Nazeer, F.S., Kamardeen, I. and Hasan, A., 2026. Digital System for effective end-user engagement in higher education building design. In: Waidyasekara, K.G.A.S., Jayasena, H.S., Chandanie, H. and Tennakoon, G.A. (eds). *Proceedings of the 14th World Construction Symposium*, 10-11 July 2026, Sri Lanka. pp. 552-564. DOI: https://doi.org/10.31705/WCS.2026.41. Available from: https://ciobwcs.com/papers/

DIGITAL SYSTEM FOR EFFECTIVE END-USER ENGAGEMENT IN HIGHER EDUCATION BUILDING DESIGN

Fathima Sabrina Nazeer[1], Imriyas Kamardeen[2] and Abid Hasan[3]

ABSTRACT

Higher education (HE) buildings often experience performance gaps that undermine occupant comfort, health, and overall satisfaction. These gaps are partly attributed to fragmented end-user engagement during the design process and the lack of effective tools and strategies to support such engagement. To address this issue, this study aims to develop a computerised system that enables professionals to effectively engage end-users in HE building design within real-world practice. The study adopts the Design Science Research methodology to develop a practical and implementable solution. The system is grounded in a knowledge-to-action end-user engagement framework derived from three key knowledge domains: the building design process, user engagement principles, and critical design elements. This framework was systematically developed and refined through multiple empirical research phases. The framework was operationalised using MS Access. The resulting computerised system supports several functions, including user requirement acquisition during the pre-design stage and design evaluation during schematic and detailed design stages. It enables the systematic collection and aggregation of feedback from diverse end-user groups and generates consolidated reports that visualise user preferences and satisfaction levels. By providing a structured mechanism for integrating end-users throughout the design process, the system offers a practical roadmap for professionals. This study bridges theory and practice by delivering a holistic computerised system that translates research knowledge into an industry-ready solution to address persistent performance gaps in HE buildings.

Keywords: *Computerised System, End-user Engagement, End-User Requirement Acquisition, Higher Education Building Design, Pre-Occupancy Design Evaluation.*

1. INTRODUCTION

Higher education (HE) buildings play a critical role in facilitating teaching, learning and research (Abisuga et al., 2020). However, previous research on the performance of HE buildings reveals a significant gap between the intended design and the actual experience of building occupants (Abdullah et al., 2012; Kim et al., 2018). These gaps often manifest in aspects related to health, comfort, functionality, spatial usability and overall

[1] Graduate Researcher, School of Architecture and Built Environment, Deakin University, Australia, f.nazeer@deakin.edu.au
[2] Professor, School of Architecture and Built Environment, Deakin University, Australia, imriyas.kamardeen@deakin.edu.au
[3] Senior Lecturer, School of Architecture and Built Environment, Deakin University, Australia, abid.hasan@deakin.edu.au

satisfaction, which lead to absenteeism, poor academic progression, lower productivity and health issues (Bae et al., 2021; Beckers et al., 2016). A key reason for these discrepancies lies in the limited and fragmented integration of end-user perspectives during the HE building design process (Gooding et al., 2021).

End-user engagement in design is an iterative process that ideally begins at the predesign and continues through schematic and detailed design. During the predesign stage, end-user requirements are identified to inform the development of the project brief. As the design progresses, these requirements should be revisited to evaluate whether the proposed design solutions effectively address the end-user needs. Such iterative engagement allows designers to refine design decisions and ensure the final outcome aligns with user expectations. However, in practice, this integrated continuous engagement rarely occurs. Several challenges hinder effective end-user participation, such as issues of accountability, limited resources, extensive time required to gather and process feedback, and lack of systematic approaches or tools to structure and manage end-user inputs (Gooding et al., 2021; Kjolle & Blakstad, 2014; Latortue et al., 2015; Seki et al., 2022).

To address these challenges and facilitate more effective end-user engagement, a systematic end-user engagement framework was developed (Nazeer et al., 2025a) and validated through previous empirical findings. Building on this foundation, the present study advances the research by translating the acquired knowledge into practical implementation through the development of a computerised system. This system represents one of the initial attempts to provide a practical solution for the effective integration of end-user engagement in HE building design.

The remainder of the paper is structured as follows. First, the end-user engagement framework underpinning the system is introduced. This is followed by the description of the system architecture. The subsequent section outlines the system development process, along with its functionality and benefits. Finally, the paper concludes with the study's contribution and direction for future research.

2. END-USER ENGAGEMENT FRAMEWORK

The framework provides a structured approach for integrating end-user inputs throughout the design process in HE building design settings. The key aspect of end-user engagement relies upon effective acquisition of end-user requirements in pre-design and evaluating the design in schematic and detailed design. Thus, the framework encompasses the following three main components:

(1) End-user engagement process map (see Figure 1),

(2) End-user requirement acquisition module (see Table 1),

(3) Pre-occupancy Design Evaluation module (see Table 2).

