SBEnrc Project 2.82

Digitally-enabled Asset Life-cycle Management

Final Industry Presentation

3 May 2023

ACKNOWLEDGEMENTS

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Partner contribution

Industry project participants

Main Roads Western Australia

Department of Communities, Housing and Digital Economy, Queensland

Department of Communities, WA

Department of Energy and Public Works, Queensland

Transport for NSW

NATSPEC

WSAA

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DE theme in SBEnrc

2017. P2.51. Developing a Cross Sector Digital Asset Information Model Framework for Asset Management

- Determine the effectiveness of existing asset information classification and structuring systems in supporting the practical requirements of asset managers.

2018. P2.64. Unlocking Facility Value through Lifecycle Thinking

- Demonstrates the value of lifecycle thinking and evidence-based decision making in facility asset management.

2020. P2.72. Leveraging an Integrated Information Lifecycle Management Framework – Building and Infrastructure Sectors

- Industry best practices and international standards related to structured and integrated data.

DE theme in SBEnrc

2021. P2.82. Digitally-enabled Asset Life-cycle Management

- A DE-enabled asset life-cycle management process and prototype (MetaBIM) to ensure that DE/BIM models can stay alive after construction and handover.

2023. P2.92. Smarter and greener built assets through digitalisation and AI

- To embed life cycle assessment (LCA) approach into digital twin (digital models with appropriate IoT sensors if required) to assess life cycle emissions of built assets, including housing, building and infrastructure assets.

Content

1. Introducing MetaBIM and key functions
    - 1.1 What is MetaBIM
    - 1.2 Key functions of MetaBIM
    - 1.3 Supporting asset management practices using MetaBIM
    - 1.4 Compliance checking through MetaBIM
    - 1.5 IFC-based 4D construction simulation in MetaBIM

2. Roadside wall detection using AI

3. Amenities and their impact on social housing

1. MetaBIM

1.1 What is MetaBIM - https://metabim.com.au/

MetaBIM is a Web-based OpenBIM platform for BIM data parsing, editing, checking, auditing and visualisation.

1. MetaBIM

1.2 Key functions of MetaBIM

BIM Model Conditioning

IFC Class mapping and editing

Uniclass mapping and editing

Property adding and editing

Zoning and Splitting

Code Compliance Checking

Rules creation and management

Rule-based code checking

BCF report generation

Cost Estimation *(Coming soon)*

Quantity take-off

Bill of Materials Preparation

Link to external cost database

Cost estimation and analysis

Life Cycle Assessment *(Coming soon)*

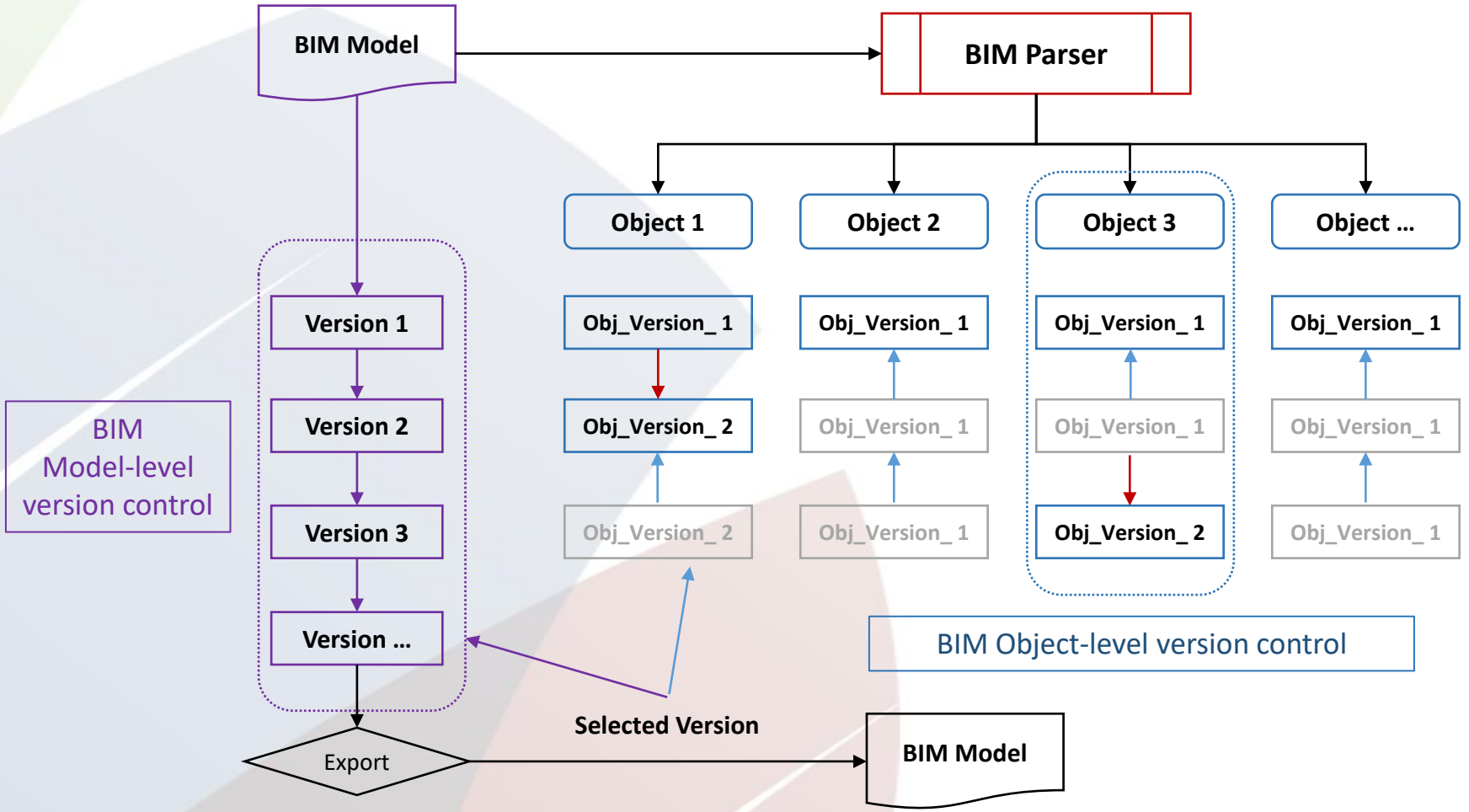
Carbon footprint calculation & visualisation

