



SMART FEATURE INDEX RATING TOOL FOR SMART LIVING HOUSING VALUATION

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Abstract

Conventional housing valuation uses the comparison approach due to homogeneous housing features, despite its limitations in capturing intangible hedonic qualities. Smart Living (SL) housing, with distinctive features prioritising resident well-being, requires a specialised valuation approach. Despite challenges in quantifying Smart Living housing's gross development value, the cost approach is deemed appropriate. This research introduces the Smart Feature Index Rating (SFIR) tool, a novel method for designing and validating valuation via a cost approach. A 5-point Likert scale survey of 45 experts was conducted to rank 43 Smart Living elements based on practicality and adoption likelihood using the Relative Importance Index (RII). Findings reveal five levels of Smart Features Implementation ranging from Certified to Diamond, forming an index rating framework for Smart Living housing valuation. This study contributes a systematic evaluation framework that integrates hedonic components to represent Smart Living housing value accurately.

Keywords: Housing Valuation, Hedonic, Literature Reviews, Smart Living Features, Survey, Smart Feature Index Rating Tool

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INTRODUCTION

The evolution of Smart Living housing in Malaysia, driven by Smart City initiatives, signals a major shift in conventional housing practices by emphasising resident well-being and sustainability across economic, social, and environmental dimensions. Beyond technological advances such as smart thermostats and universal design, Smart Living integration extends to resource-efficient systems like motion sensors and water-saving fittings. However, the absence of standardised regulations challenges developers in integrating Smart Living features into projects. Conventional valuation methods struggle to capture these innovations' intangible benefits, comfort, security, and energy efficiency

International frameworks such as BREEAM, WELL, and LEED provide sustainability and health-based assessments but primarily focus on environmental and design performance rather than valuation. The SFIR tool distinguishes itself by applying a cost-based valuation approach integrated with hedonic variables assessment, allowing monetary quantification of Smart Living components within the Malaysian context. This positions SFIR as a context-specific decision-support tool bridging valuation practice and sustainable housing innovation.

To address the gap between traditional valuation and Smart Living concepts, this study presents the Smart Feature Index Rating (SFIR) tool. The SFIR quantitatively assesses Smart Living housing features, energy efficiency, safety, and quality of life improvements, through a hedonic and cost-based framework, aligning valuation practices with Smart Living's multifaceted nature.

LITERATURE REVIEW – OVERVIEW ON SMART LIVING CONCEPT, SMART FEATURE INDEX RATING TOOL, AND COST APPROACH VALUATION

Numerous recent studies conducted in developed nations have elucidated the efficacy of Smart Living approaches due to rapid growth in their aging population. With Malaysia's ageing population as reported by Khazanah Research Institute, (2021) and the Department of Statistics Malaysia (2020), the policymakers have taken proactive steps to embrace Smart Living development, aligning with the ongoing revolution in the global housing market. (Creaney et al., 2021). Hence, this study utilized the PRISMA 2020 framework for a thorough literature review, focusing on extracting Smart Living features from published articles (Page et al., 2021) as the foundational list of features for SFIR tool.

Globally, rating systems like LEED, BREEAM, and WELL assess sustainability performance based on design criteria and occupant health. However, they do not integrate cost-based valuation metrics. The SFIR tool fills this gap by merging sustainability indicators with economic value analysis through the RII method, contextualised for Malaysian Smart Living housing.

PRISMA search keywords were categorised into Process, Body of Knowledge, Field Area, and Context, covering aspects like adoption, development, implementation, Smart Living concept, additional development cost components, market perception, Smart Living housing development, Green building development, and stakeholders such as developers and policymakers in the construction industry, particularly in housing projects.

Table 1: Categories of Search with Keywords for Relevant Articles Identification on Salient Smart Living Features

Process	Body of Knowledge	Field Area	Context
- Adoption - Development - Implementation	- Smart Living Concept - Smart Living Features - Additional Development Cost Components - Market Perception	- Sustainable Construction - Smart Living Development - Green Building Development	- Developers/Policy Makers - Construction Industry - Housing Project

Table 1 categorizes keyword searches into four categories: Process (3 keywords), Body of Knowledge (4 keywords), Field Area (3 keywords), and Context (3 keywords). The initial search yielded 161 articles under 'Process', focusing on adoption, development, and implementation. The 'Body of Knowledge' category, including keywords like Smart Living concept and market perception, narrowed the pool to 43 articles. The 'Field Area' category, with keywords on Smart Living and Green building development, further reduced it to 35 articles. The 'Context' category, focusing on developers, policymakers, and the construction industry, left 32 articles for review. Additionally, the researcher reviewed two grey literature sources: the Ministry of Housing and Local Government Malaysia (2019). This structured approach ensured a thorough review of relevant literature and resources.