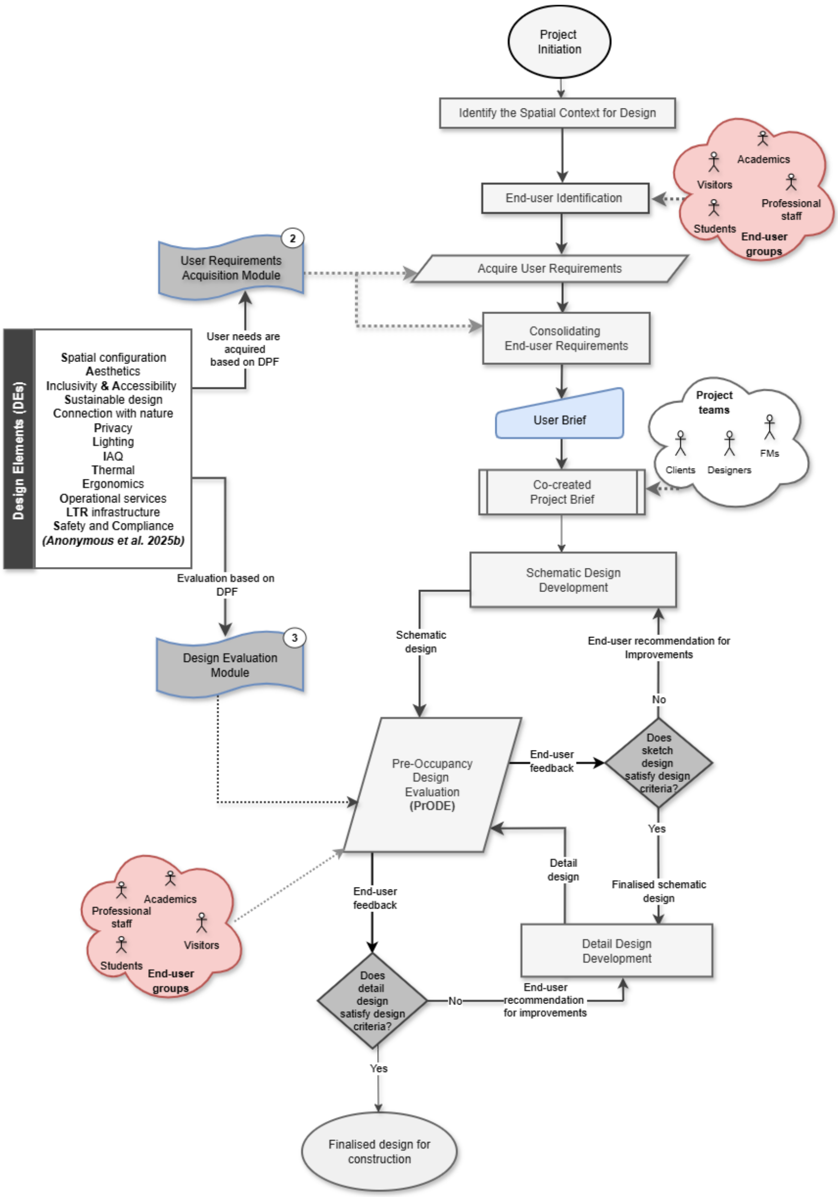

Figure 1: End-user engagement process map (Amended from Nazeer et al., 2025a)

This process map presents the steps to be taken for end-user engagement from project initiation across schematic and detailed design phases. Once the project is initiation the process map emphasises identifying respective end-user groups for iterative engagement in the design process. Initially, end-user requirements are gathered using the end-user requirement acquisition module with respect to the identified 13 Design Elements (DEs) (Nazeer et al., 2025b). The user requirements are consolidated and provide a document referred to as the “User brief”. This document summarises the overall requirements and highlights the preferences of different end-user groups for designers to base their project brief formation. Subsequently, the initial design will be developed and carried forward to the design evaluation phase. The proposed design is evaluated during both phases from the lens of end-users to assess their level of satisfaction using the design evaluation module. The evaluation results generate a total design satisfaction index (TDSI), which indicates whether the design meets the expected level of satisfaction or requires further revisions. Sample user requirement acquisition module and design evaluation modules are presented in Tables 1 and 2.

