelling (BIM) or other project management tools to support full lifecycle asset tracking and improve coordination from the initial planning phase through to long-term maintenance.
- Customizable Naming Templates: Incorporate the ability for users to define their own naming rules and templates to ensure the system can adapt to varying client standards, project scopes, or other industry-specific requirements.
- Location-Based Enhancements: Introduce features such as GPS tagging or visual asset mapping to improve the spatial accuracy of asset data and support real-time, on-site verification, which can be particularly valuable in large or complex facilities.

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