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ADDITIONAL TRANSACTION COST COMPONENTS FOR MALAYSIAN SMART LIVING FEATURES IMPLEMENTATION

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Abstract:

Despite Smart Living houses potential benefits in providing occupants convenient independence and the care for well-being, their adoption in Malaysia remains infancy. Besides, it has been reputably more expansive than conventional houses. Intensive literature review managed to uncover one of the common reasons - unclear goal of urbanisation, which is a gap between policing and enforcing. This gap in practice is convinced to derive from the uncertainty within Smart Living development. For instant, the addition of Smart Living features onto the housing development master plan, respective phases and building elements. These additions do bring more barriers in a form of development cost components that were anticipated to subsequently increase the inflating gross development cost. From the construction economics point of view, these uncertainties are conventionally identified as 'unintended consequences'. Furthermore, it is speculated to be closely relevant with the transaction cost components. Unlike the hard cost and soft cost components (from the whole development cost), transaction cost components are usually hidden and overlooked during cost planning and control. Hence, this paper is set to establish a primary list of anticipated transaction cost components for Malaysian Smart Living housing development. The research methodology adopted is PRISMA-compliant systematic literature review. The phases of development consistency will be aligned with the Royal Institute of British Architects (RIBA) Plan of Works to review, analyse, and hypothesise the anticipated transaction cost components from preceding sustainable concept housing and building development. Toward the end, this list will shed lights on

the relevant transaction cost components that are applicable within Smart Living development. In conclusion, the finding concludes that there are up to 40 anticipated transaction cost components summarised and distributed along the Smart Living housing development. With the clarity and transparency available, perhaps will promote a more aggressive Smart Living housing development growth in Malaysia.

Keywords:

Smart Living, Transaction Cost, Transaction Cost Components, Housing Development, Malaysia

Introduction – Smart Living in Smart City

The future of Smart City idea has been promising in fulfilling the rapid growing demands of citizen. As, the fact has been agreed by numerous countries through their rapid participation in the market. Interestingly, the idea has been proposed to cater the national subjects like Ageing Population, through one of the elements in the whole Smart City concept – Smart Living (Creaney, Reid, & Currie, 2021; Choi, Lazar, & Demiris, 2019; Pal, Papasratorn, Chutimaskul, & Funilkul, 2019; Sanchez, Pfeiffer, & Skeie, 2017; Visutsak & Daoudi, 2017). This Smart Living has been defined as an innovation in accommodation that focuses on catering residences' well-being. Besides, it provides an environment that will fit the inhabitants' preference and requirements (Cicirelli et al., 2016; Sanchez, Pfeiffer, & Skeie, 2017; Kadam, Mahamuni, & Parikh, 2015). Additionally, the distinct Smart Living features can enrich the sensing, actuation, interaction, and computational capabilities to help occupants for convenient independence. As compared to conventional houses, Smart houses is justified to deliver more than just a shelter, but rather meet the occupants' security, comfort, happiness and health simultaneously (Mohamad et al., 2022; Che Maznah et al., 2021).

Despite the Smart Living houses potential benefits, their adoption in Malaysia remains infancy as compared to its neighbourhood countries (Chin Yee, Ismail, & Terh Jing, 2020; Fahimnia, Sarkis, & Davarzani, 2015). Investigating the literature review and local practices had uncovered the fact regarding the unclear goal of urbanisation – a gap between policing and enforcing. This gap in practice is convinced to derive from the uncertainty within Smart Living development. Besides, Smart houses often been perceived to be more expensive than conventional houses (Kamaruddin, Adul Hamid, & Rohaizam, 2020; Syed Jamaludin, Mahayuddin, & Hamid, 2018; Wahab, Shamsuddin, Abdullah, & Yi, 2018; Macomber, 2018; Xiong, 2018; Alusi, Eccles, Edmondson, & Zuzul, 2011). Logically, the addition of Smart Living features onto typical building elements do bring 'greater barriers' as compared to conventional houses that explains the rise in prices. Like the capital costs, the needs for newer information and technology, financial risks and delays in government approvals (Qian et al., 2015). Economically, these barriers become the additional development cost components accumulated within the gross development cost. However, the gap in practice has overlook these concerns. As there is the need for a primal standard as the costing guidance in accordance with the 'greater barriers' and 'additional development cost components' since there are issues on the development uncertainty and expansive selling price.

In response to the issues mentioned, plenty research on conventional housing delved into finding the root cause of high housing prices. Most research studied from both the supply and demand analysis perspectives. According to Amit, Sapiri, & Md Yusod (2020), some factors identified are financial assistance, housing performance, housing motivational, housing market

and housing policy. According to Olanrewaju, Lim, Tan, Lee, & Adnan (2018), the factors identified are location (urban/rural), size of the house, innovation and skills required to construct, developers' profit margin, strategic factors, finance market matters and material sourcing. On the other hand, Yakob, Yusof, & Hamdan (2012) explained the factor of land usage that are the most crucial affecting factors which normally couple with the planning control in housing development process. While Osmadi, Kamal, Hassan, & Fattah (2015) explained the dependence on population, demand and supply, location, physical characteristic, accessibility, developer, cost of material and income. However, a research by Cruz (2008) had suggested the way to apprehend unaffordable housing is actually through transaction costs analysis. Regardless of numerous factors to be studies, this paper decides to take a dive into the perspective of transaction cost. As being reinforced by Cruz (2008), countries with serious housing affordability problems generally have high transaction costs and weak protection of property rights. Besides, multiple backgrounds have selected this perspective in studying uncertainty management, like mainly on business and management (Greenwood & Yates, 2006; den Butter et al., 2011), then fishing industry (Vakis et al., 2003), and the locomotive industry (Merkert et al., 2010). Hence, it is a possibility worth exploring towards better economic and environmentally sustainable for efficient decision-making.

Transaction costs are costs incurred from activities in the construction industry. However the term 'transaction cost' is not consistently defined systematically and consistently in the construction industry (H. Li et al., 2013). Subsequently, it is challenging to define 'Smart Living housing development cost'. According to Qian et al., (2015) in the context of sustainable building, the hard cost items (e.g., construction costs, material expenditures) could be easily appraised, but the problem is the additional transaction costs contributed by the additional Smart Living features. These transaction cost components are a part of the uncertainty that has been known as the 'unintended consequences' due to its distinct nature that allows possibility of by-products and repercussions (Yau et al., 2021). As the result, it leads to the difficulties in decision-making that will impact the whole Smart Living housing gross development cost.