Carbon pricing

Carbon offsetting

1. MetaBIM

1.2 Key functions of MetaBIM – BIM Parser



Great efficiency in:

- Storage
- Query
- Comparison
- Auditing

1. MetaBIM

1.3 Supporting asset management practices using MetaBIM

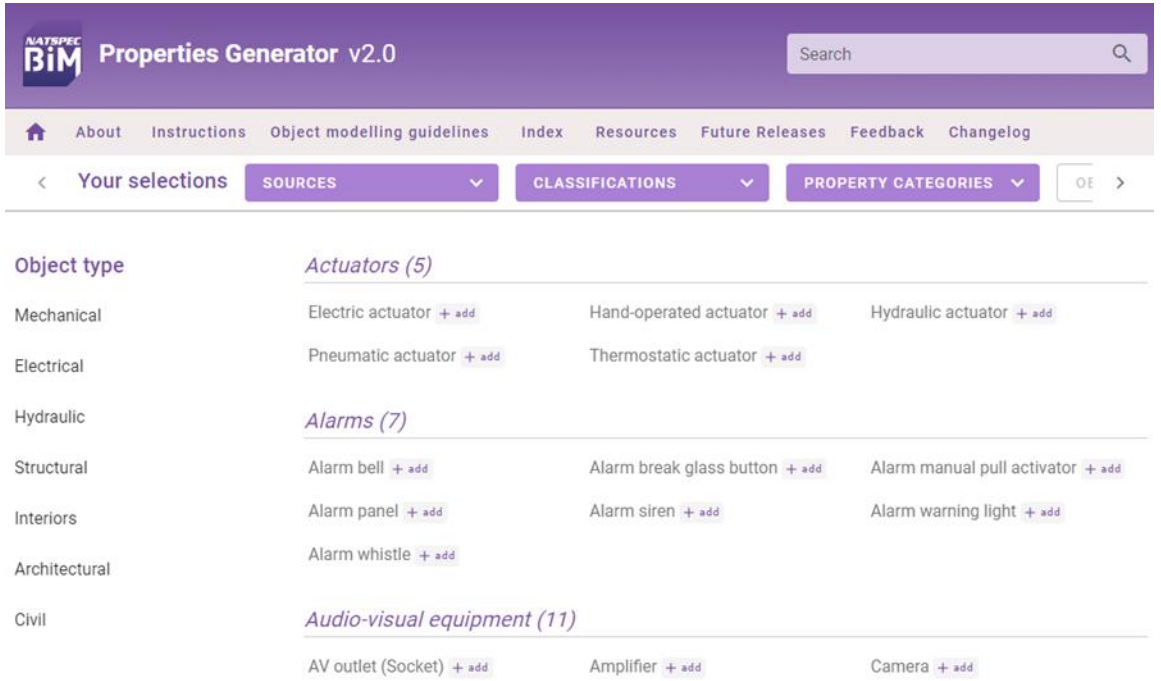
Task 1 - Validation of as-constructed data during handover stages

Task 2 - Integration of asset data from various data sources

Task 3 - Classification of as-built BIM model objects according to the AUS-SPEC activity specification and NATSPEC Maintenance reference worksections

