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Assessing Critical Risk Factors (CRFs) to Sustainable Housing: The Perspective of a sub-Saharan African Country

Michael Atafo Adabre[1]; Albert P.C. Chan[2]; David J. Edwards[3]; Emmanuel Adinyira[4]

Abstract
Ensuring safe, affordable and energy efficient housing facilities to members of the general public by 2030 are prominent objectives delineated within the United Nation's (UN) Sustainable Development Goals (SDGs). However, attaining these goals has been negatively influenced by various risk factors. This study explores linear relationships among clusters of these risk factors and the sustainable development goals in the Ghanaian housing market. Specifically, 21 risk factors, established through a comprehensive literature review, were categorized into four main clusters/constructs, namely: 1) political and procurement risks; 2) financial-related risks; 3) design and construction risks and 4) operation and maintenance risks. A questionnaire survey was conducted with respondents mostly in the formal/regulated/controlled sector of the Ghanaian housing market. Partial least square structural equation modelling (PLS-SEM) on the data revealed causal relationships among constructs of risks that could influence the SDGs. Results revealed that only 'political and procurement risks' have a significant impact (t-value of 2.321) on the SDGs. Besides, this risk category has significant impacts on all the other risk categories with the highest impact (t-value of 4.538) on 'design and construction risks'. The study contributes to the scientific literature by providing a novel investigation of the influence of risk constructs on the SDGs in housing. The study's findings may be used to influence research informed local policymakers and supranational organizations who seek to develop interventions/policies for reducing the housing crisis in most cities in Ghana and other sub-Saharan African countries.

Keywords: Affordable housing; Sustainable housing; Affordability; Risks; Critical Risks; Ghana

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[1] Corresponding author's address: Michael Atafo Adabre, Building and Real Estate Department, Hong Kong Polytechnic University, Hong Kong. Tel:+85266450743
E-mail address: 17902405r@connect.polyu.hk

[2] Co-author's address: Prof. Albert P.C. Chan, Building and Real Estate Department, Hong Kong Polytechnic University, Hong Kong. E-mail address: albert.chan@polyu.edu.hk

[3] Co-author's address: Prof. David J. Edwards, Faculty of Computing, Engineering and the Built Environment, Birmingham City University, United Kingdom. E-mail address: drdavidedwards@aol.com

[4] Co-author's address: Prof. Emmanuel Adinyira, Department of Construction Technology and Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. E-mail address: rasadii@yahoo.com

1.1 Introduction

Adequate housing supply underpins the socio-economic development of every nation and moreover, serves as a poverty reduction strategy because the cost of housing construction and operation constitutes a sizable proportion of household income (Chan & Adabre, 2019). In addition, ensuring the affordability and accessibility to housing facilities in most cities could prevent the proliferation of slums and its associated negative impacts on households' health, loss of peri-urban land and increasing vehicular emissions (Cobbinah & Amoako, 2012). Aside the fundamental purpose of providing shelter, housing facilities are assets for storing wealth and for hedging against increasing inflation. Thus, if adequately designed, situated and constructed, housing facilities promote economic, social and environmental sustainability for sustainable housing (Awadh, 2017; Balasbaneh et al., 2018; Lazar & Chithra, 2020). Despite these palpable benefits, housing deficit constitutes a major problem worldwide. Inadequately constructed makeshift facilities that lack adequate infrastructure supply are consequently proliferated by low-income earners to meet their shelter needs. Occupants of these 'makeshift' slums are generally characterized as homeless – an issue which is evinced globally (Golubchikov & Badyina, 2012). The prevailing homeless situation could be further exacerbated given the predicted global population growth from 3.6 billion to 6.3 billion by 2050 (Golubchikov & Badyina, 2012).

Homelessness has engendered global housing interventions from supranational organizations such as the United Nations and the World Bank but also local policies enacted at a national level. Policies emanating from international organizations provide a facilitative role to augment locally-established policies. Amidst a panoply of housing policies for sustainable development in most sub-Saharan African countries (Croese et al., 2016), the housing situation in the administrative capital of Ghana – Accra – requires utmost attention as it acts as an economic honey-trap for prospective employees from the surrounding impoverished rural areas. Besides, Accra could also serve as a representative case study for cities of the other sub-Saharan African countries (Obeng-Odoom, 2010). Following the era of neoliberalism, Ghana's government devolved the responsibility of housing supply to the citizens – primarily due to scant financial resources within the state (Arku, 2009). International organizations (such as the World Bank) promote this strategy in which the state mostly provides an enabling environment (i.e. tax incentives and infrastructure supply) for the private sector and some parastatal institutions (herein referred to as the '*formal housing sector*' of the Ghanaian housing market) to improve housing supply (Arku, 2009). Yet, this further increased self-build housing (herein referred to as '*informal housing sector*') since most middle- and low-income earners could not afford the prices of the facilities supplied by some of the institutions in the formal sector. About 90% of the housing supplied in Ghana are self-built, most of which are poorly constructed and poorly located. This translates into problems of overcrowding in rooms and increasing slum in cities, especially in Accra (Gaisie et al., 2019).

Although the housing facilities from the formal sector are mostly adequately constructed and furnished with other facilities, housing supply from this sector is not sufficient to ameliorate housing needs in major cities (Ghana Housing Profile, UN-Habitat, 2011). The low housing supply (< 10%) from the formal sector remains intransigent despite the enabling environment provided by successive governments (Ghana Housing Profile, UN-Habitat, 2011). Though the state has provided direct housing on a relatively small scale, some of these housing projects (at various stages of completion) have been abandoned by succeeding governments – for example, the abandoned and incomplete Asokore-Mampong Housing Project (Twumasi-Ampofo et al., 2014). Other completed housing facilities are left unoccupied or challenged with a low take-up rate (Grant et al., 2019). Moreover, the STX Korea-Ghana joint venture housing project that was initiated to provide 200,000 public housing facilities was cancelled. These recurrent failures to complete housing projects have often been attributed to unmanaged risk factors that culminate into barriers / constraints (Twumasi-Ampofo et al., 2014; Awanyo et al., 2016). For the context of this study, risk factors are defined as both macro-economic (national or international economic risks) and micro-economic (industry specific risks) factors that impact upon the development of sustainable housing. For example, the micro-economic risk of bribery and corruption in procurement processes can substantially inflate project costs (cf. Ameyaw et al., 2017). A plethora of studies have investigated the barriers to housing development, including various aspects of sustainable housing such as economic sustainability, environmental sustainability and social sustainability (cf. Adabre et al., 2020; Twumasi-Ampofo et al., 2014; Awanyo et al., 2016). Such studies are essential for efficient resource allocation (Adabre et al., 2020). Yet more importantly, adequate studies on assessing the interdependencies of risks are a precursor to mitigating the barriers for a holistic sustainable development in housing. Despite the fact that a risk event is often triggered by other risks, analysis of the interdependencies among risks as well as the project goals is seldom conducted (Kwak et al., 2017). Studies on risk identification have generally analysed risks and risk clusters independently (cf. Ameyaw & Chan, 2015; Zhao et al., 2016; Fernandez-Dengo et al., 2013; Osei-Kyei & Chan 2017; Wuni et al., 2020). Yet, other studies (cf. Kwak et al., 2017; Guan et al., 2020; Addae et al., 2019) that have acknowledged the limitations in assessing risk separately have investigated the interdependencies among risk or risk clusters albeit, some limitations in their risk assessment methodologies are apparent. For example, path diagrams developed to illustrate interdependencies are often lacking.