Generally, the estimated gross development cost is crucial for builders to evaluate the project potential initially to suit their business strategy through feasibility study (Nozeman 2014; Cho 2011). Especially for developers who stand on the ground of business, uncertainty is the variable that will be minimized or controlled at the optimum level to ensure the return of values and profits from development. According to Miles (2017), these situations appear to be a practical-knowledge gap. There is a lack of awareness and rigorous findings in implementation of Smart Living features in terms of development cost management, specifically transaction cost, has been left unexplored. The initial initiatives by the policy maker merely focusing on defining the concept of Smart City and Smart Living yet there are lacking practical features implementation cost plan and control studies to jump start the development transparently. This is important and worthy of investigation as looking closely at the doublet relationship of cost over time development is paramount within the dynamic construction business environment. Studying how every costs elements develop over time and investigating critical factors will help to manage resources effectively throughout the project life cycle (Torp et al., 2016).

Literature Review

This section will provide the overview and discuss on the Transaction Cost Economics (TCE) and its adoption in conventional housing development.

Transaction Cost Economics (TCE)

As transaction cost has been mentioned in Introduction, the study of transaction cost is established under Transaction Cost Economy (TCE) theory. The TCE theory refers to a methodology to relatively assess the cost effectiveness of institutional arrangements in managing transaction (Whittington & Young, 2013). It involves mutual relationship between human factor and environmental factor where human factor is regarded to the behaviors of construction parties such as owner and contractor while environmental factor is regarded to the surrounding and mechanism of transaction as well as project management matter (Greenwood & Yates, 2002). It allows parties to have better understanding towards the unseen costs associated with pre-contract and post contract of project work (Rajeh et al., 2015).

Within economic organizations study, transaction costs are known as the costs arise from important activities such as bid document preparation, estimating, contract drawing up and administering, as well as any contract conditions' deviations handling (Coase, 1937). For Construction Industry, Li, Arditi, & Wang (2014) explained there are three transaction cost components, which is searching and information costs, bargaining and decision costs with policing and enforcements costs. The analysis of these transaction cost components is called Transaction Cost Analysis (TCA).

Over the years, the study of transaction cost has been done on many perspectives and backgrounds, mainly on business and management (Greenwood & Yates, 2006; den Butter et al., 2011), then fishing industry (Vakis et al., 2003), and the locomotive industry (Merkert et al., 2010). While for construction industry, recently there have been the study of transaction cost in project procurement study (Ka Bean et al., 2019) and identification of transaction cost components for conventional houses (Zainuddin et al., 2021).

Transaction Cost Components in Conventional Housing

The study of transaction cost components in conventional housing by Zainuddin et al., (2021) had integrated Royal Institute of British Architects (RIBA) Plan of Work for the development activities consistency. Also, as the standard procedures to guide all parties to work in coordinated manner, where the list of activities had been suggested as the anticipated list of transaction cost components for conventional housing. As per Zainuddin et al., (2021), there are 26 transaction cost components (recorded from the RIBA Plan or Work) and additional 4 transaction cost components that were contributed through the surveys and case studies from the Malaysia construction industry players as shown in Figure 1.

Housing Development Stage	Project Stages	Transaction Cost Components derived from RIBA Plan of Work 2013
Pre-Contract	Strategic Definition	Initial considerations in assembling the project team Establish Project Program Review Feedback from previous projects Negotiation of contract
	Preparation and Brief	Prepare Project Roles Table and Contractual Tree and continue assembling the project team Review Project Program Prepare Handover Strategy and Risk Assessment Agree Schedule of Services, Design Responsibility Matrix and Information Exchanges and prepare Project Execution Plan including Technology and Communication Strategies and consideration of Common Standards to be used
	Concept Design	Review Project Program Prepare Sustainability Strategy, Maintenance and Operational Strategy and review Handover Strategy and Risk Assessments Undertake third party consultations as required and any Research and Development aspects Review and update Project Execution Plan Consider Construction Strategy, including offsite fabrication, and develop Health and Safety Strategy
	Developed Design	Review and update Sustainability, Maintenance and Operational and Handover Strategies and Risk Assessments Undertake third party consultations as required and conclude Research and Development aspects Review and update Project Execution Plan, including Change Control Procedures Review and update Construction and Health and Safety Strategies
	Technical Design	Review and update Sustainability, Maintenance and Operational and Handover Strategies and Risk Assessments Prepare and submit Building Regulations submission and any other third-party submissions requiring consent Review and update Project Execution Plan Review Construction Strategy, including sequencing, and update Health and Safety Strategy
Post-Contract	Construction	Administration of Building Contract, including regular site inspections and review of progress Review and update Sustainability Strategy and implement Handover Strategy, including agreement of information required for commissioning, training, handover, asset management, future monitoring and maintenance and ongoing compilation of 'As- constructed' Information Update Construction and Health and Safety Strategies
	Handover and Close Out	Conclude administration of Building Contract Carry out activities listed in Handover Strategy including Feedback for use during the future life of the building or on future projects Updating of Project Information as required

Figure 1: Transaction Cost Components in Procuring Conventional Housing

Source: Zainuddin et al., (2021)

The article deduced that unbundling property development costs and determining the actual cost elements in each development stages of conventional housing development will provide economic transaction efficiencies (Zainuddin et al., 2021; Ka Bean et al., 2019). Besides, identified transaction cost components and activities that can be either removed or improved to lower the housing development costs and become beneficial to builders that involved in the housing scheme development. Thus, when the study of transaction cost components for conventional housing development is being mirrored with Smart Living housing development, this leads to the following research questions:

- What are the transaction cost components contributed by the distinct Smart features in each development stages of Smart Living housing development?
- How many anticipated transactions cost components contributed by the distinct Smart features in each development stages of Smart Living housing development?

Therefore, this paper is aimed to establish a primal foundation on anticipated transaction cost components for Smart Living housing development. It does not intend to discuss about affordability, development volatility or Smart features concept design but rather a dive into development cost management focusing on the additional activities that possible incur hidden development cost.