From the gathered literature, 49 Smart Living features were identified and sorted into three sustainability pillars: social, economic, and environmental. Social features promote well-being and convenience, such as pedestrian-friendly streets. Economic features offer value and efficiency, like solar panels. Environmental features aim to reduce human impact, including disaster risk management. This ensures alignment with sustainability principles. Tables 2, 3, and 4 summarise all identified Smart Living features, organized by the three pillars, and categorized into building and townscape elements.

Table 2: 23 Smart Living Features on the Social Aspect of Sustainable

Smart Living Features	Elements (Building/Townscape)
Recreational Facilities	Townscape
Entrance Landscape	Townscape
Security Provision - Gated Guarded Community	Townscape
Public Transport Facilities	Townscape
School & Education Centre	Townscape
Health & Medical Centre	Townscape
Sport Facilities	Townscape
Retail Facilities	Townscape
Pedestrian Friendly Street	Townscape
Cycling Friendly Street	Townscape
Universal Design: Ramp with truncated dome tactile strip	Townscape
Drone/Unmanned Aerial Vehicle	Townscape
Internet Connectivity	Building
Video Monitoring System	Building
Smart Security Lock System	Building
Security-to-Household Intercom System	Building
Universal Design: Ramp & Assisted Washroom	Building
Wheelchair Lift at Staircase	Building
Occupancy, Motion Sensor System	Building
Smart Sensor Cloth Dryer	Building
Portable Parcel Box	Building
Smoke and Fire Detector	Building
Safety Panic Button	Building

Table 2 lists 23 features for the social aspect of Smart Living houses, designed to enhance convenience, independence, and well-being. These features foster community engagement, personal autonomy, and a sense of belonging, reflecting societal and cultural dynamics. Next, Table 3 presents features aligned with the environmental aspect of Smart Living houses.

Table 6: 15 Smart Living Features on the Environmental Aspect of Sustainable

Smart Living Features	Elements (Building/Townscape)
E-Governance System	Townscape
Smart Tourism Area	Townscape
Cashless Payment Equipment & System	Townscape
Solar Panel on Pedestrian Walkway Roof	Townscape
Smart Meter at Parking Area	Townscape
District Cooling System	Townscape
Light-emitting Diode (LED) type Lighting System	Building
Water Closet Item - Dual Flush Toilet	Building
Water Closet Item - Faucet Aerator	Building
Solar Panel on Building Roof/Balcony	Building
Rainwater Harvesting System	Building
Grey Water System	Building
Smart Thermostat	Building
Smart Siren	Building
Energy Management Sensor & Meter for Electrical Appliances	Building

Table 3 outlines 15 features categorized under the environmental aspect of Smart Living houses, focusing on interactions with the natural world and the ecological impact of human activities. These features include waste management, disaster risk management, and sustainable practices like urban plantations or green spaces. Table 4 presents 10 features aligned with the economic aspects of Smart Living houses, emphasizing societal and value-for-money considerations.

Table 4: 10 Smart Living Features on the Economical Aspect of Sustainable

Smart Living Features	Elements (Building/Townscape)
Tree Cover/Tree Inventory	Townscape
Disaster Risk Management (Consultation)	Townscape
Hill Slope Structure	Townscape
Flood Mitigation Structure/Facilities	Townscape
Acoustical Environmental Structure (Consultation)	Building
Daylight-oriented Structure (Consultation)	Building
Refuse Disposal - Garbage & Recycling Bin/Chute	Building
Remote Control Blinding/Shades	Building
Garden Works & Landscaping	Building
Private Farming Proximity	Building

The comprehensive review identified 48 Smart Living features detailed in Tables 2, 3, and 4, sourced from scholarly articles and grey literature. These features range from individual building elements to broader townscape elements. Examples include solar panels, LED lighting, and pedestrian-friendly streets. At the building scale, features like motion sensor thermal comfort systems and integrated landscape designs were noted, while at the townscape scale, communal spaces, and amenities such as shopping facilities and medical centres were highlighted.