In this paper, the partial least square structural equation modelling (PLS-SEM) is adopted to explore how various risk clusters influence sustainable housing in Ghana from the view of respondents in the formal sector (respondents in both public and private institutions that are involved in housing supply). The PLS-SEM serves as an analytic technique for filling two primary knowledge gaps. First, unlike previous studies, this technique provides a quantitative assessment of the causal interdependencies among the risk categories. Second, the PLS-SEM is appropriate for establishing linear relationships between the risk constructs and the various sustainable development goals in housing (Kim et al., 2009; Ahmadabadi & Heravi, 2019). By establishing these interdependencies among the risks and sustainable housing goals, emergent findings provide practical implications for research informed industry and government policymakers. Essentially, governments, planners and professionals could be informed on the risk sequence and critical risk factors that require utmost attention in the pursuit of the UN sustainable development goals (SDGs) in housing. This could improve housing supply from the formal sector of the Ghanaian housing market and other sub-Saharan African countries in Africa.

2.1 Literature Review

Sustainable development in housing or sustainable housing seeks to achieve optimum economic, social and environmental benefits; where attainment of this goal could be assessed by observable variables. Consequently, sustainable development in housing could be considered as a latent variable (i.e. a construct) that can be measured by the observable variables also known as indicators or critical success criteria (CSC). CSC are "the set of principles or standards through which judgement can be made" (Lim and Mohammed, 1992 p.243). To capture a rich synthesis of relevant literature (including risks posed, barriers within and CSC), both the Web of Science and Scopus databases were searched using pertinent keyword terminologies (cf. Sepasgozar et al., 2020). The keyword search term string was: [ALL ("Housing affordability" OR "Affordable housing" OR "Sustainable housing" OR "Green buildings" AND ("Risk factors" OR "Risks")) AND DOCTYPE (ar) AND PUBYEAR > 2010 AND PUBYEAR < 2022 AND (LIMIT-TO (LANGUAGE, "English"))]. In total, 324 and 1985 articles were retrieved from both Scopus and WoS, respectively, as at 12th February, 2021. Databases accrued were then combined and subsequently, manually cleansed to remove repetition and/or other materials that were not relevant for this study. A total of eighteen articles were identified as being important and therefore, formed the basis of this literature review.

A review study by Adabre & Chan (2018) concluded that 21 indicators (refer to Table 1) could be deployed to comprehensively measure sustainability attainment at various phases of a housing project (i.e. project and product management phases). Chan & Adabre (2019) later confirmed these findings. Although the CSC are often specified at the project's inception, some of the CSC could be affected by risk factors at various stages of the project. El-Sayegh & Mansour (2015) proffer that: "risk is defined as an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective or goal." In this study (*ibid*), risk factors include uncertain conditions that, if not appropriately managed, could negatively affect a CSC or could create barriers that engender housing project failure. Quantitatively, risks are measured as joint functions of both likelihood of occurrence and severity of impact.

Extant studies provide a broad view of the risk factors that could influence construction projects in general and housing projects in particular. Fernandez-Dengo et al. (2013) revealed that the risk factors that affect the housing market in the United States and Mexico include 'monetary inflation', 'financing risks', 'social conflicts (force majeure event)', 'economic growth' and 'bureaucratic delays'. These were inveterate risk factors in studies conducted by Lundin et al. (2015), Ameyaw & Chan (2015) and Osei-Kyei & Chan (2017) from the Ghanaian perspective. In Ameyaw & Chan (2015) and Osei-Kyei & Chan (2017), additional risk factors were identified, namely, 'contractor's financial crisis', 'difficulties with payments', 'litigation', 'construction time and cost overruns', 'poor contract design', 'design and construction contract deficiencies', 'political interferences', 'high operational costs', 'supporting utilities/infrastructure supply risks' and 'land expropriation risk'. Similarly, Zhao et al. (2016) and Hwang et al. (2017) showed that 'inflation rate fluctuation', 'currency and interest rate volatility', 'poor construction quality' and 'risk of design changes' are key risk factors to sustainable building in Singapore. Moreover, studies have identified privatization of public rental housing facilities as a risk factor to sustainable housing. In Hong Kong, for example, Zheng et al. (2017) and Ho (2004) argued that public housing privatization could exacerbate unfair distribution of housing resources. This assertion was supported by Fields and Uffer (2014 p.1486) who concluded that "financialization heightened exiting inequalities in housing affordability and stability, and rearranged spaces of abandonment and gentrification in both New York and Berlin." Ghanaian housing studies by Grant & Yankson (2003) and Taruvinga & Mooya (2018) yielded similar a conclusion on privatization of public rental housing facilities as a risk to sustainable development.

In prioritizing the risk factors, various descriptive statistical analysis techniques have been deployed such as the relative importance index (cf. Lundin et al., 2015), measure of central tendency and measure of spread (cf. Fernandez-Dengo et al., 2013; Osei-Kyei & Chan, 2017). Whilst descriptive statistics are simple to use and quantitatively describe data, the objectivity of results are often questioned. For instance, construction projects such as housing projects require different decision-makers (e.g. architects, quantity surveyors and engineers), whose risk factors assessments are based on biased experience, motivations, opinion and ideas. A quantity surveyor who seeks to reduce project cost might rate 'variations to construction design' as 'high' based on their experience if project costs escalate because of variation. However, an architect who aims to achieve the ultimate aesthetic view might not rate 'variations to construction design' as such if issuing the variation order will lead to the attainment of their aim or project goal. Another area that is prone to subjectivity is that the assessments/prioritizations of the risk factors are often expressed in equivocal linguistic terms (i.e. low, high, very high etc.). Lin & Wu (2006, p.200) examined the subjectivity of categorical scales and concluded that "to integrate various experiences, opinions, ideas and motivations of an individual decision-maker, it is better to convert the linguistic estimation/terms into fuzzy numbers". Thus, the problems of group decision-making in the real world have created a need to employ fuzzy logic.

Providing an objective and bias-free risk assessment with fuzzy synthetic evaluation (FSE) technique (an aspect of fuzzy logic) is not uncommon in construction projects (cf. Ameyaw & Chan, 2015; Ameyaw et al., 2015; Zhao et al., 2016; Wuni et al., 2020). A review study conducted by Islam et al. (2017) revealed an extensive use of the FSE in various construction projects for cost analysis under uncertainty, risk networks, risk prioritization, risk allocation modelling and project complexity assessment and construction health and safety (cf. Nwaogu & Chan, 2020). Ameyaw & Chan (2015, p. 5114) state that "the fuzzy set approach has the merit of transforming or objectifying the vague and imprecise evaluation by a set of fuzzy mathematical functions." In conducting FSE, data on the risk factors are mostly grouped into categories (herein also referred to as constructs) for easier quantification. Thus, the FSE is suitable for identification of critical risk categories and critical risk factors. In Ameyaw & Chan (2015), for instance, three risk categories/constructs were developed, namely, 'financial risk construct', 'legal and socio-political risk construct' and 'technical risk construct'. Based on the FSE analysis, the 'financial risk construct' was ranked as the most critical with an index of 4.909. 'Foreign exchange rate' and 'inflations' were identified as among the critical risk factors. Similarly, in Zhao et al. (2016), eleven categories were developed, among the risk categories include: 'macro-economic risk'; 'contract problems'; 'client-related risk'; 'design problems'; 'safety risk'; 'procedure complexity'; 'technical problems'; 'human resource risk'; 'materials & equipment problems'; 'project team risk' and 'cost overrun risk'. Among these categories, 'cost overrun risk' was established as the critical risk group while 'inaccurate cost estimation' was the top risk factor.