The finding will be a list of anticipated transaction cost components contributed by Smart features implementation. Findings will be synthesized and hypothesized from the literature reviews on recent available Smart concept development, previous green building development and any sustainable building construction. To understand what are the additional development activities and hidden cost that were unprecedented. This will be the benchmark for the 'greater barriers' and 'unintended consequences' for builders to be consider during cost planning and cost control for efficient decision-making. The decision to synthesize and hypothesize are due to the limited attention and findings that highlights on the transaction cost study of Smart Living development. Besides, as Smart development is the successor from green development, the idea for both developments requires additional features onto conventional development which will be ethically similar.

A systematic review is guided by the research question priory mentioned and the research objective is to identify transaction cost components for Smart Living housing development contributed by the distinct Smart features. The general hypothesis drawn will be there are additional TCC for Smart Living housing development due to its distinct features and the more and various the additional Smart Living features, the more the transaction cost components for Smart Living housing development. Thus, this paper is structured as Introduction, Literature Reviews, Research Methodology, Result and Findings, Discussion and Limitations then finally the Conclusion.

Research Methodology
Research methodology is an approach of solving research problems thoroughly (Mishra & Alok, 2017). A structured strategy critical in achieving the objectives research as will be aligned with research philosophies, the reasoning of research and evaluation of data (Sutrisna, 2009). For this paper, the research is guided by PRISMA Statement through 'Preferred Reporting Items for Systematic Literature Review and Meta-Analysis' (Moher et al., 2009) and 'The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews' (Page et al., 2021). The PRISMA method is chosen because it has been widely applied in the field of built environment (Tesfaye et al., 2016; Zhang et al., 2019). Besides, the PRISMA method covers three explicit approach (1) identifying large databases of scientific academic literature through keyword and search strategies, (2) screening inclusion and exclusion criteria, and (3) conducting eligibility process in appraising the relevant literature to analyze the data from the studies (Shahruddin & Zairul, 2020). Following are the steps involved:

| Step 1: Selection of Journal Data-based | Step 2: Keywords Sets & Configuration | Step 3: Inclusion & Exclusion Criteria | Step 4: Eligibility Criteria | Step 5: Data Abstraction & Analysis |

Figure 2: PRISMA steps for Systematic Literature Review
Source: Tesfaye et al., (2016) and Zhang et al., (2019)

Step 1: Selection of Journal Data-based
The main source of data for the systematic review was Scopus. A more significant number of journals have been indexed by Scopus in comparison to PubMed, WOS, and Google Scholar (Leslie and Chris, 2014; Chadegani et al., 2017). Unlike other databases, Scopus enables the

operation of four key search techniques: (1) Boolean operators, (2) phrases, (3) truncation, and (4) wildcards. Table 1 and 2 shows the search terms and search string:

Process	Body of Knowledge	Field Area	Context
• Adoption • Development • Implementation	• Requirement • Specification • Additional Tasks • Additional Development Cost Components • Additional Transaction Cost Components • Transaction Cost Economy	Sustainable Construction • Smart Living Development • Green Building Development Project Development • Development Management • Project Development Process	• Developers/Builders • Construction Industry • Housing Project

Table 1 Search Terms

Source	Journal Data-based	Search String
Primary	Scopus	TITLE-ABS-KEY • Adoption/Development/Implementation; and • Requirement/Specification/Additional Tasks/ Additional Development Cost Components/Additional Transaction Cost Components/Transaction Cost Economy; and • Sustainable Construction (Smart Living Development/Green Building Development) & Project Development (Development Management/Project Development Process); and • Developers/Builders/Construction Industry/Housing Project

Secondary	(a) Sustainability Journal; (b) Journal of Engineering, Design and Technology; (c) Journal of Cleaner Production; (d) Geojournal; (e) Smart and Sustainable Built Environment; (f) Journal of the Society of Automotive Engineers Malaysia; (g) Journal of Building Engineering; (h) International Journal of Data Analysis Techniques and Strategies; (i) Energy; (j) Journal of Housing and the Built Environment; (k) Renewable Energy; (m) International Journal of Environmental Research and Public Health; (n) International Journal of Environmental Research and Public Health; (p) The Scientific World Journal; (q) Australian Journal of Basic and Applied Sciences	The combination of keywords outlined in row above were formulated interchangeably as some journal did not support all the key search techniques

Table 2 Search String

Step 2: Keywords Set and Configurations
Table 1 and 2 listed the keywords, and their synonyms were derived in accordance with the research question and research objective. As the secondary sources, the keywords were arranged interchangeably. A total number of n=209 (primary source) and n=61 (secondary source) was retrieved, arranged, and managed within 'Mendeley' for screening.

Step 3: Inclusion and Exclusion Criteria
After the screening process through Step 2, 270 journal articles were filtered according to Table 3, the predetermined inclusion and exclusion criteria.

Criteria	Inclusive	Exclusive
Source	Journal article and conference paper	Book chapter and Book series
Type of study	Green & Smart concept development, including framework protocol & difficulties relevant to this development	Typical conventional development to be excluded
Time Horizon	Project development/studies profile from 5 to 10 years, dated from 2012 till 2022	Project development/studies profile longer than 10 years, dated < 2012
Intervention	Summarise the issues and additional cost components/transaction cost components for the Smart Living development, mostly from abroad practice and several from local practice	N/A
Outcome Measure	Establish a checklist of TCC for builders to consider before building Smart Living houses that will	N/A

	provide transparency for uncertainty during the decision-making process throughout the whole development	
Language	English	Non-English

Table 3 Inclusion and Exclusion Criteria for the Article Screening

For the source, only article journals and conference papers with empirical evidence were included, whereas book chapter and book series were excluded. Next, for type of study, it is to focus on Green and Smart concept development, including framework protocol & difficulties relevant to this development. Excluding conventional development. Thirdly, regarding time horizon, articles published within a duration of 5-10 years (between 2012 and 2022) was selected because most literature from abroad practices have been priorly available. Besides, the publication of the grey literatures from Malaysia Ministry of Housing regarding Smart Living only available after 2018. Fourthly, the intervention involves in for this research summarising the issues and additional cost components/transaction cost components for the Smart Living development, mostly from abroad practice and several from local practice. Then, the outcome measure is to establish a checklist of transaction cost components for builders to consider before building Smart Living houses that will provide transparency for uncertainty during the decision-making process throughout the whole development. Lastly, the searching activities focused merely on articles published in the English language to prevent any complication and confusion in interpreting non-English publications. The list of countries that are referred to for this research is mainly China, Poland, North Africa, Ghana, Hong Kong, Philippines, Kazakhstan, and Nigeria.