Table 1: Sample module for end-user requirements acquisition (Amended from: Nazeer et al., 2025a)

Design Element: Aesthetics (AE)							
How important are the following aesthetic features to support your work productivity/learning within the space/building?	Importance rating Low……………….High						Additional comments
(1) Warm colours (red, oranges, yellows)	NA	1	…	…	…	10	
(2) Cool colours (blues, greens, purples)	NA	1	…	…	…	10	
(3) Neutral colours (White, greys, beiges)	NA	1	…	…	…	10	
(4) Nature texture (wood grain, stone textures, …)	NA	1	…	…	…	10	
(5) Smooth surface	NA	1	…	…	…	10	
(6) Rough surface	NA	1	…	…	…	10	
(7) Patterns	NA	1	…	…	…	10	
(8) Identity (local environment/ heritage)	NA	1	…	…	…	10	
(9) Personalisation/ workstation spatial views	NA	1	…	…	…	10	
(10) Historical/ achievement wall	NA	1	…	…	…	10	
(11) Ceiling preferences	NA	1	…	…	…	10	
(12) Ease of maintainability and practicality	NA	1	…	…	…	10	
Please indicate any other important features for the aesthetic appearance you prefer within the space.							

Table 2: Sample module for PrODE (Amended from: Nazeer et al., 2025a)

Design Element: Connection with nature (CN)							
How effective are the following natural elements to support your work productivity or learning within the space/building?	Satisfaction rating Low……………….High						Additional comments
(1) Indoor plants and selection of plants (native/foreign)	NA	1	…	…	…	10	
(2) Courtyards or greenspaces,	NA	1	…	…	…	10	
(3) Rooftop gardens,	NA	1	…	…	…	10	
(4) Study gardens,	NA	1	…	…	…	10	
(5) Window views/ quality views/unobstructed views/ view types: flora, fauna or sky, movement, objects	NA	1	…	…	…	10	
(6) Layout arrangement, textures and colour selection	NA	1	…	…	…	10	
(7) Connected with nature	NA	1	…	…	…	10	
(8) Waterscape design	NA	1	…	…	…	10	

To operationalise the framework and support its practical implementation, it was translated into a technology-supported application. The next section presents the methodology adopted for this study.

3. METHODOLOGY

This research adopts the Design Science Research (DSR) methodology to develop an industry-ready computerised system for the effective engagement of end-users in HE building designs. The DSR approach emphasises the balance between maintaining scientific rigour and ensuring industry relevance, with the development of an artefact as an outcome. Within this methodology, appropriate data collection methods can be selected at different stages of the research process, including the exploration of existing theories and principles, systematic literature reviews (SLR), and empirical data collection techniques to inform the development of the artefact. Accordingly, the development of the proposed computerised system is grounded in a series of rigorous scientific data collection and analysis techniques conducted across four research phases.

3.1 SETTING THE SCENE

In phase I, a preliminary literature review was conducted to determine the root causes of performance gaps in HE buildings. The review revealed that one of the key issues is the limited participation of end-users in the design process. To further investigate this issue, three series of SLR were undertaken focussing on: (1) end-user engagement principles, (2) design evaluation and (3) design elements. The findings from these reviews were disseminated in previous publications (Nazeer et al., 2024, 2025a, 2025b). In addition, related knowledge domains, including the project life cycle, functional performance specification (FPS) theories and knowledge-based expert systems, were reviewed to inform the development of a potential solution. These investigations collectively led to the development of a conceptual framework for end-user engagement.

Phase II focused on the empirical validation and refinement of the conceptual framework. In this phase, four focus group discussions and 70 interviews were conducted with professionals and end users. The findings enabled the identification of significant design elements (Nazeer et al., 2025b) and contributed to the validation of the proposed framework. These findings informed the design and development of the system in Phase III for developing the computerised system in facilitating effective end-user engagement and decision support. Finally, phase IV involved the evaluation of the developed system through a focus group discussion with experienced HE building professionals from a single institution. The session aimed to assess the system's functionality, potential benefits and areas of improvements.

4. DESIGN AND DEVELOPMENT OF A COMPUTERISED SYSTEM

4.1 SYSTEM ARCHITECTURE

Figure 2 portrays the system architecture adopted for this study. This computerised system comprises four components:

(1) Project team and End-user groups – this refers to the system users for data entry and information retrieval.

(2) User requirement acquisition module: This facilitates the engagement of users in acquiring their requirements for the design. The user requirement acquirer will obtain and process the user requirements based on the design elements (DEs) and design features (DFs), and the overall user requirement will be fed into the project

end-user interface (EUI) data. The numerical and subjective data will be consolidated and processed in the user requirement acquirer and organised into a heatmap. This will be translated into a user brief and carried forward to the co-creator project brief. The project brief co-creator will combine both project teams and user brief details, form the co-creator project brief and store it in the project database.

(3) Database: This stores all the output from the user requirement acquirer, design satisfaction rater, and the designs produced based on the co-creator project brief.

(4) Design evaluation module: This module evaluates designs using the design satisfaction rater. End-users provide satisfaction ratings based on the DEs and DFs in schematic and detailed design. These ratings are processed in the system to compute the Total Design Satisfaction Index (TDSI) and consolidate qualitative feedback, which informs decisions on design improvements or acceptance.