Notwithstanding the importance of the FSE, its usage is not without limitations. The FSE has weaknesses in providing a holistic risk assessment for effective project control and management (Ameyaw & Chan, 2015) One limitation is its inability to offer interdependent relationships among the risk categories. Although FSE categorizes risk factors into separate constructs, it is worth noting that the constructs are usually not independent (Kwak et al., 2018). Risk constructs which may not be determined as critical in FSE may originate more critical risk constructs and factors. Therefore, integrating the criticality assessment and the interdependent relationships of risk constructs could improve their assessment and/or prioritization. Furthermore, the FSE analysis only prioritizes the risk constructs and factors based on their importance, but it does not offer the performance of the risk constructs and factors on the dependent construct. Thus, importance-performance analysis is not feasible with the FSE technique Moreover, with the FSE, relationships cannot be established between the risk constructs (the independent constructs) and the SDGs in housing (the dependent construct). Although traditional multiple regression (TMR) analysis could be deployed to solve this problem in FSE, it is only applicable if there is only one dependent variable.

Besides, TMR is not appropriate for measuring latent variables. Notwithstanding the evolution of fussy logic techniques such as fuzzy DEMATEL to solve some of the problems in FSE (Addae et al., 2019), measuring the significance of the relationships (i.e. the cause-effect relationships) among risks remains problematic with this approach. Consequently, other analytical techniques have been adopted to study the interactive relationships among risk constructs and project objectives.

Studies have employed interpretive structural modelling (ISM) as an analytical technique for investigating interdependencies among risks and project goals (Etemadinia & Tavakolan, 2018; Kwak et al., 2018; Guan et al., 2020). For instance, Guan et al. (2020) used ISM to determine binary interrelationships among project objectives, constraints and risks in green building projects. The findings (*ibid*) showed a hierarchical network structure of the objectives, constraints and risks. Despite their study's relevance, Guan et al. (2020) acknowledged a limitation with the use of ISM viz: "The strength of risk interdependencies needs to be explored based on a green building project risk network for a more accurate risk assessment" (Guan et al., 2020, p. 15). Thus, the strength or the level of significance of the risk interdependencies could not be determined in their study. Based on these limitations, Kim et al. (2009) concluded that risk interactive networks generated by structural equation modelling (SEM) provide better performance on assessing interdependencies among risks and project goals. Accordingly, a study by Ahmadabadi & Heravi (2019) is one of the recent studies that used a type of SEM – PLS-SEM – to model risk interaction and project success in public private partnership projects. However, modelling the interdependencies among risks and the SDGs in housing remains a knowledge gap in extant literature.

In summary, limitations are apparent within the statistical analyses employed in previous studies. Therefore, this study adopts the PLS-SEM to assess the interdependencies among risks (a limitation of the FSE) and evaluate causal relationships/interactions between risks and more than one dependent variable (project goals) (a limitation of the TMR analysis). Moreover, with PLS-SEM, the strength of risk interdependence can be evaluated, which is a caveat in the ISM. Given the many UN SDGs in housing (e.g. price/rental affordability, energy efficiency and reduced commuting cost), this study seeks to establish a linear relationship between these goals and risk clusters to identify those that could influence the attainment of the goals. The study also provides a novel analysis of the relationships among the various risk constructs. This is essential for identifying critical risk constructs and for establishing possible causal relationships among them. Finally, in addition to estimating the total effect of risk factors, the PLS-SEM provides their performance estimates. Such estimates are prerequisite for decision making on improving the attainment of the target goals. Table 1 contains a list of some of the sustainable housing goals and the risk factors under their respective constructs.

Table 1: Summary of Literature on Sustainable Housing Goals (Measured by CSC) and Risk Factors

Latent Variables / Constructs	Code	Observable Variables / Indicators	Sources
Sustainable Housing (Measured by CSC)	CSC01	Timely completion of project	Adapted from Adabre & Chan (2018) Chan & Adabre (2019) Guan et al. (2020) Ahmadabadi & Heravi (2019) Cruz et al. (2019); Yang et al. (2016)
	CSC02	Construction cost performance of housing facility	
	CSC03	Quality performance of project	
	CSC04	Safety performance	
	CSC05	End user's satisfaction with the housing facility	
	CSC06	Project team satisfaction with the housing facility	
	CSC07	Environmental performance of housing facility (Eco-friendly)	
	CSC08	Reduced life cycle cost of housing facility	
	CSC09	Maintainability of housing facility	
	CSC10	Energy efficiency of housing facility	
	CSC11	Reduced occurrence of disputes and litigation	
	CSC12	Reduced public sector expenditure on managing housing facility	
	CSC13	Functionality of housing facility	
	CSC14	Technical specification of housing	
	CSC15	Aesthetic view of completed house	
	CSC16	Price affordability of housing facility	
	CSC17	Rent affordability of housing facility	
	CSC18	Reduced commuting cost/distance from the location of housing to public facilities	
	CSC19	Technology transfer/innovation	
	CSC20	Take up rate of housing facility (marketability of housing facility)	
Risk Constructs			
Political and Procurement Risks	BCR	Bribery and corruption risk	Ameyaw & Chan (2015); Hwang et al. (2017)
	DPA	Delays in project approval	Ameyaw & Chan (2015); Lundin et al. (2015)
	ICR	Inadequate competition risk	Cheung & Chan (2011); Ahmadabadi & Heravi (2019)
	IPD	Inadequate project design	Fernandez-Dengo et al. (2012); Guan et a. (2020)
	LAR	Land acquisition risks	Osei-Kyei & Chan (2017); Boateng et al. (2015)
	PCR	Political continuity risk	Osei-Kyei & Chan (2017); Ameyaw & Chan (2015)
	PIR	Policy instability risk/inadequate government commitment	Osei-Kyei & Chan (2017); Fernandez-Dengo et al. (2012); Ameyaw & Chan (2015)
Financial-Related Risks	DPR	Delay payment risk	Zhao et al. (2016); Chileshe et al. (2012)

	FCF	Fluctuating cost of finance (interest rate fluctuations)	Ameyaw et al. (2015); Zhao et al. (2016)
	IFI	Inadequate financing institutions	Hwang et al. (2017); Ameyaw & Chan (2015)
	IRV	Inflation rate volatility	Osei-Kyei & Chan (2017); Hwang et al. (2017)
	LOC	Litigation over claims payment	El-Sayegh & Mansour (2015); Lundin et al. (2015)
Design and Construction Risks	CDR	Construction defects/deficiencies	Ameyaw & Chan (2015)
	COR	Cost overrun risk	Ameyaw & Chan (2015); Chileshe et al. (2012)
	DCV	Design and construction variation orders/alteration/rework due to construction variation	Fernandez-Dengo et al. (2012); Hwang et al. (2017)
	FME	Force majeure events	Chileshe et al. (2012); Wuni et al. (2020)
	TOR	Time overrun risk	Ameyaw & Chan (2015); Grant et al. (2019)
Operations and Maintenance Risks	FDR	Fluctuating demand risks	Grant et al. (2019); Cheung & Chan (2011)
	IIR	Inadequate infrastructure risks	Grant et al. (2019); Ameyaw & Chan (2015)
	OCO	Operating cost overruns	Ameyaw & Chan (2015); Grant et al. (2019)
	PRR	Privatization risk (i.e. selling of rental stock)	Taruvinga & Mooya (2018); Grant & Yankson (2003)