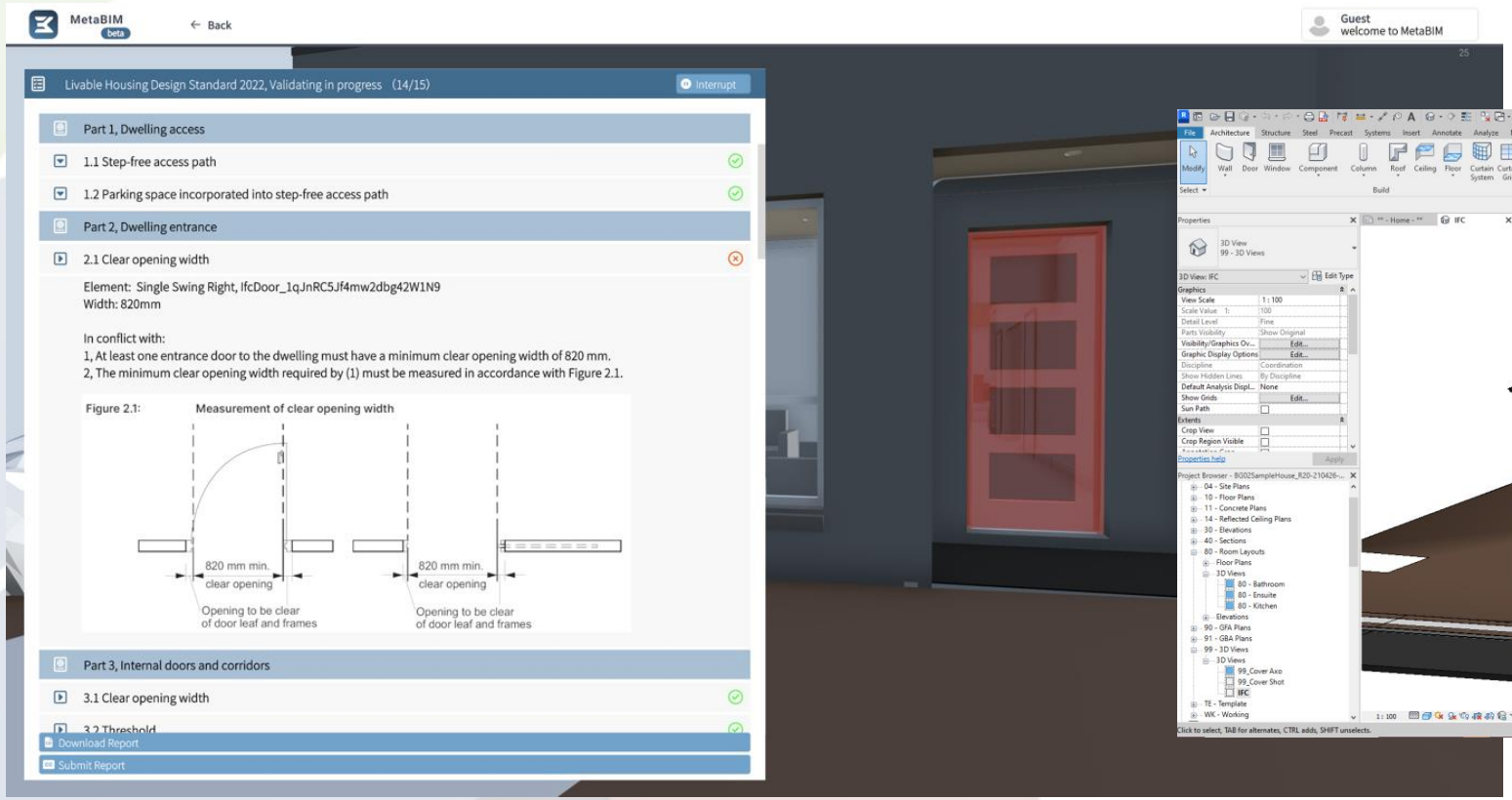
List of AUS-SPEC Activity specifications and related NATSPEC reference worksections

AUS-SPEC Activity specification	Activity code	Maintenance component code	Relevant NATSPEC Maintenance reference worksections
Structure			
1530 External works	E	TM	*0184m Termite management*
		AC	*0272m Asphaltic concrete*
		SB	*0273m Sprayed bituminous surfacing*
		CP	*0274m Concrete pavement*
		SM	*0275m Paving – mortar and adhesive bed*
		SS	*0276m Paving – sand bed*
		LM	*0259m Landscape maintenance*