Step 4: Eligibility Criteria
The eligibility screening of the remaining 78 articles was carried to include only relevant articles to be used for the qualitative analysis. The last stage of the review resulted in the exclusion of 44 articles due to the lack of focus towards the Smart Living implementation, Smart Living development cost management, and transaction cost components within Smart Living housing development.

Step 5: Data Abstraction and Analysis
Towards the end, only 34 papers left to be analysed. The qualitative analysis was conducted using the thematic analysis approach to identify themes and subthemes (codes) related to the transaction cost components synthesize and hypothesize from the literatures. As recommended by Ryan and Bernard (2000), the authors identified a pre-existing set of codes and merged them with new emerging codes after completing the data collection.

Data Collected and Analysis
The results obtained from the qualitative thematic analysis are presented in Appendix A. Like the research conducted to identify the transaction cost components for conventional housing, this research also integrates with RIBA Plan of Work for development phase consistency. However, the stages of development have been simplified into four rather than seven detailed stages as the main themes due to the overlapping of activities by stages. The review derived four main themes to categories the findings that are consistent with the RIBA Plan of Works (PREC 1 – Strategic Definition, Preparation for Briefing Phase; PREC 2 – Concept, Developed and Technical Design Phase; POSC 3 – Construction Phase; POSC 4 – Handover and Close

Out Phase) and 40 subthemes (the transaction cost components) that are proposed to potentially associate with Smart Living features implementation in Smart housing development.

According to Appendix A, a total of 34 articles have been collected. They were analysed, synthesized, and hypothesized for the anticipated of transaction cost components for Smart Living housing development. From the overall 34 articles, there are 14 qualitative research, 15 mix-method research and 5 quantitative research. Besides, the table displays the availability/frequency of the anticipated transaction cost components at respective theme/development phase. To simplify, there are 27 out of 34 articles mentioned the anticipated transaction cost components are present during PREC 1 – Strategic Definition, Preparation for Briefing Phase; 27 out of 34 articles mentioned the anticipated transaction cost components are present in PREC 2 - Concept, Developed and Technical Design Phase; 14 out of 34 articles mentioned the anticipated transaction cost components are present in POSC 3 – Construction Phase; and 17 out of 34 articles mentioned anticipated transaction cost components are present during the POSC 4 – Handover and Close Out Phase.

Theme 1: Anticipated Transaction Cost Components Associate during PREC 1 – Strategic Definition, Preparation for Briefing Phase for Smart Living Housing Development

As in Appendix A, there are 27 out of 34 articles that highlighted the anticipated transaction cost components are present for theme 1. Within, there are 16 subthemes, the anticipated transaction cost components, contributed by implementing Smart features as Table 4:

Themes: Development Phases	Sub-theme: Anticipated Transaction Cost Components
PREC 1 – Strategic Definition, Preparation for Briefing Phase	1. Special allocation on new department/organisation related to decision making for Smart Living concept related project, e.g., new offices, cubicles (Qian et al., 2015) 2. Provide the required computing, storage and other resources and the most basic services for the entire project, such as log records, cache processing, message notifications, etc. (An et al., 2021) 3. Procurement documents contain instructions regarding equal risk responsibility for the main parties who are involved in the construction project (Willar et al., 2021) 4. Efforts on monitoring and familiarising with Smart Living related market policy requirements: market & policy study (Qian et al., 2015; Mohamad et al., 2022; Akadiri et al., 2012; Abidin et al., 2013; Assadiki et al., 2022; J. Zhang et al., 2019; Zhuang et al., 2020; Wu et al., 2019; Y. Zhang et al., 2021; Willar et al., 2021) 5. Practical market study to meet market requirements, expectations and potential users by considering local community need/supply/competitiveness (Qian et al., 2015; Butryn et al., 2019; Kamaruddin et al., 2020; Wu et al., 2019) 6. Appoint special taskforces (e.g., architect, engineer) to attract special stakeholders relating to Smart Living (Qian et al., 2015; Abidin et al., 2013; J. Zhang et al., 2019) 7. Consideration and initiatives for a joint-venture (Qian et al., 2015)

8. The timeous involvement of key stakeholders during the decision-making process, owners' motivation, and developers' commitments. (Akadiri et al., 2012; J. Zhang et al., 2019; Kamaruddin et al., 2020; Lu et al., 2021; Willar et al., 2021; Mustaffa et al., 2021)

9. Provide the necessary knowledge basis to encourage stakeholders' action and to create technical capacity that support and develop action. (Abidin et al., 2013; Ghansah et al., 2022; J. Zhang et al., 2019; Moulai & Drias, 2021; Willar et al., 2021)

10. Improving the efficiency of management processes - reducing losses, reducing indirect and overhead costs in tariffs, etc. (Dmitrieva, 2021; Willar et al., 2021; Franco et al., 2021)

11. Reducing the volume of accounts receivable in the industry and the resulting additional financial burden on the business. (Dmitrieva, 2021; Mustaffa et al., 2021)

12. Comprehensive design on both Smart City township and Smart Living housing planning simultaneously by analysing the available maps and the act on spatial planning. (Qian et al., 2015; Mohamad et al., 2022; Akadiri et al., 2012; Che Maznah et al., 2021; Chen et al., 2015; Zhuang et al., 2020; Y. Zhang et al., 2021; Ying, 2021; Atanda & Olukoya, 2019; Butryn et al., 2019; Hao & Wang, 2019)

13. Study the extra financial risk corresponding to Smart Living features implementation (Qian et al., 2015; Dmitrieva, 2021; Franco et al., 2021; Mustaffa et al., 2021)

14. Efforts & initiatives in optimizing development cost plan (e.g., hard cost elements, soft cost elements, land cost element). (Mohamad et al., 2022; Y. Zhang et al., 2019; Willar et al., 2021)

15. Consideration of extra-legal liability risk corresponding to the Smart Living features (Qian et al., 2015)

16. Valuation of property during feasibility study through the quantitative indicators on Smart Concept (Zhao et al., 2022; J. Zhang et al., 2019)

Table 4 Anticipated Transaction Cost Components Associate within PREC 1 – Strategic Definition, Preparation for Briefing Phase for Smart Living Housing Development