2.2 Establishing a Conceptual Model

The literature review provided the basis for developing a conceptual model between the sustainable housing construct (measured by CSC) and four risk constructs (refer to Fig. 1). This conceptual model provides a network of constructs that offers a thorough understanding of how the potential risk constructs could influence one another and the sustainable housing CSC. From the conceptual model, ten hypotheses were developed and were based on the number of possible relationships among the risk constructs, and between the risk constructs and the sustainable housing construct. Fig. 1 reveals that every path or line between constructs represents a hypothesis. The hypotheses among the risk constructs depict the impact of a risk construct from one phase of a project on another starting with risks at the tendering stage, resource mobilization (mostly financial-related), project construction and operation and maintenance of the project. These stages are typical in Ghana. Therefore, the 'political and procurement risks' construct (which mostly occur at the project tendering stage) could affect subsequent stages such as project construction and operation of the facility. However, risk constructs at the later stages such as 'operation and maintenance risks' construct may not be able to influence the 'political and procurement risks' construct since it precedes 'the operation and maintenance risks' construct in time. Thus, 'political and procurement risks' could influence 'operation and maintenance risks' and not vice-visa. These unilateral directions of the impact of a risk construct on another have also been established in Yuan et al. (2018). Yet, with a different statistical analysis, future study could investigate the impact in both directions, especially between the 'financial-related risks' and the 'design and construction risks' constructs. The arrow line (refer to Fig. 1) represents the direction of the hypothesized impact of a construct on another construct. The resulting hypotheses regarding the formal sector of the Ghanaian housing market include:

Hypothesis 1: 'political and procurement risks' have a significant impact on 'financial-related risks' because they cause or lead to the events of 'financial-related risks'. This assertion is true if the hypothesis is valid. Otherwise, 'political and procurement risks' do not have any relationship and do not lead to 'financial-related risks'.

Hypothesis 2: 'political and procurement risks' have a significant impact on 'design and construction risks' because they are risk sources that cause the 'design and construction risks' events. This statement is true if the hypothesis is valid. If the hypothesis is null, then 'political and procurement risks' do not have any relationship and do not lead to 'design and construction risks'.

Hypothesis 3: 'political and procurement risks' have a significant impact on 'operation and maintenance risks'. If this hypothesis is valid, then 'political and procurement risks' cause the 'operation and maintenance risks'. However, if the hypothesis is null, then it will imply that 'political and procurement risks' do not have any relationship and do not lead to 'operation and maintenance risks'.

Hypothesis 4: 'financial-related risks' have a significant impact/influence on 'design and construction risks'. Therefore, 'financial-related risks' cause or lead to the events of 'design and construction risks' provided the hypothesis is supported. Otherwise, 'financial-related risks' do not have any relationship and do not lead to 'design and construction risks'.

Hypothesis 5: 'financial-related risks' have a significant impact/influence on 'operation and maintenance risks'. Thus, 'financial-related risks' cause or lead to the events of 'operation and maintenance risks' on condition that the statement is valid. Otherwise, 'operation and maintenance risks' are not dependent on / caused by 'financial-related risks'.

Hypothesis 6: 'design and construction risks' have a significant impact/influence on 'operation and maintenance risks'. That is, 'design and construction risks' are the sources or causes of the occurrences of 'operation and maintenance risks'. This claim is true if the hypothesis is valid. If the assertion is null, then the events of 'operation and maintenance risks' are not dependent on 'design and construction risks'.

Hypothesis 7: 'political and procurement risks' have a significant impact/influence on 'sustainable housing'. If this statement is valid, then 'political and procurement risks' influence the attainment of the sustainable housing goals in Ghana. Otherwise, 'political and procurement risks' have no effects on the goals and may not be critical for the attention of policymakers in the pursuit of the UN SDGs in housing.

Hypothesis 8: 'financial-related risks' have a significant impact/influence on 'sustainable housing'. Thus, 'financial-related risks' negatively influence the attainment of the sustainable development goals or CSC of sustainable housing provided the hypothesis is valid. If the claim is null, it will imply that 'financial-related risks' do not have any direct impact on the CSC of sustainable housing, and they may not be critical in decision for sustainable housing in the formal sector of the Ghanaian housing market.

Hypothesis 9: 'design and construction risks' have a significant impact/influence on 'sustainable housing'. Accordingly, 'design and construction risks' influence the attainment of the sustainable development goals provided the hypothesis is valid. Otherwise, it will imply that 'design and construction risks' do not have any direct influence on CSC of sustainable housing, and the risks may not be critical in decision making for sustainable housing in the Ghanaian housing market.

Hypothesis 10: 'operation and maintenance risks' have a significant impact/influence on 'sustainable housing'. That is, 'operation and maintenance risks' influence the attainment of the sustainable development goals or CSC if the hypothesis is confirmed. If not, then 'operation and maintenance risks' do not have any direct influence on CSC of sustainable housing, and they may not be critical in decision for sustainable housing in the formal sector of the Ghanaian housing market.

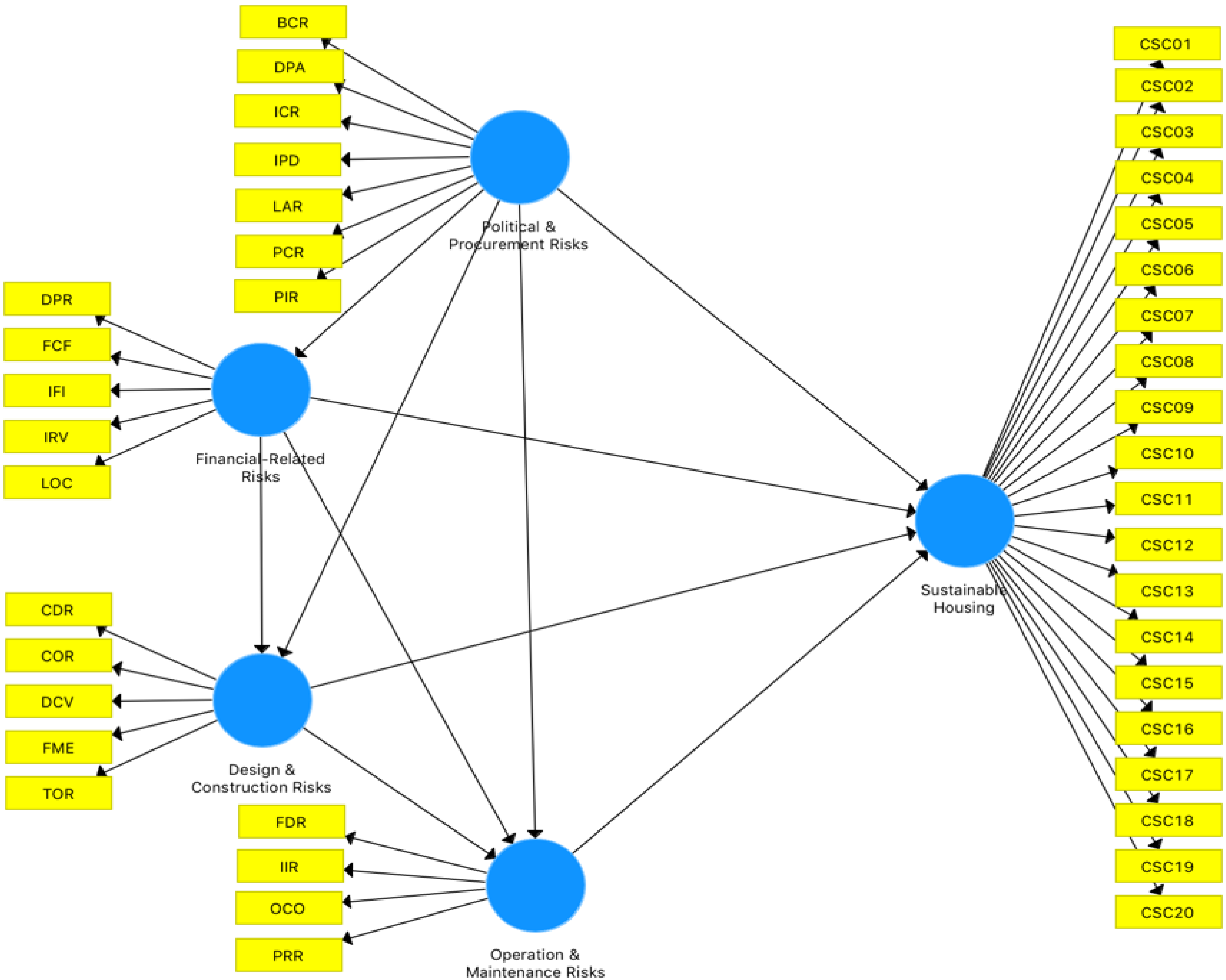

Fig. 1: A Conceptual Model on the Influence of Risk Constructs on Sustainable Housing