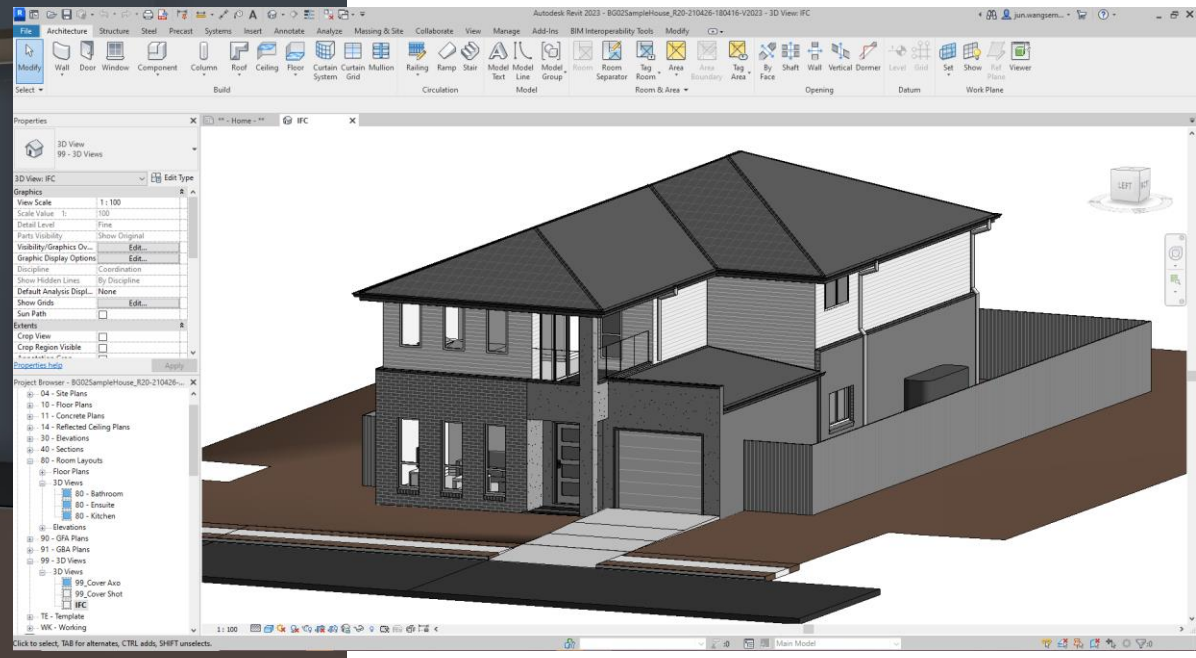


1. MetaBIM

1.4 Compliance checking using MetaBIM – Livable House Design Check



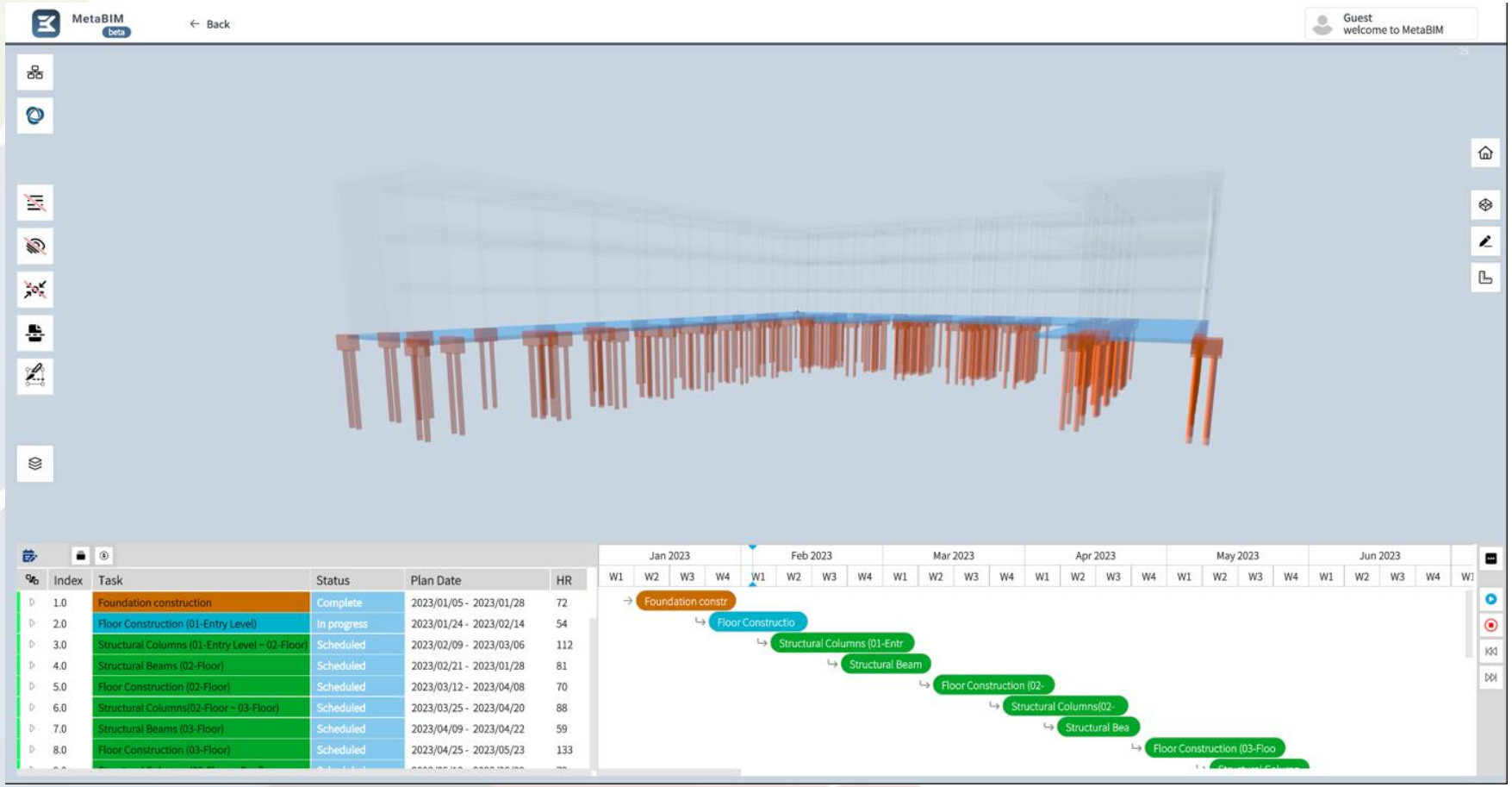
BIM-based Livable House Design Check (the dwelling entrance check has failed as the width of the door leaf for the entrance door in the given BIM model is 820mm, which is less than the required 870mm for a clear opening width of 820mm for a single swinging door.)



Revit House Model from BIM Guru

1. MetaBIM

1.5 IFC-based 4D construction simulation in MetaBIM



The use of IFC for creating and saving 4D construction simulation provides two **key benefits**:

1. **Longevity** refers to the ability of the 4D simulation to be used and accessed over a long period of time, even if the software or company that created it is no longer in business.

2. **Interoperability** refers to the ability of different software programs and systems to work together seamlessly.

1. MetaBIM

Some useful information about MetaBIM can be found from the below links:

- Link to MetaBIM Platform: https://platformdev.metabim.com.au/
- A short video demonstration of the platform: https://metabim.com.au/platform.html
- MetaBIM webste: https://metabim.com.au/

2. Roadside wall detection using AI

Roadside walls are common highway structures. These offer functions such as noise reduction. To ensure quality, these wall structures should satisfy general physical and specific acoustic requirements.