For PREC 1 - Strategic Definition, Preparation for Briefing Phase, it consists of the most anticipated transaction cost components required for implementing the Smart Living features as compared to the other themes/development phases. Firstly, it is regarding the technicality. Like, special allocation on new department or organisation to cater for decision making on Smart concept related project (Qian et al., 2015). For example, the new office space and cubicles. Next, is the tasks to provide the required computing, storage and other resources and the most basic services for the entire project, such as log records, cache processing, message notifications, etc. (An et al., 2021). Then, it is a need to prepare procurement documents contain instructions regarding equal risk responsibility for the main parties who are involved in the construction project (Willar et al., 2021). Builders need to put efforts on monitoring and familiarising with Smart Living related market policy requirements, like market & policy study (Qian et al., 2015; Mohamad et al., 2022; Akadiri et al., 2012; Abidin et al., 2013; Assadiki et al., 2022; J. Zhang et al., 2019; Zhuang et al., 2020; Wu et al., 2019; Y. Zhang et al., 2021; Willar et al., 2021). Besides, a practical market study needs to be conducted to meet local neighbourhood comprehensive requirements, expectations, and potential users by considering

their need/supply/competitiveness (Qian et al., 2015; Butryn et al., 2019; Kamaruddin et al., 2020; Wu et al., 2019).

Qian et al., (2015), Abidin et al., (2013) and J. Zhang et al., (2019) commonly agreed for the need to appoint a special taskforces (e.g., architect, engineer) to attract special stakeholders relating to Smart Living or perhaps consideration and initiatives for a joint-venture. As it is crucial for timeous involvement of key stakeholders during the decision-making process, owners' motivation, and developers' commitments. (Akadiri et al., 2012; J. Zhang et al., 2019; Kamaruddin et al., 2020; Lu et al., 2021; Willar et al., 2021; Mustaffa et al., 2021). Furthermore, the builders are required to Provide the necessary knowledge basis to encourage stakeholders' action and to create technical capacity that support and develop action. (Abidin et al., 2013; Ghansah et al., 2022; J. Zhang et al., 2019; Moulai & Drias, 2021; Willar et al., 2021). With the purpose of Improving the efficiency of management processes - reducing losses, reducing indirect and overhead costs in tariffs, etc. (Dmitrieva, 2021; Willar et al., 2021; Franco et al., 2021). Somehow, it is a concerns to reduce the volume of accounts receivable in the industry and the resulting additional financial burden on the business. (Dmitrieva, 2021; Mustaffa et al., 2021).

In terms of initial sketches of design, it has to consider comprehensive design on both Smart City township and Smart Living housing planning simultaneously by analysing the available maps and the act on spatial planning. (Qian et al., 2015; Mohamad et al., 2022; Akadiri et al., 2012; Che Maznah et al., 2021; Chen et al., 2015; Zhuang et al., 2020; Y. Zhang et al., 2021; Ying, 2021; Atanda & Olukoya, 2019; Butryn et al., 2019; Hao & Wang, 2019). Along with the study the extra financial risk corresponding to Smart Living features implementation (Qian et al., 2015; Dmitrieva, 2021; Franco et al., 2021; Mustaffa et al., 2021). This can be read as an efforts & initiatives in optimizing development cost plan (e.g., hard cost elements, soft cost elements, land cost element). (Mohamad et al., 2022; Y. Zhang et al., 2019; Willar et al., 2021). Furthermore, as relevant to financial matter, there must be consideration of extra-legal liability risk corresponding to the Smart Living features (Qian et al., 2015). Lastly, adopt the valuation approach on property during feasibility study through the quantitative indicators on Smart Concept (Zhao et al., 2022; J. Zhang et al., 2019).

Theme 2: Anticipated Transaction Cost Components Associate within PREC 2 - Concept, Developed and Technical Design Phase for Smart Living Housing Development
Like theme 1, there are 27 articles out of 34 articles that mentioned anticipated transaction cost components are available within Smart Living housing development at the PREC 2 – Concept, Developed and Technical design phases. There are 10 subthemes, the transaction cost components, contributed by implementing Smart features as Table 5:

Themes: Development Phases	Sub-theme: Anticipated Transaction Cost Components
PREC 2 - Concept, Developed and Technical Design Phase	1. Special concept/design/spatial planning that needs negotiation with the government for approval. (Qian et al., 2015; Dmitrieva, 2021; Assadiki et al., 2022; Zhuang et al., 2020; Wu et al., 2019; Atanda & Olukoya, 2019) 2. Design leading to efficient use of floor area. (Butryn et al., 2019; Zhuang et al., 2020) 3. Special user requirement study to express how a facility, equipment or process should perform in terms of the product (Qian et al., 2015; Che Maznah et al., 2021; Ying, 2021; Willar et al., 2021) 4. Additional consideration of tenant for Smart Living products/ End-users' integration (Mohamad et al., 2022; Akadiri et al., 2012; Kim et al., 2020; Zimmerling et al., 2017; Y. Zhang et al., 2019; Butryn et al., 2019; Kamaruddin et al., 2020; Zhuang et al., 2020; He et al., 2021; Tomal, 2020; Ying, 2021; Franco et al., 2021; Fu et al., 2021) 5. Explore special technical solutions/workforces for construction. (Qian et al., 2015; Abidin et al., 2013; Assadiki et al., 2022; Bragança et al., 2014; Willar et al., 2021; Atanda & Olukoya, 2019) 6. Search for a list of a contractor with special expertise. (Qian et al., 2015) 7. Extra effort to brief all project personnel of the project requirement and procedures for administering the project. (Qian et al., 2015; Ghansah et al., 2022; Abidin et al., 2013; Ghansah et al., 2022; Zhang et al., 2019; Q. Li et al., 2021) 8. Special promotion strategy and materials for Marketing and Leasing. (Qian et al., 2015; Mohamad et al., 2022) 9. Financial negotiations for new design features, consideration of mortgage/Loan/construction loan) (Qian et al., 2015; Bragança et al., 2014; Zhuang et al., 2020) 10. Special cost study for using new design features. (Qian et al., 2015; Bragança et al., 2014; Wu et al., 2019; Franco et al., 2021; Q. Li et al., 2021)

Table 5 Anticipated Transaction Cost Components Associate within PREC 2 - Concept, Developed and Technical Design Phase for Smart Living Housing Development

Theme 2 rank the second that consist of high number of transaction cost components. Firstly, it focus on the quality of features where the need for special concept/design/spatial planning that needs negotiation with the government for approval. (Qian et al., 2015; Dmitrieva, 2021; Assadiki et al., 2022; Zhuang et al., 2020; Wu et al., 2019; Atanda & Olukoya, 2019). Besides, the design must be leading to efficient use of floor area. (Butryn et al., 2019; Zhuang et al., 2020). Along with special user requirement study to express how a facility, equipment or process should perform in terms of the product (Qian et al., 2015; Che Maznah et al., 2021; Ying, 2021; Willar et al., 2021). Furthermore, there need to have additional consideration of tenant for Smart Living products/ End-users' integration (Mohamad et al., 2022; Akadiri et al., 2012; Kim et al., 2020; Zimmerling et al., 2017; Y. Zhang et al., 2019; Butryn et al., 2019;

Kamaruddin et al., 2020; Zhuang et al., 2020; He et al., 2021; Tomal, 2020; Ying, 2021; Franco et al., 2021; Fu et al., 2021).