3. Research Method

The epistemological positioning of the research was couched within a postpositivist philosophical stance and deductive reasoning to test hypothesis generated from extant literature. This empirical design has been widely utilized within contemporary construction management literature to, for example: conduct post-occupancy evaluation (GTbPOE) of dormitory building performance (Hou et al., 2020); evaluate the challenges of smart city development in developing countries (Aghimien et al., 2020); and measure hand-arm vibration exposure in the utilities industry (Edwards et al., 2020). From an operational perspective, primary data was sourced from a closed-ended questionnaire and modelled using PLS-SEM. This robust scientific approach to data analysis has been previously validated in a plethora of published articles viz: to model the safety behavior of construction workers (Zaira and Hadikusumo, 2017; Adinyira et al. 2020); measure occupational stress and determine mitigation measures (Bowen et al., 2014); and model organizational justice and cooperative behavior in the construction project claims process (Aibinu et al., 2011). Cumulatively, this body of knowledge justifies the approach adopted for the present study.

3.1 Questionnaire Design

A closed-ended questionnaire was adopted because it offers inherent cost-effectiveness over alternative approaches and can expedite quantitative data collection (cf. Gillham, 2015). The questionnaire was structured into five sections. Section one collected demographic profile data of respondents. Section two presents a list of the SDGs on housing (also known as CSC and sourced from literature) to respondents who rated the level of importance of the CSC using a five-point Likert scale (1=not important; 2=less important; 3=neutral; 4=important; 5=very important). Based on the CSC, section three invited respondents to assess both the likelihood of occurrence and severity of impact of a set of risk factors. Similarly, a five-point Likert scale (1=very low; 2=low; 3=medium; 4=high and 5=very high) was provided for respondents to rate the risk factors. Section four invites respondents to rate their level of criticality of barriers presented in hindering the attainment of the CSC. Section five invites respondents to rank the importance of a list of policies or interventions which are relevant for mitigating the risk and barriers while attaining the CSC. While the questionnaire consisted of five sections, this study reports only the findings on the CSC and risks. Prior to the survey, the questionnaire was piloted among four experts in the Ghanaian housing market, each of whom have at least five years of industrial experience and have conducted various studies on Ghanaian housing. Following the experts' feedback, the questionnaire was revised and finalized for the main survey data collection.

3.2 Population and Sampling

The survey population includes respondents from the Ghanaian housing market's formal sector which includes construction professionals from recognized institutions and private developers. These institutions include: Public Works Department (PWD); Ministry of Water Resources, Works and Housing (MWRWH); State Housing Cooperation (SHC); Tema Development Cooperation (TDC); Social Security and National Insurance Trust (SSNIT); Architectural and Engineering Service Limited (AESL); Building and Road Research Institute (BRRI) and Ghana Real Estate Developers Association (GREDA). Because no comprehensive list of members within these institutions exist, the study's population could not be determined and probability sampling could not be conducted. Due to this prevailing limitation, non-probability sampling techniques (i.e. purposive sampling and snowballing) were deemed appropriate as sampling techniques adopted. The limitation of a non-probability sampling method is sample bias – because there is no way to determine whether the sample is truly representative of the population. However, non-probability samples are well established within established literature and can be used where a population cannot be defined. The focus must be to preserve appropriate management of the process using strategies to control sampling bias and generate non-biased data (as far as is reasonably practicable). To ensure the data were obtained from different potential respondents of the population, we first identified the institutions that broadly constitute the population for the study. Then, strategies were deployed for collecting data from different respondents from the varied institutions.

3.3 Questionnaire Administration / Data Collection

Regarding data collection, a questionnaire survey was conducted with much consideration to the timing of the questionnaire administration. The questionnaire was strategically administered at the Annual General Meeting (AGM) of the Ghana Institutions of Surveyors (GhIS), which was held on 2nd March 2019 at the Ghana Institute of Management and Public Administration (GIMPA) in Accra, where most employees of the regulated housing institutions gather annually. The members of the Ghana Institution of Surveyors are made up of three divisions: the quantity surveying division; general practice division (valuation); and the land surveying division. Employees of the regulated institutions who are professional members of the Ghana institutions of surveyor are required to attend the AGM. Therefore, most of the respondents were identified at the AGM by first introducing them to the research and its purpose prior to questionnaires administration. Since some of the professionals like architects and planners are likely not to attend this AGM, the researchers visited the offices of the regulated institutions such as PWD; MWRWH, SHC, TDC, SSNIT; GREDA, AESL and BRRI. Through such visits, the questionnaires were administered to other potential respondents. A brochure containing the list of private developers, together with their telephone numbers and emails addresses, was obtained from the office of GREDA. Phone calls to 40 developers were conducted; most developers (i.e. < 12) who target middle-income category of households participated in the survey based on their availability and willingness. The questionnaire was emailed to them with a further request for them to forward it to other potential survey respondents. In addition, face-to-face administration of the questionnaire was conducted. Thus, the timely administration of the questionnaire was adopted to ensure that most members of the population are selected in order to avoid sampling bias as well as biased data. Within a three-month duration, 47 valid questionnaires were retrieved in all out of a total of 110 administered questionnaires – representing a 42.7% response rate.

Although the PLS-SEM is not sensitive to sample size compared with the covariance-based SEM (cf. Aibinu & Al-Lawati, 2010), adequate sample size was assured by meeting some basic requirements. First, Ott & Longnecker (2015) suggest that a minimum sample size of 30 is required to meet the central limit theorem. Therefore, a sample size of 47 was appropriate to achieve the central limit theorem requirement and could be a representative sample for statistical analysis. Second, at least one of the following requirements was achieved (cf. Hair et al., 2011 cited in Ahmadabadi & Heravi, 2019). By a 'rule of thumb', the required number of samples is estimated to be 10 times more than the maximum value of the following two criteria: 1) maximum number of relationships between a latent construct and the observant variable; 2) maximum number of relationships between a latent construct and other latent constructs. For instance, based on the second requirement, there are five latent constructs in this study, and a latent construct can form a maximum of four relationships with the other constructs. Thus, a sample size of 40 is required for the data analysis. The sample size for this study is higher (i.e. 47) and is therefore, suitable for the PLS-SEM analysis.