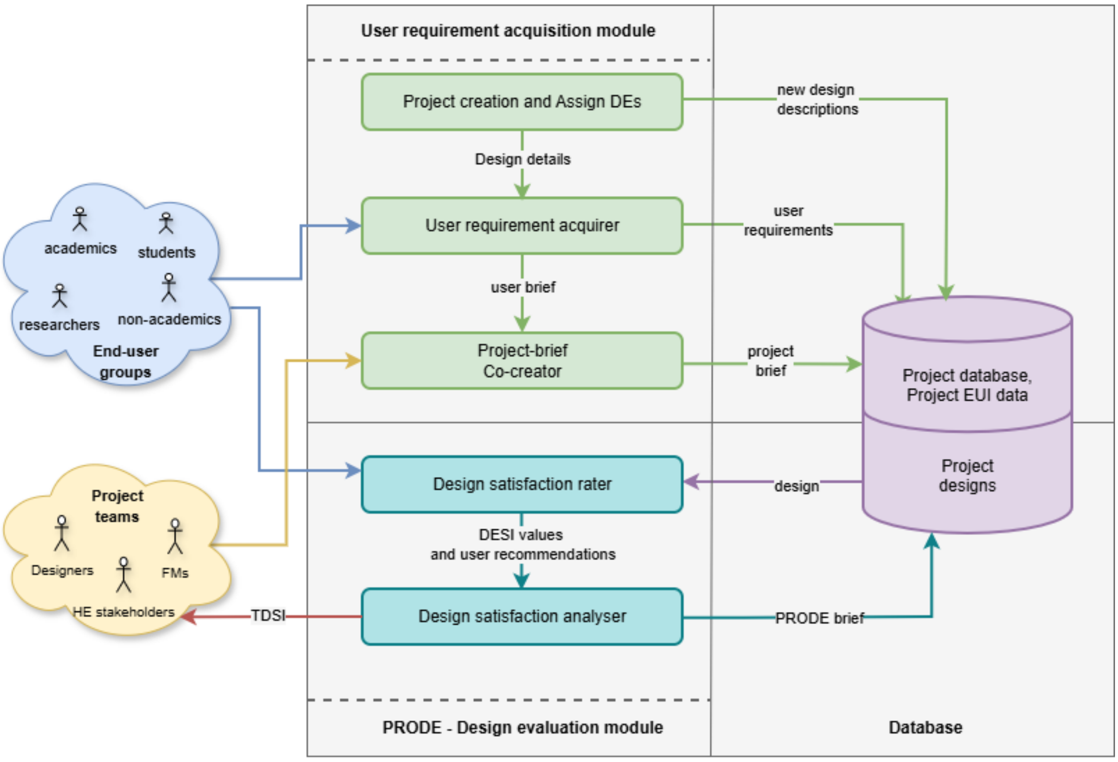

Figure 2: System architecture

4.2 DEVELOPMENT AND INTEGRATION OF SYSTEM COMPONENTS

The development of the computerised system involved the integration of an intermediate unit processing (IPU) and a system database, enabling both knowledge processing and structured data management. The system database was designed and implemented using MS Access to store and manage project data and user inputs. MS Access was chosen due to its capacity to efficiently manage relational data, support the development of user-friendly interfaces and facilitate integration with external applications. Furthermore, its accessibility and cost-effectiveness make it a suitable platform for developing initial proof of concept using database-driven prototype systems.

The development of the IPU utilised the basic and advanced features of MS Access, including: Tables, Queries, Forms, Macros, Reports, and Modules. As an initial step, an entity-relationship diagram (ERD) was developed to define entities and relationships required for structuring the system database, as presented in Figure 3.

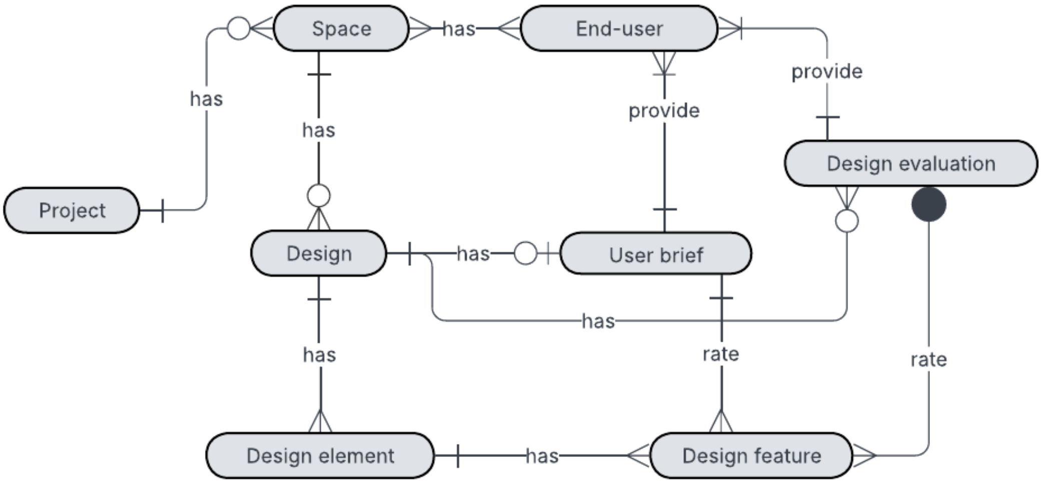

Figure 3: Entity-relationship diagram

4.2.1 Formation of Tables

Based on the ERD, the following database tables were created to store the relevant system inputs, rules and output.