This case study aimed to develop a tool for extracting features and recognizing objects in roadside wall structures.

(a) Limestone

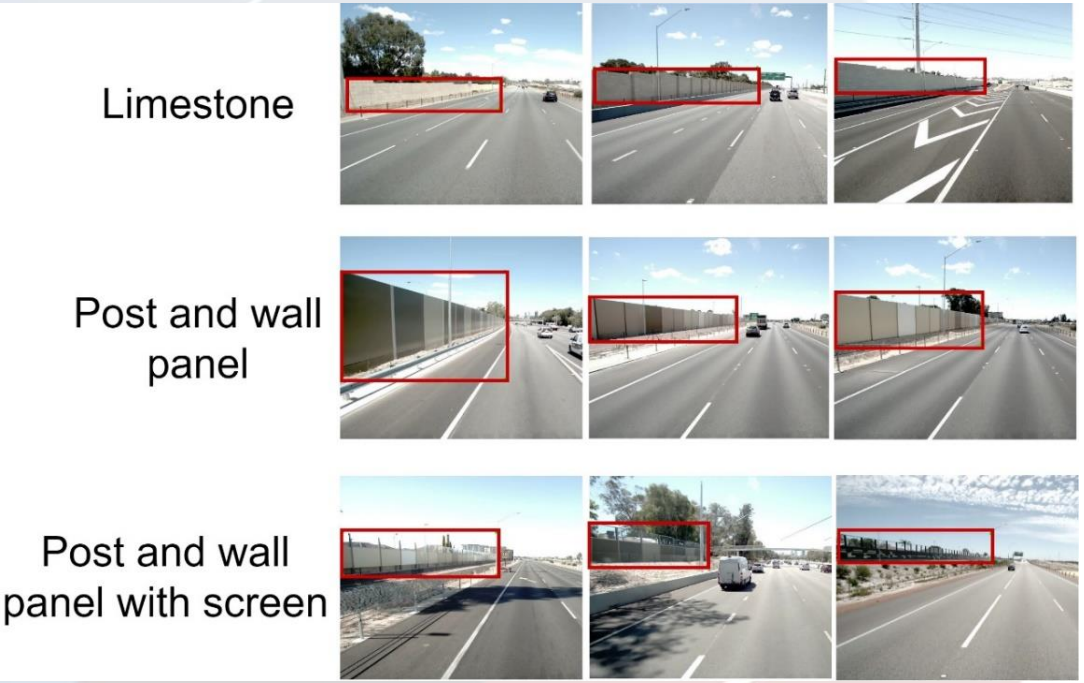
(b) Post and wall panel

(c) Post and wall panel with screen

2. Roadside wall detection using AI

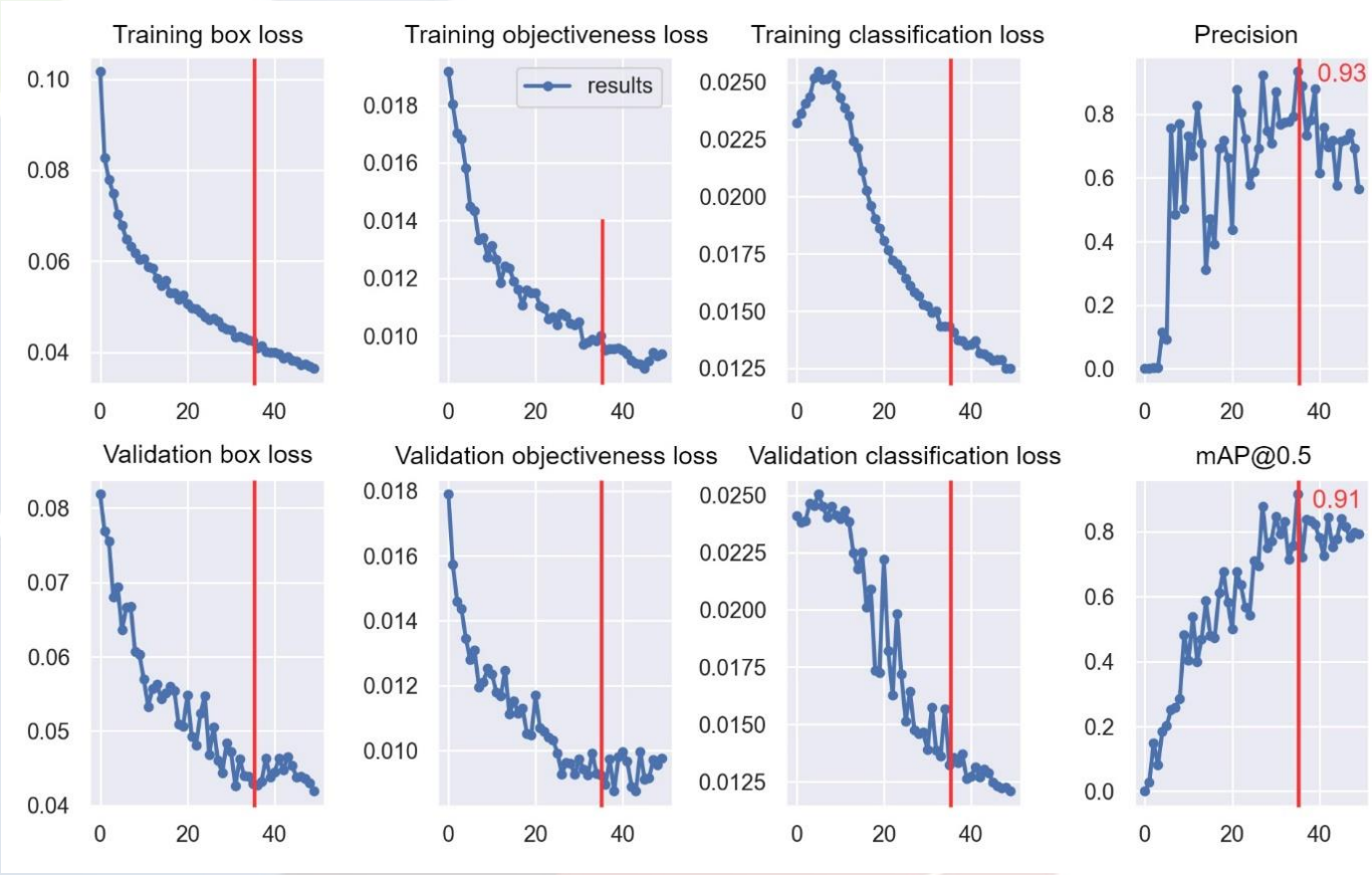
This project selects the “You Only Look Once Version 5” (YOLO-v5) as the basic object detection algorithm. It is further modified based on training.