3.4 PLS-SEM Technique for Data Analysis

SEM was adopted because of the limitations of other methods/techniques (i.e. FSE and TMR). Moreover, in conducting a questionnaire survey, errors could occur in the data collection e.g., random errors, attributed to possible respondents' fatigue and the order of the variables, are common in questionnaire surveys. However, SEM is a robust multivariate statistical technique that is appropriate for controlling these errors during data analysis (Haenlein & Kaplan, 2004). It is also suitable for simultaneously assessing the relationships among the various risks constructs and the relationships between the risk constructs and sustainable housing. Consequently, all the stated hypotheses (refer to Fig. 1) could be tested. To test the hypotheses in SEM, two main models were established, namely, a measurement model and a structural model. The relationship between a construct and its indicators is known as the measurement model. However, the relationships among the risk constructs and the relationships between the risk constructs and the sustainable housing construct constitute the structural model.

In the measurement model, the constructs' indicators could be measured either as formative indicators or reflective indicators. Indicators that are highly correlated with one another can be measured as reflective indicators - otherwise, they are measured as formative indicators. Prior studies by Ameyaw & Chan (2015) and Chan & Adabre (2019) indicated that the risk factors and the CSC respectively, are correlated with one another. Therefore, all the indicators of the risk constructs and the sustainable housing construct were specified as reflective indicators before performing SEM. To conduct SEM on the garnered data, covariance-based (CB-SEM) or partial least square (PLS-SEM) could be used. CB-SEM is appropriate if the collected data are large (> 200) and are normally distributed. However, in a situation where hypotheses are to be tested (prediction) with relatively small size of non-normally distributed data, the PLS-SEM is more apposite.

PLS-SEM data analysis was carried out by assessing the adequacy of the measurement model using reliability and validity analyses. The measurement model was first established by conducting a confirmatory factor analyses to confirm that the classification of the indicators concurs with their constructs. High factor loadings of the indicators verified previous classification of risk factors in the Ghanaian construction industry (Ameyaw & Chan, 2015; Osei-Kyei & Chan, 2017). Composite reliability and Cronbach's alpha were then determined to assess data reliability. According to Nunnally (1978), estimated values of both measures should be at least 0.7 for adequate data reliability. On data validity, construct validity was measured using convergent validity and discriminant validity. Convergent validity examines if the indicators measure the constructs as theorized in Fig. 1. Factor loadings of the indicators and average variance extracted (AVE) of the constructs serve as assessments of convergent validity. This validity is achieved if both factor loadings of the indicators and AVE of constructs are at least 0.50 (Hair et al., 2014; Fornell & Larcker, 1981). Discriminant validity measures the level to which the indicators of the risk constructs are distinct. To assess the discriminant validity, Fornell & Lacker criterion, cross loading of measurement items and the heterotrait-monotrait (HTMT) ratio of correlation analyses were conducted. According to the Fornell & Lacker criterion, the variance between the same construct should be the highest when compared with the variance between the construct and any other construct (Darko et al., 2018). For the indicator's cross loading approach, an indicator really measures its hypothesized construct if it has the highest loading in that construct when compared to its loadings in other constructs. Assessment by the HTMT is based on comparing the HTMT results with a predetermined value.

After the assessment of the measurement model, the structural model was specified. This was followed by an assessment of the structural model using the variance inflation factor (VIF) which checks for the presence of multicollinearity in the model. If all the VIF values are < 5.00, then there is no multicollinearity in the model. Test of significance of the structural model was achieved through bootstrapping once data normality was evaluated using the Mardia's Multivariate skewness and kurtosis.

4. Data Analysis and Results

4.1 Profile of Respondents

Descriptive analysis of the respondents' profile showed that 47.9% of them are employed in the public sector, 35.4% in academic institutions and 16.7% as private developers. Most of the respondents (55.3%) were quantity surveyors, 19.2% were architects and 12.8% were construction managers while the remaining (12.7%) included other professionals such as planners and engineers. Regarding the number of housing projects handled, the majority of respondents (52.2%) indicated that they have handled at least two housing projects in the Ghanaian housing market, most of which (55.1%) are public or state housing projects. Regards the respondents' years of working experience, 63.9% have > five years of work experience. Based on the respondents' profile, it can be concluded that they are well-informed of the Ghanaian housing market and therefore, could offer the required data for modelling the impact of risk constructs on sustainable housing.

4.2 Descriptive and Reliability Analysis

Table 2 presents the indicators of the risk constructs - the mean scores and standard deviations were calculated for the likelihood of occurrence (LO) and severity of impact (SI) of the risk factors. Using the mean scores of the LO and the SI, the magnitude of impact (MI) of each risk factor was determined by means of eqn. 1. For the content validity of the risk factors, Cronbach's alpha values of 0.935 and 0.928 were estimated for both the LO and SI, respectively. Since these values are > the recommended threshold of 0.700, the content validity of the risk factors was confirmed as adequate.

$$MI_i = \sqrt{LO_i \; X \; SI_i} \quad \text{……………………………………………………..eqn. (1)}$$

For the sustainable housing construct, the mean scores of all its indicators revealed that respondents regarded the indicators as important, since their mean scores are above the categories of *less important* (≤ 2) and *neutral* (≤ 3). The low standard deviations (i.e. SD < 1.000) for most of the indicators reveal a high level of consistency among the respondents in rating the indicators. The 'corrected item-total correlation' and 'Cronbach's alpha if item deleted' were estimated for only indicators of the sustainable housing construct. These statistics are relevant for assessing the contribution of each indicator to the content validity of the sustainable housing construct (Adabre & Chan, 2020b). The overall Cronbach's alpha of the CSC is 0.876, which is > the threshold (i.e. 0.700). This further supports the relevance of all the sustainable housing CSC.

Table 2: Descriptive Statistics of Constructs and Indicators of Risks and Sustainable Housing

Constructs of Risk Factors	Indicators	Likelihood of Risk Occurrence (LO)		Severity of Impact of Risk (SI)		Magnitude of Risk Impact (MI) $\sqrt{(LO \times SI)}$	Ranks of Indicators
		Mean	SD	Mean	SD		
Political and Procurement Risks	BCR	4.041	1.077	4.002	1.051	4.021	7
	DPA	3.364	1.052	3.368	1.100	3.366	20
	ICR	3.390	1.128	3.477	0.987	3.433	18
	IPD	3.702	1.144	3.781	1.158	3.741	12
	LAR	4.081	0.941	4.039	0.831	4.060	5
	PCR	3.760	1.091	4.062	1.071	3.908	9
	PIR	3.721	0.869	3.840	0.914	3.779	11
Financial-Related Risks	DPR	4.462	0.738	4.401	0.681	4.431	1
	FCF	4.367	0.694	4.309	0.663	4.338	2
	IFI	3.944	0.734	3.934	0.824	3.939	8
	IRV	4.231	0.830	4.118	0.785	4.174	3
	LOC	3.742	1.066	4.031	0.998	3.884	10
Design and Construction Risks	CDR	3.349	1.008	3.632	0.943	3.487	17
	COR	4.138	0.913	4.188	0.898	4.163	4
	DCV	3.561	0.935	3.740	0.926	3.649	14
	FME	3.140	1.173	3.371	1.169	3.253	21
	TOR	4.000	0.803	4.084	0.988	4.042	6
Operation and Maintenance Risks	FDR	3.622	0.929	3.757	0.988	3.689	13
	IIR	3.537	0.840	3.602	0.967	3.569	15
	OCO	3.369	1.030	3.263	0.974	3.316	19
	PRR	3.621	1.043	3.530	1.108	3.574	15

Sustainable Housing Construct	Code	Mean	SD	Corrected Item-total correlation	Cronbach' Alpha if Item is Deleted	Overall Cronbach's Alpha	Ranks of Indicators
Timely completion of project	CSC01	4.340	0.815	0.378	0.875	0.878	3
Construction cost performance of housing	CSC02	4.468	0.584	0.231	0.878		1