Table 3: Table database structure of the computerised system

	Table name	Description/Purpose
1	Project	Stores information on each project
2	Space	Contains spaces within projects
3	Design	Stores designs associated with individual spaces
4	Design element	Contains identified DEs
5	Design feature	Contains identified DFs linked to DEs
6	Design- design element	Links designs to associated DEs
7	End-user	Stores end-user details
8	User brief	Stores user briefs associated with individual designs
9	User brief - rating	Stores ratings provided by end-users
10	User brief – comment	Stores comments from end-users on DEs
11	PRODE	Stores design evaluation sessions for each design
12	PRODE-schematic rating	Feeds schematic design evaluation ratings and comments from end-users
12	PRODE- detailed rating	Feeds detailed design evaluation ratings and comments from end-users

4.2.2 Defining Relationships

Subsequently, after creating the tables, the relationships between these tables were defined to ensure data integrity and proper linkage across the system. The defined relationships are presented in Figure 4, illustrating how projects, spaces, designs, end-users, DEs, DFs, user brief and design evaluation (PRODE) data are interconnected.

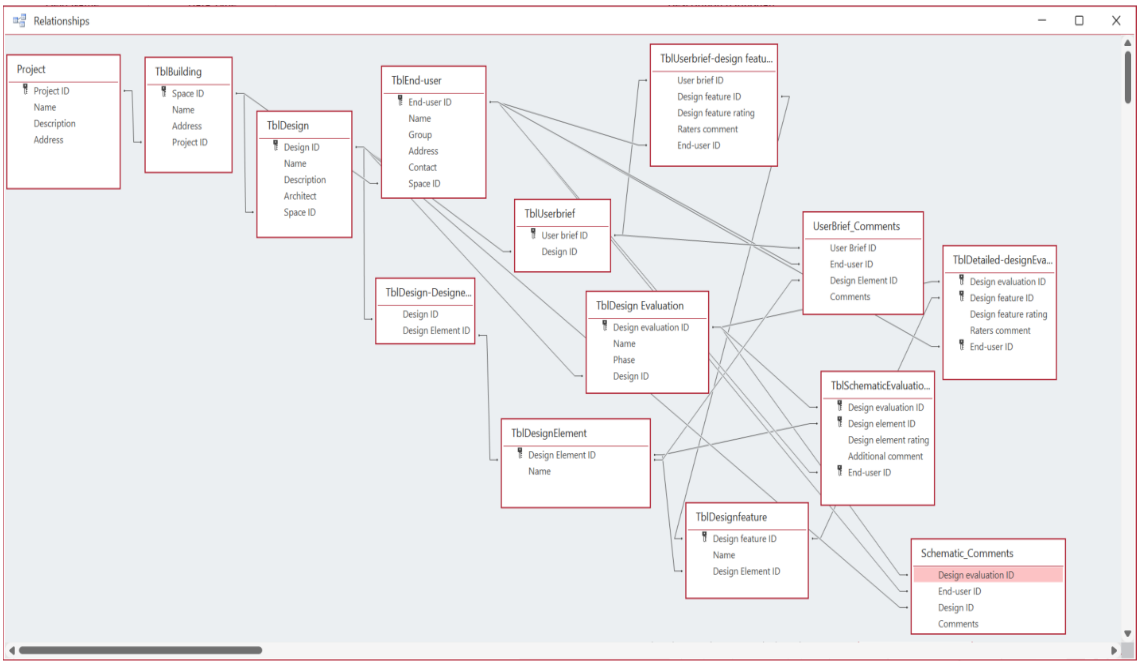

Figure 4: Relationship between data tables

4.2.3 Queries and Computational Procedures

After defining the relationships, a series of queries was created to process the data within the system database. Queries transform raw data stored in tables into meaningful information, forming the analytical engine of the system. Data retrieval queries, structure management queries, feature and element level calculation queries, summary and comparison, and crosstab and visualisation queries were generated to process the computerised system.

User-friendly interfaces for data entry and management were developed using Form Wizard. Subforms were incorporated where necessary to improve the navigation and usability. For example, the subforms for assigning design elements and creating new projects were embedded within the Create project and assign DEs form, allowing related information to be managed within a single interface. Reports were then generated using the Report Wizard to summarise, analyse, and present the processed data into a structured format. Two main reports were produced: a user brief (summarising user requirements) and PRODE (presenting design evaluation results).