The raw inputs for the case study were 12 videos from the high-speed data provided by MRWA.



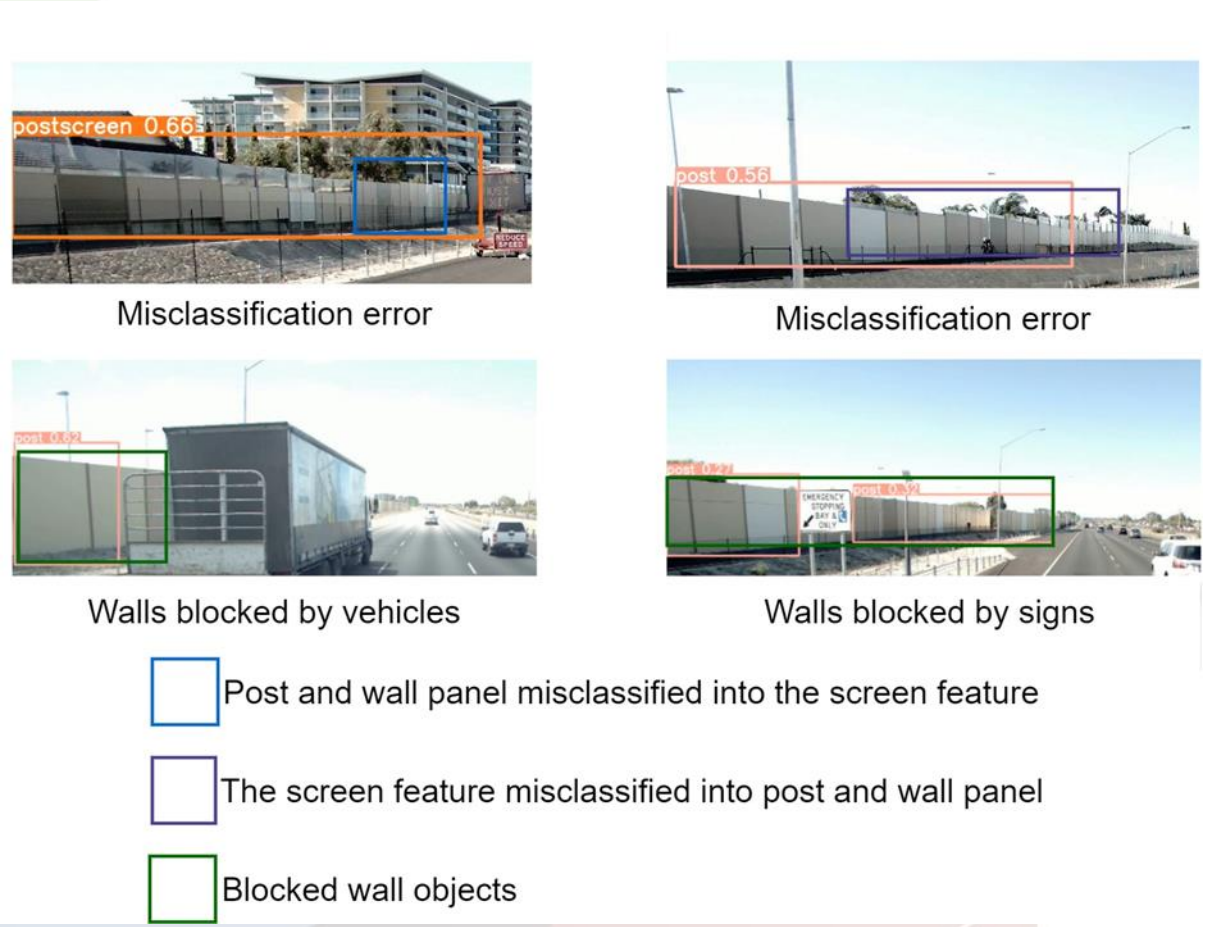
In total, 1,059 images were selected from the 12 videos. In this study, the training test/validation ratio was set as 9:1. Thus, 953 images were randomly selected as training datasets, and the remaining 106 images were used for validation.