In Malaysian Smart Living housing valuation, integrating these Smart Living features is crucial for enhancing overall quality of life and property desirability (Kaczmarek et al., 2022). These features offer intangible benefits like convenience, safety, and connectivity, beyond mere functionality. Recognizing these benefits influences property attractiveness and commands premium pricing in the real estate market. The Smart Features Index Rating (SFIR) tool addresses gaps in existing frameworks by providing a structured basis for evaluating Smart Living features comprehensively. It quantifies their holistic value, aligning with market trends and promoting transparency in rating systems.

RESEARCH METHODOLOGY

This research combines literature reviews and quantitative approaches to investigate the impact of Smart Living features on housing valuation in Malaysia. The literature review systematically explores existing knowledge, identifying gaps and trends related to Smart Living features. Through reviews of scholarly

articles and industry reports, disparities between Smart Living feature implementation and conventional housing valuation methods are uncovered. Additionally, a theoretical list of 48 Smart Living features is established.

The study employs structured surveys among stakeholders to prioritize these features based on perceived value and impact on housing valuation metrics. The 45 experts were selected through purposive sampling, including registered valuers, quantity surveyors, developers, and local authority officers with a minimum of 10 years of professional experience in housing or smart city projects. The questionnaire was pre-tested with five senior academics and industry professionals to ensure content clarity and construct validity before full deployment.

Next, this research utilised statistical analysis and the Relative Importance Index (RII), the research quantitatively evaluates feature viability, as shown in Equation 1.

$$RII = \sum W / (A * N) \quad (\text{Equation 1})$$

The calculation of the Relative Importance Index (RII) involves summing the average weightages (W) assigned by respondents and dividing this by the highest point of the Likert scale (A), multiplied by the total number of respondents (N), which in this case is 45. Since a 5-point Likert scale was utilized, A is equal to five. For instance, if the average weightage for Entrance Landscape is rated as 3 (Neutral) on the Likert scale, and 41 respondents gave this rating, the calculation would be $(3 * 41) / 5 * 45$, resulting in an RII value of 0.547 for Entrance Landscape features. The following Table 5 illustrates the RII rules.

Table 7: Rules of Relative Importance Index Valuation

Index Range	Index Rules
1.00-0.80	Most Likely and Very Practical
0.79-0.55	Likely and Practical
0.54-0.31	Relevant
< 0.30	Less Likely and Less Practical

The Relative Importance Index (RII), outlined by Rajgor et al., (2016), offers a structured framework for assessing Smart Living features' practicality in the Malaysian housing market. RII values from 1.00 to 0.80 indicate features as 'most likely and very practical' for implementation, while 0.79 to 0.55 are 'likely and practical.' Those from 0.54 to 0.31 are 'relevant,' suggesting moderate feasibility, and ≤ 0.30 are 'less practical and less likely.'

For instance, the Entrance Landscape feature is 'relevant,' implying potential implementation with necessary adjustments in Malaysian Smart Living

housing contexts. The Smart Features Index Rating (SFIR) tool uses a 4-point penalty system alongside index rules for systematic evaluations of Smart Living features. This approach enhances assessment accuracy, fostering transparency and informed decision-making among stakeholders. See Table 6 for the 4-point system related to each index rule.

Table 8: 4-points system related to RII Rules

4-Points System	Index Range	Index Rules
4	1.00-0.80	Most Likely and Very Practical
3	0.79-0.55	Likely and Practical
2	0.54-0.31	Relevant
1	< 0.30	Less Likely and Less Practical

By integrating these methodological strategies, the research seeks to contribute a comprehensive, evidence-based analysis that illuminates the nuanced interplay between Smart Living features and housing valuation dynamics specific to the Malaysian housing market.

FINDINGS AND DISCUSSION

The findings and discussion section reveals insights from literature reviews, quantitative analysis, and SFIR tool application in Smart Living housing valuation.

Unlike frameworks such as BREEAM and WELL, which measure environmental or wellness performance, the SFIR tool quantifies implementation feasibility through stakeholder perception. This provides a cost-oriented assessment model adaptable for valuation practice, addressing Malaysia's lack of measurable smart housing indicators.

Key findings highlight practical, feasible Smart Living features in Malaysian housing, categorised into building and townscape elements based on RII values. Discussions explore their implications on housing valuation, sustainability, and consumer preferences. Refer to Table 7 and Table 8 for RII evaluations of social aspects in building and townscape elements Smart Living features.