The second focus in this phase is the professional workforce. Builders must explore special technical solutions/workforces for this innovative construction (Qian et al., 2015; Abidin et al., 2013; Assadiki et al., 2022; Bragança et al., 2014; Willar et al., 2021; Atanda & Olukoya, 2019). By searching for a list of a contractor with special expertise. (Qian et al., 2015). Extra effort to brief all project personnel of the project requirement and procedures for administering the project to ensure less friction during the project procurement. (Qian et al., 2015; Ghansah et al., 2022; Abidin et al., 2013; Ghansah et al., 2022; Zhang et al., 2019; Q. Li et al., 2021).

The third focus will be on the selling, promoting/marketing part where builders are required to begin their planning for special promotion strategy and materials for Marketing and Leasing. (Qian et al., 2015; Mohamad et al., 2022). Then involve in financial negotiations for new design features, consideration of mortgage/loan/construction loan) (Qian et al., 2015; Bragança et al., 2014; Zhuang et al., 2020). Along with the effort of studying special cost study for using new design Smart Living features. (Qian et al., 2015; Bragança et al., 2014; Wu et al., 2019; Franco et al., 2021; Q. Li et al., 2021).

Theme 3: Anticipated Transaction Cost Components Associate within POSC 3 – Construction Phase for Smart Living Housing Development

It appears to have 27 articles out of 34 articles that mentioned anticipated transaction cost components are available within Smart Living housing development at the Construction phases. There are 5 subthemes, the transaction cost components, contributed by implementing Smart features as in Table 6:

Themes: Development Phases	Sub-theme: Anticipated Transaction Cost Components
POSC 3 – Construction Phase for Smart Living Housing Development	1. Extra requirement on Testing and Commissioning of service installations to obtain Smart standard etc. (Qian et al., 2015; Dmitrieva, 2021; Assadiki et al., 2022; Willar et al., 2021; Fu et al., 2021) 2. Special effort to prepare maintenance manual. (Qian et al., 2015; Willar et al., 2021; Q. Li et al., 2021) 3. Extra fee for certificates involving Smart items. (Qian et al., 2015; Che Maznah et al., 2021; Y. Zhang et al., 2019; Mohamad et al., 2022; Akadiri et al., 2012; Abidin et al., 2013; Assadiki et al., 2022; J. Zhang et al., 2019; Mustaffa et al., 2021) 4. Waste management strategy and practice (Willar et al., 2021; Atanda & Olukoya, 2019) 5. Review each construction work target to see if it meets the design document (Willar et al., 2021; Q. Li et al., 2021)

Table 6 Anticipated Transaction Cost Components Associate within POSC 3 – Construction Phase for Smart Living Housing Development

There are only 5 anticipated transaction cost components summarised from the literature reviews for theme 3. This theme consists of the lowest of transaction cost components as compared to theme 1, 2 and 4. During the construction stage of Smart Living housing development. Builders are required to fulfil extra requirements on Testing and Commissioning of service installations to obtain Smart standard etc. (Qian et al., 2015; Dmitrieva, 2021; Assadiki et al., 2022; Willar et al., 2021; Fu et al., 2021). Next is the special effort to prepare maintenance manual for the users (Qian et al., 2015; Willar et al., 2021; Q. Li et al., 2021). On top of that, builders are required to allocate extra fee for certificates involving Smart items. (Qian et al., 2015; Che Maznah et al., 2021; Y. Zhang et al., 2019; Mohamad et al., 2022; Akadiri et al., 2012; Abidin et al., 2013; Assadiki et al., 2022; J. Zhang et al., 2019; Mustaffa et al., 2021). Besides, the need for a systematic waste management strategy and practice have to be available (Willar et al., 2021; Atanda & Olukoya, 2019). Lastly, is to constantly review each construction work target to see if it meets the design document (Willar et al., 2021; Q. Li et al., 2021).

Theme 4: Anticipated Transaction Cost Components Associate within POSC 4 – Handover and Close Out Phase for Smart Living Housing Development

For the POCS 4 - Handover and Close Out Phase for Smart Living Housing Development, 17 articles out of 34 articles mentioned the anticipated transaction cost components are available. There are 9 subthemes, the transaction cost components, contributed by implementing Smart features as in Table 7:

Themes: Development Phases	Sub-theme: Anticipated Transaction Cost Components
POSC 4 – Handover and Close Out Phase	1. Special property skill requirement for the Property management plan. (Qian et al., 2015; Wu et al., 2019) 2. To keep the building running effectively and under good repair. (Qian et al., 2015) 3. Involve more guaranteed certificates. (Qian et al., 2015; Willar et al., 2021) 4. Consideration on Recovery Cost - the cost of demolition and material recovery. (Akadiri et al., 2012; Wu et al., 2019; Q. Li et al., 2021) 5. Special strategy and materials for overseeing marketing or leasing, Fostering pro-wellbeing behaviour for awareness purpose, (Qian et al., 2015; Mohamad et al., 2022; Assadiki et al., 2022; Ghansah et al., 2022; He et al., 2021; Wu et al., 2019; Franco et al., 2021; Fu et al., 2021) 6. Set up and manage ownership entity. (Qian et al., 2015; Abidin et al., 2013) 7. More special SL items to be taken care of for property improvement. (Qian et al., 2015) 8. Formation of a database of complete, reliable, and up-to-date data on the state of the housing stock, on the volume and quality of provided services and energy consumption, on consumers of housing and communal services. (Ying, 2021; Willar et al., 2021) 9. Testing of all project results is carried out by competent third parties together with the owners and users (Willar et al., 2021)