Project						
Quality performance of project	CSC03	4.343	0.644	0.496	0.872	2
Safety performance	CSC04	4.085	0.803	0.654	0.867	11
End user's satisfaction with the housing facility	CSC05	4.319	0.980	0.646	0.866	4
Project team satisfaction with the housing facility	CSC06	3.957	0.833	0.385	0.875	12
Environmental performance of housing facility (Eco-friendly)	CSC07	4.085	0.803	0.380	0.875	10
Reduced life cycle cost of housing facility	CSC08	3.933	0.918	0.502	0.872	14
Maintainability of housing facility	CSC09	4.283	0.851	0.566	0.869	6
Energy efficiency of housing facility	CSC10	3.915	0.880	0.547	0.870	15
Reduced occurrence of disputes and litigation	CSC11	3.660	1.027	0.469	0.873	19
Reduced public sector expenditure on managing housing facility	CSC12	3.851	0.932	0.377	0.876	17
Functionality of housing facility	CSC13	4.174	0.789	0.567	0.870	8
Technical specification of housing	CSC14	4.128	0.824	0.563	0.870	9
Aesthetic view of completed house	CSC15	3.913	0.717	0.363	0.876	16
Price affordability of housing facility	CSC16	4.298	0.749	0.393	0.875	5
Rent affordability of housing facility	CSC17	4.196	0.824	0.472	0.872	7
Reduced commuting cost/distance from the location of housing to public facilities	CSC18	3.787	0.999	0.582	0.869	18
Technology transfer/innovation	CSC19	3.468	0.856	0.621	0.868	20
Take up rate of housing facility (marketability of housing facility)	CSC20	3.936	0.818	0.264	0.879	13

4.3 Results of the PLS-SEM Data Analysis

4.3.1 Results of the Measurement Model

Smart PLS version 3.2.7 was used for modelling the data collected. In establishing the measurement model, the factor loadings of some indicators were < the required 0.50. Therefore, such indicators were deleted, and the analysis was repeated. The iteration of the analysis continued until a valid and reliable measurement model was obtained. Table 3 presents the results of the measurement model; each of the factor loadings of the indicators and the AVE of the constructs are > the recommended 0.50 for data validity. Furthermore, the composite reliability and the Cronbach's alpha are > the 0.70 minimum required for convergent validity therefore, the measurement model's validity is deemed acceptable.

Table 3: Measurement Model Results

Constructs	Indicators	Loadings[a]	AVE[b]	CR[c]	CA[d]
Political and Procurement Risks	BCR	0.652	0.542	0.853	0.828
	ICR	0.765			
	IPD	0.832			
	PCR	0.567			
	PIR	0.829			
Financial-Related Risks	DPR	0.618	0.566	0.837	0.745
	FCF	0.840			
	IFI	0.762			
	IRV	0.769			
Design and Construction Risks	CDR	0.739	0.559	0.863	0.805
	COR	0.848			
	DCV	0.677			
	FME	0.684			
	TOR	0.777			
Operation and Maintenance Risks	FDR	0.700	0.559	0.833	0.792
	IIR	0.585			
	OCO	0.859			
	PRR	0.815			
Sustainable Housing	CSC04	0.741	0.525	0.885	0.862
	CSC05	0.672			
	CSC09	0.795			
	CSC10	0.581			
	CSC13	0.749			
	CSC14	0.746			
	CSC18	0.680			
	CSC19	0.750			

Items removed: indicators are below 0.5 factor loading: LAR, DPA, LOC, CSC01, CSC02, CSC03, CSC06, CSC07, CSC08, CSC11, CSC12, CSC15, CSC20

a. All item loadings ≥ 0.5 shows indicator Reliability
b. All Average Variance Extracted (AVE) > 0.5 suggests Convergent Reliability
c. All Composite reliability (CR) > 0.7 implies internal consistency
d. All Cronbach's alpha (CA) > 0.7 indicates Reliability

4.3.1.1 Discriminant Validity Assessment

Table 4 presents the results of the discriminant validity assessment using Fornell and Lacker criterion. The results show that the highest correlations exist between the same constructs, which are indicated diagonally in the table. These correlations are higher than any correlations between the construct and any other construct. Thus, since the diagonal values are the highest in any column or row, the discriminant validity is considered satisfactory (Chin, 1998).

Table 4: Fornell and Lacker Criterion

Constructs	Political and Procurement Risks	Financial -Related Risks	Design and Construction Risks	Operation and Maintenance Risks	Sustainable Housing
Political and Procurement Risks	**0.736**				
Financial-Related Risks	0.447	**0.752**			
Design and Construction Risks	0.725	0.564	**0.747**		
Operation and Maintenance Risks	0.626	0.440	0.631	**0.748**	
Sustainable Housing	0.602	0.459	0.578	0.401	**0.724**

*The diagonal values are the square root of the AVE of the latent variables and indicate the highest in any column or row

4.3.1.2 Cross Loading of Indicators

The measurement model was further checked using the cross loadings of the indicators (refer to Table 5). Since all the indicators have the highest loadings in their hypothesized constructs, the discriminant validity was considered acceptable.

Table 5: Indicator Item Cross Loadings

Indicators	Political and Procurement Risks	Financial-Related Risks	Design and Construction Risks	Operation and Maintenance Risks	Sustainable Housing
BCR	**0.652**	0.518	0.464	0.333	0.301
ICR	**0.765**	0.192	0.509	0.443	0.357
IPD	**0.832**	0.342	0.579	0.380	0.442
PCR	**0.567**	0.232	0.308	0.282	0.430
PIR	**0.829**	0.352	0.705	0.727	0.621
DPR	0.300	**0.618**	0.497	0.332	0.305
FCF	0.385	**0.840**	0.453	0.422	0.404
IFI	0.283	**0.762**	0.405	0.311	0.267
IRV	0.361	**0.769**	0.317	0.228	0.389
CDR	0.571	0.269	**0.739**	0.424	0.465
COR	0.588	0.482	**0.848**	0.491	0.537
DCV	0.626	0.391	**0.677**	0.494	0.332
FME	0.483	0.485	**0.684**	0.380	0.444
TOR	0.433	0.473	**0.777**	0.563	0.374
FDR	0.410	0.330	0.347	**0.700**	0.226
IIR	0.309	0.229	0.200	**0.585**	0.247
OCO	0.547	0.382	0.586	**0.859**	0.443

PRR	0.551	0.353	0.627	**0.815**	0.248
CSC04	0.312	0.140	0.330	0.321	**0.741**
CSC05	0.330	0.352	0.345	0.200	**0.672**
CSC09	0.550	0.340	0.567	0.343	**0.795**
CSC10	0.296	0.407	0.371	0.349	**0.581**
CSC13	0.605	0.334	0.468	0.334	**0.749**
CSC14	0.485	0.401	0.531	0.323	**0.746**
CSC18	0.492	0.310	0.345	0.264	**0.680**
CSC19	0.305	0.409	0.414	0.200	**0.750**

*Bold value indicates that each indicator had the highest loading on its respective construct.

4.3.1.3 Heterotrait-Monotrait Ratio of Correlation (HTMT)

Finally, the discriminant validity was examined by using the results of the heterotrait-monotrait (HTMT) ratio of correlations (refer to Table 6). This form of assessment requires that the HTMT values should be compared with a predetermined threshold. Although different thresholds have been recommended in extant literature, this study adopted a value of 0.90 (($HTMT_{0.90}$) as proposed by Teo et al. (2008). Table 6 reveals that all the inter-construct correlations are < 0.90, which implies that the discriminant validity of the measurement model is again confirmed as satisfactory.