Table 9: Building Elements Features, the RII value and 4-Points System

Building Elements: Features on Social Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-Points System
Internet Connectivity	1.000	4
Video Monitoring System	1.000	4
Universal Design: Ramp & Assisted Washroom	1.000	4
Smoke & Fire Detector	1.000	4

Building Elements: Features on Social Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-Points System
Wheelchair Lift at Stairs	0.911	4
Safety Panic Button	0.844	4
Portable Parcel Box	0.747	3
Occupancy, Motion & Sensory based Appliances System	0.733	3
Smart Security Lock System	0.711	3
Security-to-Household Intercom System	0.693	3
Smart Sensor Cloth Dryer	0.400	2
Drone/Unmanned Aerial Vehicle	0.213	1

Table 10: Townscape Elements Features, the RII value and 4-Points System

Townscape Elements: Features on Social Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-Points System
Universal Design: Ramp with truncated dome tactile strip	1.000	4
Health & Medical Centre	0.764	3
Recreational Facilities & Ancillaries	0.747	3
School & Education Centre	0.747	3
Pedestrian Friendly Street	0.747	3
Security Provision - Gated Guarded Community	0.711	3
Sport Facilities	0.711	3
Cycling Friendly Street	0.711	3
Public Transport Facilities	0.573	2
Entrance Landscape	0.547	2
Retail Facilities	0.462	2

The tables summarize building elements (Table 7) and townscape elements (Table 8), along with their Relative Importance Index (RII) values and 4-Points System ratings for social aspect in Smart Living context. In Table 7, building elements like Internet Connectivity and Safety Systems rank high, while elements like Smart Sensor Cloth Dryer rank lower. Similarly, in Table 8, the townscape elements such as Health & Medical Centre are highly rated, while Public Transport Facilities rank lower. Next, see Table 9 and Table 10 for RII evaluation of environmental aspects in building and townscape elements.

Table 11: Building Elements Features, the RII value and 4-Points System

Building Elements: Features on Environmental Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-Points System
Daylight-oriented Structure (Consultation)	0.867	4
Refuse Disposal - Garbage & Recycling Bin/Chute	0.800	4

Building Elements: Features on Environmental Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-Points System
Garden Works & Landscaping	0.747	3
Acoustical Environmental Structure (Consultation)	0.600	3
Remote Control Blinding/Shades	0.467	2
Private Farming Proximity	0.382	2

Table 12: Townscape Elements Features, the RII value and 4-Points System

Townscape Elements: Features on Environmental Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-Points System
Farming/Tree Cover/Tree Inventory	1.000	4
Disaster Risk Management (Consultation)	1.000	4
Hill Slope Structure	0.978	4
Flood Mitigation Structure/Facilities	0.889	4

Tables 9 and 10 outline building elements and townscape elements features, focusing on their Relative Importance Index (RII) values and 4-Points System ratings for environmental aspect in Smart Living contexts. In Table 9, elements like Daylight-oriented Structure and Refuse Disposal systems rank high, while elements like Remote Control Blinding/Shades score lower. Table 10 highlights townscape elements such as Farming/Tree Cover and Disaster Risk Management with top ratings, emphasizing their critical roles in enhancing environmental sustainability. See Table 11 and 12 for RII evaluation of the economic aspect in building and townscape elements.

Table 11: Building Elements Features, the RII value and 4-Points System

Building Elements: Features on Economical Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-PoiSnts System
Water Closet Items - Faucet Aerator, Dual Flush Toilet	1.000	4
Rainwater Harvesting System	1.000	4
Solar Panel on Building Roof	0.956	4
Light-emitting Diode (LED) type Lighting System	0.933	4
Solid Waste Management System	0.889	4
Energy Management Sensor & Meter for Electrical Appliances	0.800	4
Grey Water System	0.782	3
Smart Thermostat	0.711	3
Smart Siren	0.711	3
Cashless Payment Equipment & System	0.200	1

Table 13: Townscape Elements Features, the RII value and 4-Points System

Townscape Elements: Features on Economical Aspect of Sustainable for Smart Living Housing	RII [$\Sigma W / (A * N)$]	4-Points System
Solar Panel on Pedestrian Walkway Roof	1.000	4
E-Governance System	0.747	3
Smart Tourism Area	0.533	2
District Cooling System	0.293	1
Smart Meter at Parking Area	0.200	1

Tables 11 and 12 detail building elements and townscape elements features, focusing on their Relative Importance Index (RII) values and 4-Points System ratings for economical sustainability in smart living contexts. Elements like district cooling system and Smart meter at parking area deem to be the less practical and less likely features for this aspect of Smart Living.