Table 7 Anticipated Transaction Cost Components Associate within POSC 4 – Handover and Close Out Phase for Smart Living Housing Development

During the handover and close out phase in Smart Living housing development, there are 9 subthemes/transaction cost components anticipated that were contributed by Smart features implementation. The builders are required to cater special property skill requirement for the property management plan since Smart buildings are distinct from conventional buildings (Qian et al., 2015; Wu et al., 2019). So that, more special SL items to be taken care of for property improvement. It is the priority of builders to provide initiatives that ensure the building running effectively and under good repair. (Qian et al., 2015). Furthermore, builders have to secure more guaranteed certificates in order to convince target users in purchasing the property (Qian et al., 2015; Willar et al., 2021). Also, to provide special strategy and materials for overseeing marketing or leasing, fostering pro-wellbeing behaviour for awareness purpose, (Qian et al., 2015; Mohamad et al., 2022; Assadiki et al., 2022; Ghansah et al., 2022; He et al., 2021; Wu et al., 2019; Franco et al., 2021; Fu et al., 2021). At the same time, conduct testing of all project results is carried out by competent third parties together with the owners and users (Willar et al., 2021)

Besides, a critical consideration must be put on Recovery Cost. Which is the cost of demolition and material recovery (Akadiri et al., 2012; Wu et al., 2019; Q. Li et al., 2021). Also, is to set up and manage ownership entity. (Qian et al., 2015; Abidin et al., 2013). Lastly is to form of a

database of complete, reliable, and up-to-date data on the state of the housing stock, on the volume and quality of provided services and energy consumption, on consumers of housing and communal services that will be available for property management transparency (Ying, 2021; Willar et al., 2021).

Conclusion

As conclusion, implementing the Smart Living features throughout the Smart Living housing development is not as simple as 'add-on' items. This is because builders will have to do more than obey the bare minimum of the law and regulatory policies to minimize the potential costs and risks engendered by the extra works entailed from complying Smart Living concept. The extra works are compulsory because Smart Living houses demand special materials, expertise, regulation and specialized equipment that typical man powers or conventional work methods cannot procure (King & Perry, 2017). These are the possibly hidden cost that mentioned by (Qian et al., 2015) as the 'greater barriers' and 'unintended consequences' that closely link the uncertainties in decision-making. Thus, the purpose of this systematic literature review is to uncover the transaction cost components within Smart Living housing development that are contributed by those distinct Smart features.

When the study of transaction cost components for conventional housing development is being mirrored with Smart Living housing development, this leads to the following research questions:

- What are the transaction cost components contributed by the distinct Smart features in each development stages of Smart Living housing development?
- How many anticipated transactions cost components contributed by the distinct Smart features in each development stages of Smart Living housing development?

Following the research questions, finding discovers that there are 40 anticipated transaction cost components which are analyzed, synthesized, and hypothesized from preceding sustainable concept housing and building development that are relevant to Smart Living housing development. Table 8 shows the anticipated transaction cost components and Table 9 summarise the number of transaction cost components for Smart living housing development.

Themes: Development Phases	Sub-theme: Anticipated Transaction Cost Components
PREC 1 – Strategic Definition, Preparation for Briefing Phase	1. Special allocation on new department/organisation related to decision making for Smart Living concept related project, e.g., new offices, cubicles. 2. Provide the required computing, storage and other resources and the most basic services for the entire project, such as log records, cache processing, message notifications, etc. 3. Procurement documents contain instructions regarding equal risk responsibility for the main parties who are involved in the construction project. 4. Efforts on monitoring and familiarising with Smart Living related market policy requirements: market & policy study.

	5. Practical market study to meet market requirements, expectations, and potential users by considering local community need/supply/competitiveness 6. Appoint special taskforces (e.g., architect, engineer) to attract special stakeholders relating to Smart Living. 7. Consideration and initiatives for a joint venture. 8. The timeous involvement of key stakeholders during the decision-making process, owners' motivation, and developers' commitments. 9. necessary knowledge basis to encourage stakeholders' action and to create technical capacity that support and develop action. 10. Improving the efficiency of management processes - reducing losses, reducing indirect and overhead costs in tariffs, etc. 11. Reducing the volume of accounts receivable in the industry and the resulting additional financial burden on the business. 12. Comprehensive design on both Smart City township and Smart Living housing planning simultaneously by analysing the available maps and the act on spatial planning. 13. Study the extra financial risk corresponding to Smart Living features implementation. 14. Efforts & initiatives in optimizing development cost plan (e.g., hard cost elements, soft cost elements, land cost element). 15. Consideration of extra-legal liability risk corresponding to the Smart Living features 16. Valuation of property during feasibility study through the quantitative indicators on Smart Concept.
PREC 2 - Concept, Developed and Technical Design Phase	1. Special concept/design/spatial planning that needs negotiation with the government for approval. 2. Design leading to efficient use of floor area. 3. Special user requirement study to express how a facility, equipment or process should perform in terms of the product. 4. Additional consideration of tenant for Smart Living products/ End-users' integration. 5. Explore special technical solutions/workforces for construction. 6. Search for a list of a contractor with special expertise. 7. Extra effort to brief all project personnel of the project requirement and procedures for administering the project. 8. Special promotion strategy and materials for Marketing and Leasing. 9. Financial negotiations for new design features, consideration of mortgage/Loan/construction loan 10. Special cost study for using new design features.
POSC 3 – Construction Phase	1. Extra requirement on Testing and Commissioning of service installations to obtain Smart standard etc. 2. Special effort to prepare maintenance manual. 3. Extra fee for certificates involving Smart items. 4. Waste management strategy and practice. 5. Review each construction work target to see if it meets the design document.

POSC 4 – Handover and Close Out Phase	1. Special property skill requirement for the Property management plan. 2. To keep the building running effectively and under good repair. 3. Involve more guaranteed certificates. 4. Consideration on Recovery Cost - the cost of demolition and material recovery. 5. Special strategy and materials for overseeing marketing or leasing, Fostering pro-wellbeing behaviour for awareness purpose, 6. Set up and manage ownership entity. 7. More special SL items to be taken care of for property improvement. 8. Formation of a database of complete, reliable, and up-to-date data on the state of the housing stock, on the volume and quality of provided services and energy consumption, on consumers of housing and communal services. 9. Testing of all project results is carried out by competent third parties together with the owners and users.