Macros were used to generate simple routine automation tasks like: navigating between forms, deleting records, and triggering predefined commands. For more advanced operations, VBA modules were implemented to control system mechanisms, including managing application behaviour, refreshing queries when data changes, and coordinating data processing steps. Through this integrated workflow, the system converts raw user responses into structured results and supports intelligent decision-making.

5. COMPUTERISED SYSTEM FOR END-USER ENGAGEMENT

This system is developed to support effective, integrated end-user engagement practice in HE building design. This comprises many functions, which are incorporated into a user-friendly Graphical User Interface (GUI) that can be navigated through point-and-click icons. All the functions in the computerised system are grouped under three main catalogues: (1) Create project and assign DEs, (2) User brief, and (3) PRODE. Functions in the system were refined and optimised through multiple trial-and-error interactions and brainstorming sessions. These improvements were targeted at effectively integrating the framework developed and finalised during the empirical phase of the study. Through these iterative improvements, the computerised system was structured to provide a clear workflow, allowing project managers/architects to create projects, capture end-user requirements, and evaluate design options within a single integrated platform. The final GUI of the computerised system is presented in Figure 5.

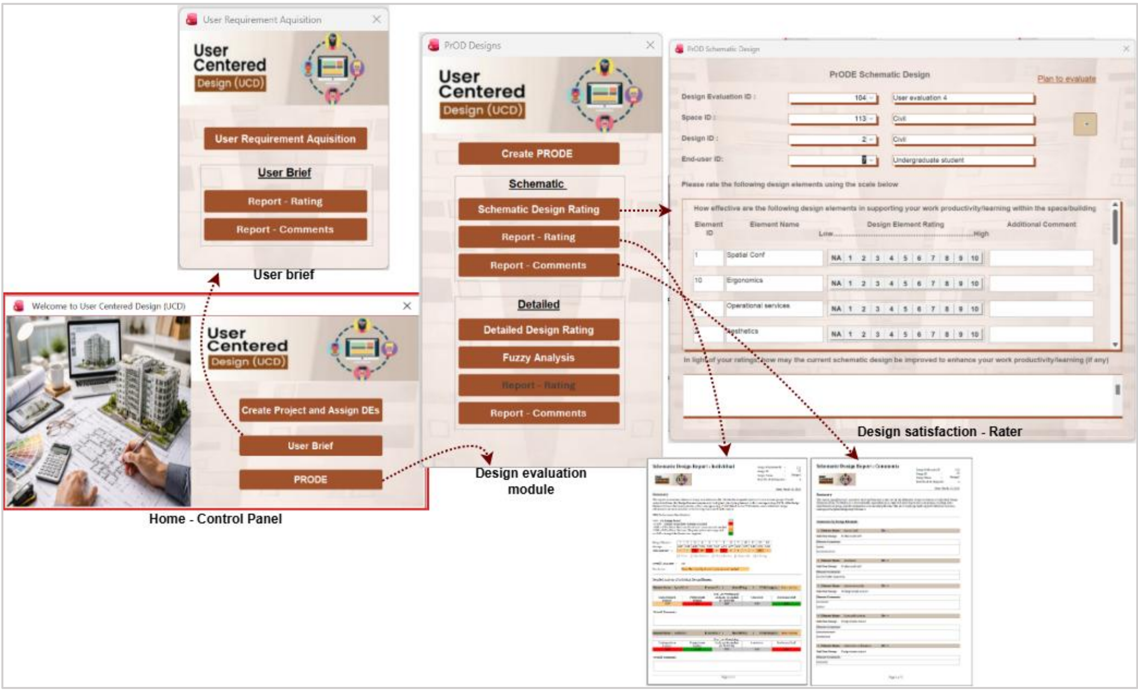

Figure 5: Sample GUI of the developed computerised system

5.1 WORKFLOW MODEL FOR THE COMPUTERISED SYSTEM

This section presents the workflow model for the developed computerised system. The process begins with a project need set up by the HE stakeholders or HE building professionals. The following sequential steps shall be taken:

i. **Project creation:** The project manager or architect creates a new project within the system by registering project information, space details, design descriptions and architect details. A unique design ID is automatically generated, which is used for gathering end-user requirements and later performing the design evaluations.

ii. **Assignment of DEs:** The architect or project manager assigns the relevant DEs associated with the particular design.

iii. **User requirement acquisition:** End-user requirements are collected through the user requirement acquisition interface by following these sub-steps:
   a. An end-user manual is created and uploaded to the interface to guide users.
   b. End-users register themselves by furnishing basic information such as: name, end-user group, address, contact details and associated space.
   c. Registered end-users provide their preferences and expectations for each DF by rating on a 1 – 10 Likert scale and adding additional comments, if any.