2. Roadside wall detection using AI



A pilot test comprising 50 training sessions was conducted. In terms of accuracy, the best-trained parameters occurred at the 35th training iteration. This optimal set of parameters had a **precision of 93%** and mean averaged precision **(mAP) of 91%.**

2. Roadside wall detection using AI



The general performance of this pilot machine learning model is acceptable; however, its accuracy is limited owing to misclassification and issues such as missing objects blocked by other features.

Nevertheless, AI can be used for roadside wall detection with satisfactory performance and extending its use to detect roadside walls for the entire network is feasible.

3. Amenities and their impact on social housing

Sustainable Built Environment National Research Centre AUSTRALIA

Background

- Significance of location and accessibility in social housing, as they influence tenant satisfaction & community participation
- Internal and external amenities, socio-economic factors, and individual perceptions influence residential satisfaction
- Better tools for measuring amenity satisfaction in the social housing context.

Objectives

- Review literature on public and housing amenities
- Explore the correlation between amenities and tenant satisfaction

3. Amenities and their impact on social housing

Types of amenities

- Location of residence
- House design
- House features, e.g. car parking, energy efficiency, yard space and fencing, water efficiency
- Size of the living spaces, e.g. no of bedrooms, size of cooking and storage spaces

- Safety and Privacy
- Food stores & groceries
- Pollution
- Proximity to public transportation
- Access to medical services
- Recreational facilities
- Education centres
- Other facilities access, e.g. community centres, worship places, shops and banking

- **Household/Dwelling/ Properties amenities**

- **Neighbourhood/ Community amenities**

3. Amenities and their impact on social housing

Understanding Satisfaction in Residential Environments

- Satisfaction is the resolution of a want, influenced by changing desires and **social contexts**
- **Factors** contributing to satisfaction:
  - Housing amenities
  - Neighbours and neighbourhood facilities
- Residential satisfaction as an indicator of the quality of life and behavioural patterns
- Research focuses on cross-sectional data, including:
  - Socioeconomic traits
  - Housing and neighbourhood characteristics
  - Environmental amenities
  - Alignment between resident preferences and real-world circumstances

3. Amenities and their impact on social housing

Measuring Neighbourhood and Household Amenities Satisfaction

Neighbourhood satisfaction

Perception of comfort or discomfort within a neighbourhood

Influenced by amenities, safety, accessibility, and environment

Correlated with life satisfaction, happiness, and eudaimonia

Geospatial analysis in GIS is used to measure satisfaction based on the distance to amenities

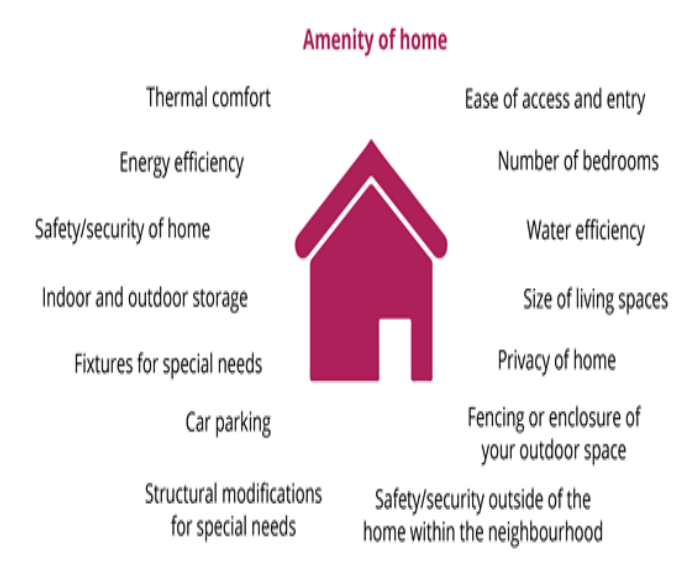
Household amenities satisfaction

Assessment of end-user satisfaction for housing units considering building characteristics, neighbourhood, socio-cultural amenities, and management