Table 8 Anticipated Transaction Cost Components for Smart Living housing Development

THEMES	ANTICIPATED TCC WITHIN SMART LIVING HOUSING DEVELOPMENT			
	PRE-CONTRACT STAGE (PREC)		POST-CONTRACT STAGE (POSC)	
	STRATEGIC DEFINITION & PREPARATION FOR BRIEFING PHASE	CONCEPT, DEVELOPED & TECHNICAL DESIGN PHASE	CONSTRUCTION PHASE	HANDOVER & CLOSE OUT PHASE
	(PREC 1)	(PREC 2)	(POSC 4)	(POSC 5)
Number of Anticipated Transaction Cost Components for Smart Living Housing Development	16	10	5	9

Table 9 Anticipated TCC derived for Smart Features Implementation

This study adds to the existing literature by extending the base knowledge of transaction cost components based on the synthetization of previous green development and recent available Smart concept development. Nevertheless, this study has brought about further queries in need of further investigation in which, it could be extended by conducting a survey within the industry to validate the list of transaction cost components that are relevant and practicality for Smart Living housing development.

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Appendix A

AUTHOR	PAPER TITLE	RESEARCH DESIGN			ANTICIPATED TCC WITHIN SMART LIVING HOUSING DEVELOPMENT			
					PRE-CONTRACT STAGE (PREC)		POST-CONTRACT STAGE (POSC)	
		QUALI-TATIVE	MIX-METHOD	QUANTI-TATIVE	STRATEGIC DEFINITION & PREPARATION FOR BRIEFING PHASE	CONCEPT, DEVELOPED & TECHNICAL DESIGN PHASE	CONSTRUCTION PHASE	HANDOVER & CLOSE OUT PHASE
					(PREC 1)	(PREC 2)	(POSC 4)	(POSC 5)
(Mohamad et al., 2022)	Embedding Eco-Friendly and Smart Technology Features in Affordable Housing for Community Happiness in Malaysia	/				/	/		/
(Assadiki et al., 2022)	Status and Prospects of Green Building in the Middle East and North Africa (MENA) Region with a Focus on the Moroccan Context		/		/	/	/	/
(Zhao et al., 2022)	Monetary Valuation of the Environmental Benefits of Green Building: A Case Study of China	/			/	/		
(Ghansah et al., 2022)	Assessing the Level of Awareness of Smart Building Technologies (SBTs) in the Developing Countries			/	/	/		/
(Y. Zhang et al., 2021)	Identification of Independent Variables to Assess Green-Building Development in China based on Grounded Theory		/		/	/	/	
(Moulai & Drias, 2021)	Towards Knowledge Warehousing: Application to Smart Housing	/			/	/		
(Ying, 2021)	Research on Big Data and New Smart City Construction		/		/	/		/
(An et al., 2021)	Research on the Design and Key Technology of 'Smart Housing Construction' Service Management Platform-Taking Zhejiang City as an Example	/			/			

(Che Maznah et al., 2021)	Sustainable Township and Sustainable Home: Public Perceptions			/	/	/	/	
(Mustaffa et al., 2021)	Top-Down Bottom-Up Strategic Green Building Development Framework: Case studies in Malaysia		/		/	/		/
(Q. Li et al., 2021)	Optimizing Energy Efficiency and Thermal Comfort in Building Green Retrofit	/			/	/	/	
(Franco et al., 2021)	Green Building Policies in Cities: A Comparative Assessment and Analysis		/		/	/	/	/
(Lu et al., 2021)	An Integrated Decision-Making Framework for Existing Building Retrofits Benefit Analysis		/		/			
(He et al., 2021)	Analysis of Smart Home use based on the Degree of Health-related Risk Variation: A Cross-Sectional National Survey in China		/			/		/
(Fu et al., 2021)	New Dimension to Green Buildings: Turning Green into Occupant Well-Being		/				/	/
(Assylbekov et al., 2021)	Factors Influencing Green Building Development in Kazakhstan			/				
(Dmitrieva, 2021)	Digitalization of the Housing and Communal Services: Development Prospects	/			/			/
(Willar et al., 2021)	Sustainable Construction Practices in the Execution of Infrastructure Projects: The Extent of Implementation		/		/	/	/	/
(Kim et al., 2020)	Developing Design Solutions for Smart Homes Through User-Centred Scenarios	/				/		
(Tomal, 2020)	Moving Towards a Smarter Housing Market: The Example of Poland		/		/	/	/	/
(Zhuang et al., 2020)	An Analysis of Urban Renewal Decision-Making in China from the Perspective of Transaction Costs Theory: The Case of Chongqing		/			/	/	/
(Kamaruddin et al., 2020)	A Situational Study on Sustainable Housing Features in Johor			/	/	/		

(Hao & Wang, 2019)	Study on Spatial Evolution of Chinese Green Building	/			/	/		
(Wu et al., 2019)	What Hinders the Development of Green Building? An Investigation of China	/			/	/		/
(Y. Zhang et al., 2019)	A Survey of the Status and Challenges of Green Building Development in Various Countries	/			/	/	/	
(Butryn et al., 2019)	Sustainable Formation of Urban Development on the Example of the Primary Real Estate Market in Krakow		/			/	/	/
(Atanda & Olukoya, 2019)	Green Building Standards: Opportunities for Nigeria		/		/	/	/	
(J. Zhang et al., 2019)	A Successful Delivery Process of Green Buildings: The Project Owners' View, Motivation and Commitment			/	/			
(Zimmerling et al., 2017)	End-Users as Co-developers for Novel Green Products and Services – An Exploratory Case Study Analysis of the Innovation Process in Incumbent Firms		/		/	/	/	/
(Chen et al., 2015)	A Comprehensive Review on Passive Design Approaches in Green Building Rating Tools	/			/	/		
(Qian et al., 2015)	Challenges in Delivering Green Building Projects: Unearthing the Transaction Costs (TCs)		/		/	/	/	/
(Bragança et al., 2014)	Early-Stage Design Decisions: The Way to Achieve Sustainable Buildings at Lower Costs	/				/		
(Abidin et al., 2013)	Enablers and Challenges of a Sustainable Housing Industry in Malaysia	/			/			/
(Akadiri et al., 2012)	Design of a Sustainable Building: A Conceptual Framework for Implementing Sustainability in the Building Sector	/			/	/		
Total	34	14	15	5	27	27	14	17