iv. **User brief generation:** The system generates user brief reports that summarise the rating and comments. These reports provide both quantified and qualitative feedback to understand end-user priorities.

v. **Schematic design preparation and evaluation:** Prepare the co-creator project brief, and the schematic design is finalised for evaluation. Follow the sub-steps:
   a. The schematic design and any instructions are uploaded to the PRODE – schematic design RATER interface.
   b. Registered end-users evaluate the design by rating their satisfaction with individual DEs, and providing additional comments for any improvements.

vi. **Schematic design report:** The system generates a schematic design report presenting ratings, comments, and the TDSI, along with recommendations.

vii. **Design improvement decisions:** Based on the evaluation results and suggestions, the design may either be improved or progressed to the detailed design phase.

viii. **Detailed design evaluation:** For detailed design evaluation, the following sub-steps are performed:
   a. The detailed design and relevant instructions are uploaded to the PRODE – detailed design RATER interface.
   b. Registered end-users evaluate their satisfaction with individual DFs and provide additional comments.

ix. **Detailed design report:** The system generates a detailed design report presenting ratings, comments, and the TDSI, along with recommendations. These outputs provide both quantitative and qualitative feedback to support further design refinement if required.

6. SYSTEM VALIDATION

An initial evaluation of the developed computerised system was conducted through a focus group discussion involving four experienced HE building professionals. The participant represented diverse professional disciplines, including a senior designer, project manager, engagement specialist and property and portfolio manager. Each participant possessed a minimum of ten years of experience in the HE building settings.

During the session, the developed system was initially presented to the group, demonstrating all the functions and capabilities of the system. This presentation provided participants with an overview of how the system operates and how it can support the end-user engagement process. Subsequently, an interview guide was shared to the participants to facilitate structured feedback on the system. The discussion focused on three key aspects of the system: functionality, benefits and improvements under 15 questions as presented in Table 4.

Table 4: Expert's judgement over the developed computerised system

	Questions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Function of the system:							
Q-01	Provides a more structured and systematic approach	1	3	0	0	0	4
Q-02	Support active participation, direct representation, and gather feedback	2	2	0	0	0	4
Q-03	Support an effective documentation process and reduce repetitions	3	1	0	0	0	4
Q-04	Increase effective communication between end-users and project stakeholders	3	1	0	0	0	4
Q-05	Capture, aggregate, and prioritise end-users' requirements at the pre-design stage	3	1	0	0	0	4
Q-06	Evaluate and capture recommendations from end-users at the schematic design stage	2	2	0	0	0	4
Q-07	Evaluate and capture recommendations from end-users at the detailed design stage	0	4	0	0	0	4
Q-08	Addresses the challenges inherent in the subjective evaluation	1	3	0	0	0	4
Q-09	An effective method for improved engagement of end-users in HE building design	3	1	0	0	0	4
Benefits of the system:							
Q-10	Enable designing HE buildings that satisfy the needs of diverse user groups	3	1	0	0	0	4
Q-11	Minimise the discrepancies between the performance of the building and the expectations of end-users during the operation stage	1	3	0	0	0	4
Q-12	Help reduce costly modifications to the building during the operation stage	4	0	0	0	0	4
Q-13	Supports inclusivity, accessibility and presence accountability	2	2	0	0	0	4
Q-14	Help minimise the time taken for engaging users in the design	2	2	0	0	0	4

All participants in the focus group discussion either strongly agreed or agreed with the positive aspects of the developed system. None of the participants expressed neutral or negative views regarding the system. The following comments and insights were collated from the participants' feedback.

- Functionality – The system provides a centralised platform to facilitate end-user engagement and collect feedback throughout the process. It assists in minimising challenges commonly associated with end-user participation, such as removal of subjectivity, fragmented communication and inefficient feedback management. Furthermore, the system enables documentation of user inputs and design evaluations, reducing redundant work while ensuring the information remains traceable and accessible in later phases. The experts overall strongly agreed that this system offers an efficient mechanism for integrating end-users throughout the design process, spanning from pre-design to schematic to detailed design.

- Benefits – The experts highlighted several foreseeable benefits of implementing the system in the industry. They noted that the system has the capability to accommodate diverse end-user needs while reducing discrepancies between end-user expectations and the final built outcome. Additionally, it can help minimise costly modifications during the operational stage by facilitating early identification and incorporation of user requirements during the design process. The experts further indicated that the system supports inclusivity, accessibility and accountability in the implementation of engagement practices. Overall, it was recognised as a platform that can enhance transparency in the decision-making process.
- Improvements – The expert suggested that the system be integrated into real-world projects to further evaluate its practical applicability and performance. Since this was developed as a proof of concept, the experts suggested further improvements to the user interface and navigation features to enhance usability and accessibility. Furthermore, they recommended pursuing patent rights to protect the novelty and potential commercial value of the system.