Hence, the presented tables offer a structured framework for identifying and prioritising Smart Living features crucial for sustainable and cost-effective environments. Through Relative Importance Index (RII) values and a 4-Points System, stakeholders can gauge the significance of elements in economical sustainability. Features like rainwater harvesting systems and solar panels receive high ratings, underscoring their roles in promoting sustainability and economic efficiency. Next step is to categorise these features based on their RII values and points into five-tier implementation levels.

The five-tier categorisation of Smart Living feature implementation in Malaysian housing, from Diamond to Certified, provides a structured framework for evaluating sustainability and innovation. At the Diamond level, the most comprehensive integration includes advanced features enhancing energy efficiency, user comfort, security, and environmental sustainability. Platinum, Gold, and Silver levels indicate progressively lower but still significant integration, meeting specific criteria. Certified, the lowest tier, ensures basic sustainability and technological standards across housing developments. This categorization facilitates stakeholder comparisons and encourages ongoing improvement towards sustainable and smart living environments.

Determining Smart Living feature levels involves assigning points based on integration. Diamond features score 1 to 4 points, reflecting the highest level. Platinum features score 2 to 4 points, indicating a slightly lower yet significant level. Gold features score 3 to 4 points, showing substantial integration. Silver features score 4 points, representing fundamental integration. Certified features, rated at 4 points, are divided based on Relative Importance Index (RII) values. This approach ensures acknowledgment of basic yet essential features, promoting sustainability and innovation across housing development

levels. See Table 13 for implementation levels, 4-Points System, RII values, and index rules.

Table 14: 5 Levels of Smart Living features implementation, 4-Points System, RII Value and Index Rules

Level	4-point System	Relative Importance Index Value	Index Rules
Diamond	4	0.89 – 1.00	Most likely & very practical
Platinum		0.80 – 0.89	
Gold	3	0.55 – 0.79	Likely practical
Silver	2	0.54 – 0.31	Relevant
Certified	1	Less than 0.30	Less likely & less practical

The categorisation of Smart Living Features into levels like Diamond, Platinum, Gold, Silver, and Certified provides a standardised framework for stakeholders to understand Smart Living integration in housing projects. This aids decision-making, fosters competition, guides developers towards higher standards, and supports regulatory compliance. Tables 14 summarize sample rating ranges for each level, aiding in implementation assessment.

Table 14: Rating Range for Each Level of Smart Living Features Implementation on Landed and High-rise Buildings

Level	Overall Rating Range			
	High-rise		Landed	
	Minimum	Maximum	Minimum	Maximum
Diamond	185	196	187	196
Platinum	156	184	164	186
Gold	128	155	124	163
Silver	77	127	77	123
Certified	-	76	-	76

The categorisation of Smart Living feature levels, as shown in Table 14 for high-rise and landed buildings, is essential due to the unique requirements of each building type. High-rise housing necessitates features tailored to spatial constraints and urban lifestyles, whereas landed housing allows for more expansive amenities. For instance, features like private farming proximity may be more relevant to landed buildings, whereas smart sensor cloth dryers cater to the space limitations of high-rise dwellings. This customised approach ensures that Smart Living features align with the practical needs of each building type, optimizing sustainability accordingly.

CONCLUSION

In conclusion, the Smart Features Index Rating (SFIR) tool emerges as a pivotal instrument for stakeholders, facilitating the quantification of Hedonic values and special attributes of Smart Living features. Through a methodical process

involving feature identification, Relative Importance Index (RII) evaluation, and categorization into distinct implementation levels, the SFIR tool offers a systematic approach tailored to both high-rise and landed housing categories.

In contrast to international frameworks like BREEAM, WELL, and LEED, which primarily assess sustainability performance, the SFIR focuses on value quantification and implementation practicality within Malaysia's socio-economic context. It bridges the gap between theoretical sustainability standards and real-estate valuation metrics, promoting data-driven decision-making in Smart Living development.

This enables informed decision-making regarding Smart Living feature implementation based on quantifiable metrics and ratings and addresses conventional valuation limitations by systematically identifying, assessing, and categorizing Smart Living features based on RII values, enhancing precision and transparency in housing valuations. Its adaptability across diverse architectural contexts signifies a crucial step in aligning traditional valuation methods with the evolving Smart Living landscape.

ETHIC STATEMENTS

Ethical approval for this research was obtained under the Universiti Teknologi Malaysia Research Ethics Guidelines. All survey respondents participated voluntarily and provided informed consent prior to completing the questionnaire.

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