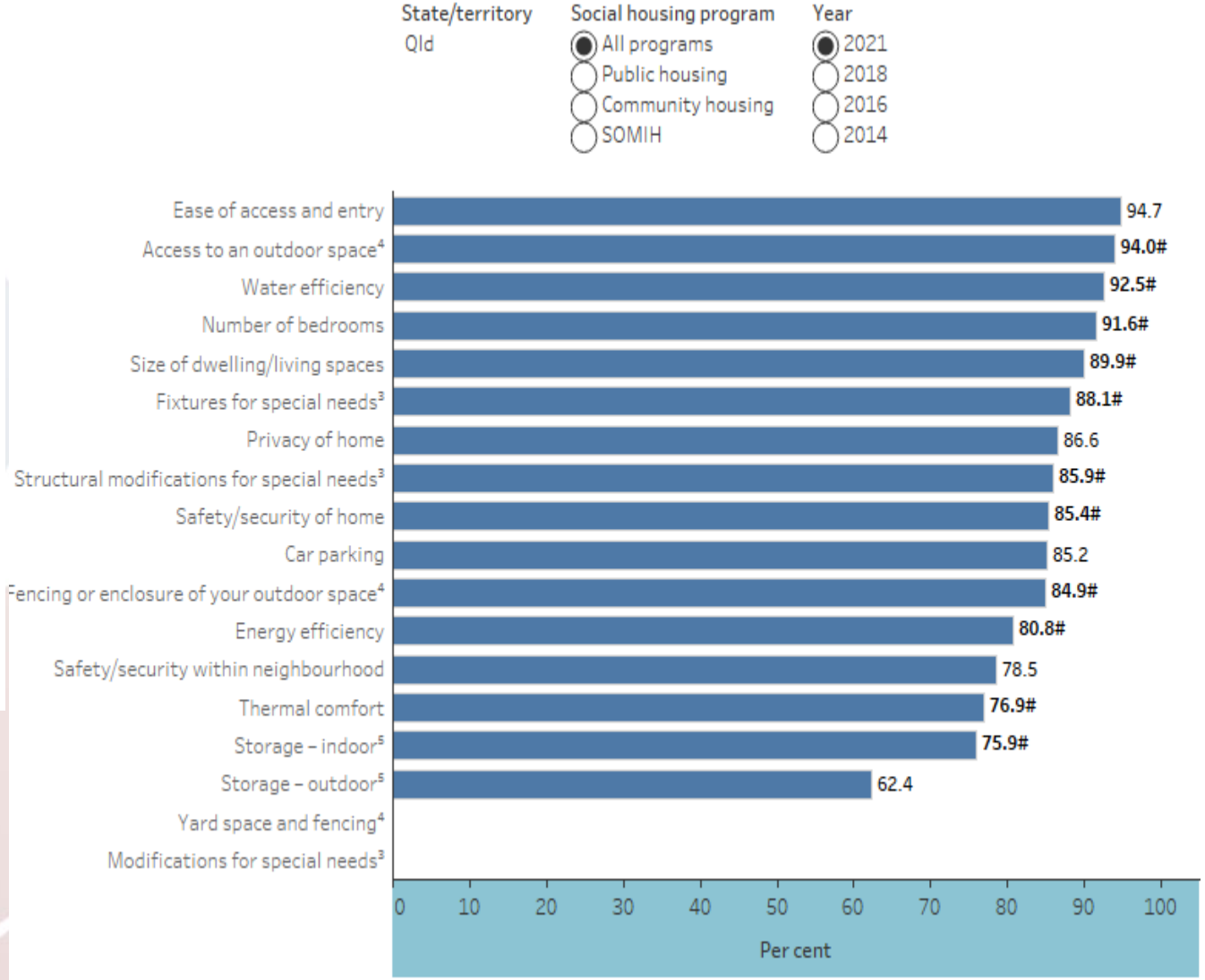
Factors linked to housing satisfaction include structure quality, design, size, internal space, amenities, and cost

3. Amenities and their impact on social housing

National Social Housing Survey in Australia



[AIHW: National Social Housing Survey 2021]



3. Amenities and their impact on social housing

Existing approaches to measuring amenities satisfaction

Title	Description	Type of Amenities
Neighbourhood asset mapping by the community (Canada)	The asset mapping section related to neighbourhood gatherings was adapted partly from the Hamilton Neighbourhood Action Planning Toolkit, Tool B – Asset Mapping. View Hamilton's Toolkit	**Neighbourhood amenities** • Shopping malls/centres • Grocery stores • Markets • Restaurants, cafes and bars • Entertainment centres
American Housing Survey (AHS) (USA)	AHS is the only national dataset that includes neighbourhood quality and satisfaction, which can be identified based on nativity status	**Neighbourhood amenities Infrastructure and physical attributes** • Community recreational facilities • Open Green Spaces within 1/2 Block • Bodies of water within 1/2 Block • Roads within 1/2 Block Need Repairs • Railroad/Airport/4-Lane Highway within 1/2 Block • Parking Lots within 1/2 Block • Safety amenities • Walls/Fences surrounding the community
Social housing: Housing amenities - tenant ratings (Australia)	The National Social Housing Survey (NSHS) provides insights into the experience of social housing tenants. Tenant opinions on amenities firstly require tenants to nominate amenities as necessary, and then the proportion reported are those who then also judge whether their needs are met against these amenities	**House amenities** • Ease of access and entry • Number of bedrooms • Size of dwelling • Water efficiency • Privacy of home • Car parking • Yard space and fencing • Safety/security of home • Modifications for special needs • Safety/security outside of the home within the neighbourhood • Energy efficiency Thermal comfort

3. Amenities and their impact on social housing

Concluding Remarks and Recommendations

- Subjective perception drives residential satisfaction
- Socio-cultural influences on desired neighbourhood amenities
- Flexible measurement criteria and accounting for multiple factors
- Focus on neighbourhood amenities and socio-cultural amenities
- Use a multi-dimensional approach for measuring housing satisfaction
- Data-driven Techniques for geospatial amenity accessibility analysis

Moving forward

2023-2024. P2.92 Smarter and greener built assets through digitalisation and AI

This project aims to systematically investigate how digital twin (DT) and relevant technologies, e.g., IoT and artificial intelligence, can be adopted to manage built assets towards efficiency and sustainability.

The expected outcomes include a digital twin platform that assists life cycle emissions analysis and reporting, as well as embedded AI-driven approaches to achieve operational efficiency and lower emissions of built assets.

We welcome potential partners who intend to explore the benefits of advanced digital engineering and artificial intelligence approaches in their daily practices.

More information can be found at:

https://sbenrc.com.au/research-programs/2-82/

https://sbenrc.com.au/research-programs/2-92/