Further evaluations may be undertaken with a large number of participants.

7. CONCLUSIONS

This study presented the developed computerised system to facilitate effective integration of end-users throughout the design process in HE buildings. The development and application of this system using DSR methodology provides a more robust and legitimate solution with practical applicability to real-world design problems associated with end-user engagement.

The proposed system serves as a roadmap for integrating end-users throughout the HE building design process. It adopts a holistic approach by identifying the significant DEs and DFs to acquire end-user requirements and evaluate the HE building design. The computerised system includes key functions such as project creation, assignment of relevant DE to specific designs, collection of end-user requirements and design assessment feedback, consolidation of end-user input, and automated report generation (presented through quantitative scores, heat colour-coded visualisation and qualitative summaries). The system facilitates systematic collection, processing and analysing of user feedback, thereby supporting more informed decision-making during the design process.

The system can be effectively utilised by designers or professionals who may have limited experience in end-user engagement. By incorporating this, the system facilitates the adoption of best practices for engaging end-users throughout the design process. The use of this computerised system can reduce the costs, time and planning effort required to organise and manage user participation compared with conventional practices. As a result, the proposed computerised system offers a practical industry-oriented solution to a prolonged challenge in integrating end-users within the design process. This may ultimately enable the reduction/mitigate the performance gap. Although the system was developed and evaluated within HE building setting, the underlying framework, decision-making logic, and evaluation approach can be adapted to other project types with appropriate modifications to the design parameters. Nevertheless, further studies are required to test and refine the computerised system through real-world applications.

8. ACKNOWLEDGEMENTS

This study acknowledges the funding received from Deakin University as part of the PhD studies.

9. REFERENCES

Abdullah, S., Mohd Ali, H., & Sipan, I. (2012). Benchmarking space usage in higher education institutes: attaining efficient use. *Journal of Techno-Social*, *4*(1), 11–20. https://publisher.uthm.edu.my/ojs/index.php/JTS/article/view/1346

Abisuga, A. O., Wang, C. C., & Sunindijo, R. Y. (2020). A holistic framework with user-centred facilities performance attributes for evaluating higher education buildings. *Facilities*, *38*(1–2), 132–160. https://doi.org/10.1108/F-07-2018-0083

Bae, S., Martin, C. S., & Asojo, A. O. (2021). Higher education students' indoor environmental quality satisfaction benchmark. *Building Research and Information*, *49*(6), 679–694. https://doi.org/10.1080/09613218.2020.1813012

Beckers, R., van der Voordt, T., & Dewulf, G. (2016). Learning space preferences of higher education students. *Building and Environment*, *104*, 243–252. https://doi.org/10.1016/j.buildenv.2016.05.013

Gooding, L., Erdogan, B., & Gürsel Dino, I. (2021). Involving end users in retrofit of higher education buildings. *Journal of Building Engineering*, *44*, 102633. https://doi.org/10.1016/j.jobe.2021.102633

Kim, T. W., Cha, S., & Kim, Y. (2018). Space choice, rejection and satisfaction in university campus. *Indoor and Built Environment*, *27*(2), 233–243. https://doi.org/10.1177/1420326X16665897

Kjolle, K. H. , & Blakstad, S. H. (2014). Architects and end-users: boundary objects in participatory briefing and design. *Nordic Journal of Architectural Research*, (1), 35–64. https://arkitekturforskning.net/na/article/view/477

Latortue, X., Minel, S., Pompidou, S., & Perry, N. (2015). Integration of end-user needs into building design projects: use of boundary objects to overcome participatory design challenges. *20th International conference on engineering design (ICED2015)* (pp. 269-278). HAL Open Science. https://hal.science/hal-01360417

Nazeer, F. S., Kamardeen, I., & Hasan, A. (2024). Research needs for enhancing pre-occupancy evaluation of buildings. *Built Environment Project and Asset Management*, *14*(4), 529–546. https://doi.org/10.1108/BEPAM-11-2023-0190

Nazeer, F. S., Kamardeen, I., & Hasan, A. (2025a). Establishment of an end-user engaged building design framework. *Built Environment Project and Asset Management*, *15*(1), 106–124. https://doi.org/10.1108/BEPAM-01-2024-0010

Nazeer, F. S., Kamardeen, I., & Hasan, A. (2025b). Redefining design features for mitigating performance gaps in higher education buildings. *Smart and Sustainable Built Environment*, *Ahead-of-Print*. https://doi.org/10.1108/SASBE-02-2025-0059

Seki, Y., Olanipekun, A. O., & Sutrisna, M. (2022). End-user stakeholder engagement in refurbishment design in higher education. *Sustainability*, *14*(19), 11949. https://doi.org/10.3390/su141911949