Table 6: Heterotrait-Monotrait Ratio of Correlation (HTMT)

Constructs	Political and Procurement Risks	Financial-Related Risks	Design and Construction Risks	Operation and Maintenance Risks	Sustainable Housing
Political and Procurement Risks					
Financial-Related Risks	0.584				
Design and Construction Risks	0.885	0.728			
Operation and Maintenance Risks	0.759	0.611	0.790		
Sustainable Housing	0.677	0.565	0.677	0.503	

4.3.2 Structural Model Estimation

Based on the measurement model's reliability and validity tests, it was concluded that the data are suitable for developing the structural model. Accordingly, path analysis was carried out among the risk constructs and the sustainable housing construct. The value between each path represents the path coefficient, which measures the level of influence of a construct on another. The higher the path coefficient between constructs, the higher the influence from a construct on the other. Path coefficients from 0.1 to 0.3 show weak impact, between 0.3 to 0.5 moderate impact and 0.5 to 1.0 strong influence (Murari, 2015). From the result of the structural model (refer to Fig. 2), the paths between 'political and procurement risks' and each of the constructs, namely, 'financial-related risks'; 'operation and maintenance risks'; and 'sustainable housing' show moderate impacts. Similarly, the path between 'financial-related risks' and 'design and construction risks' indicate moderate impact and likewise the path between 'design and construction risks' and 'operation and maintenance risks'.

However, a strong impact was revealed concerning the path between ‘political and procurement risks’ and ‘design and construction risks’ while the other path coefficients show weak influences (refer to Fig. 2).

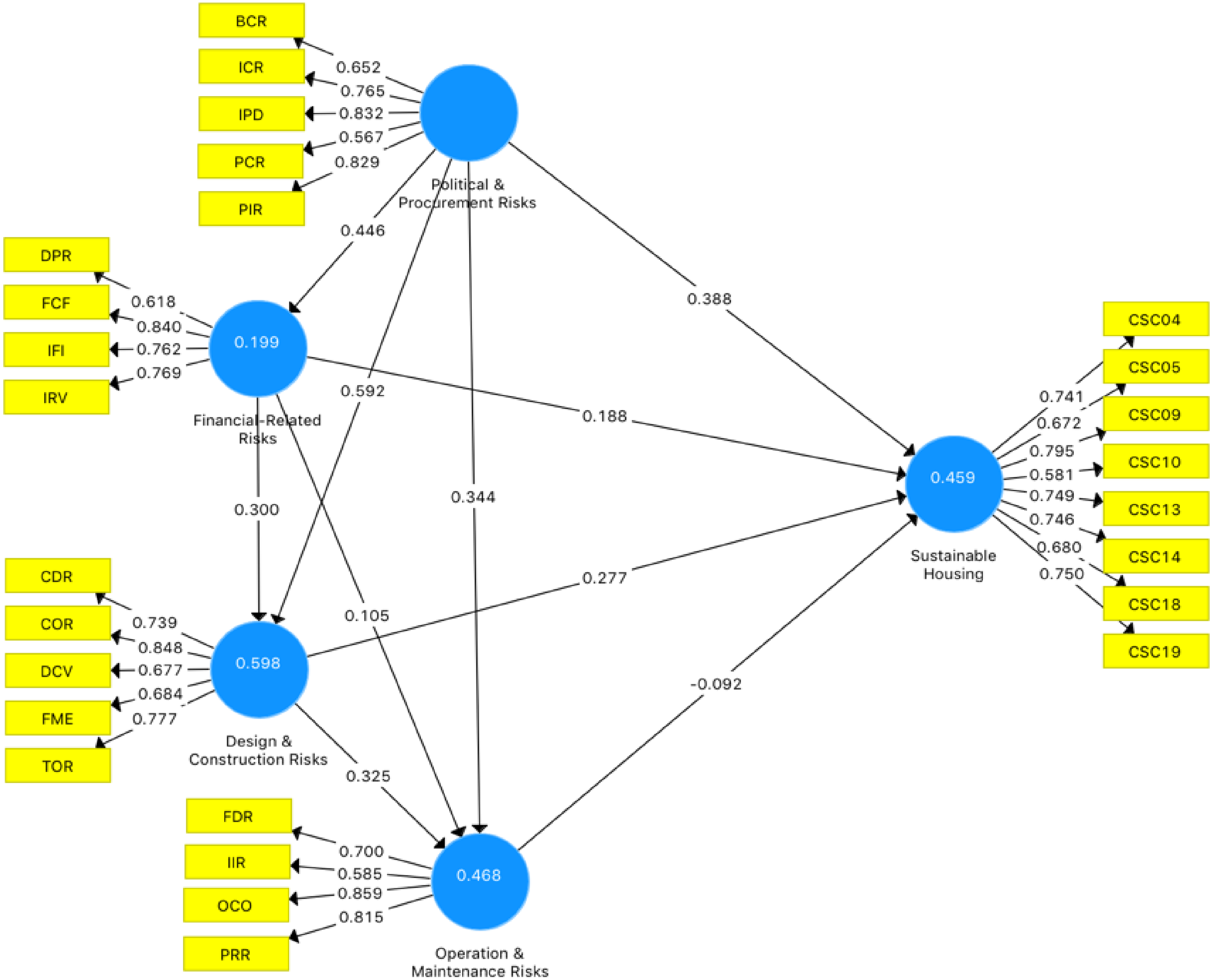

Fig. 2: Structural Model with Path Coefficient Values

4.3.2.1 Structural Model Assessment

A multicollinearity test of the structural model was conducted by checking the inner VIF. The VIF values were all < 5.00, which illustrate that multicollinearity was not a concern in the structural model. A further test of the structural model was carried out using the coefficient of determination (R^2) to determine total effect size and variance explained in the sustainable housing construct by the risk constructs. An R^2 value of 0.459 was obtained for the sustainable housing construct which according to Hair et al. (2014), is considered satisfactory. Furthermore, the significance of the paths in the structural model was tested. Prior to this test, data normality was examined using the Mardia's multivariate skewness and kurtosis. Values of 7.890 and 39.081 were obtained for Mardia's multivariate skewness and kurtosis, respectively. These values are > their respective cut-offs of ±1 and ±20, which are indications that the data are not normally distributed. Therefore, significance test of the paths or hypotheses was achieved through bootstrapping analysis which measures the direct effects of all the hypotheses (hypotheses 1 to 10). Results of the bootstrapping analysis are shown in Fig. 3 and Table 7. In Fig.3, the value in the path between constructs represents the t-value of each path. If a t-value is > 1.96 for a 2-tailed test, then the path (hypothesis) is significant at 0.05 ($t_{0.05} > 1.96$). If the t-value is > 2.58 for a 2-tailed test, the hypothesis is significant at 0.01 ($t_{0.01} > 2.58$) (Hair et al., 2014).

4.3.2.2 Validation of the Hypotheses

Among the 10 paths (hypotheses) tested, the path between 'political and procurement risk' and 'financial-related risks' was significant at 0.01 since its t-value (3.039) is > 2.58. Similarly, the paths between 'political and procurement risks' and 'design and construction risks' and the path between 'financial-related risks' and 'design and construction risks' are significant at 0.01 considering their respective t-values of 4.538 and 2.714. For t-values of 2.321 and 2.028 for the respective paths: 'political and procurement risks' -> 'sustainable Housing' and 'political and procurement risks' -> 'operation and maintenance risks', they are significant at 0.05. However, the other paths were neither significant at 0.01 nor 0.05.

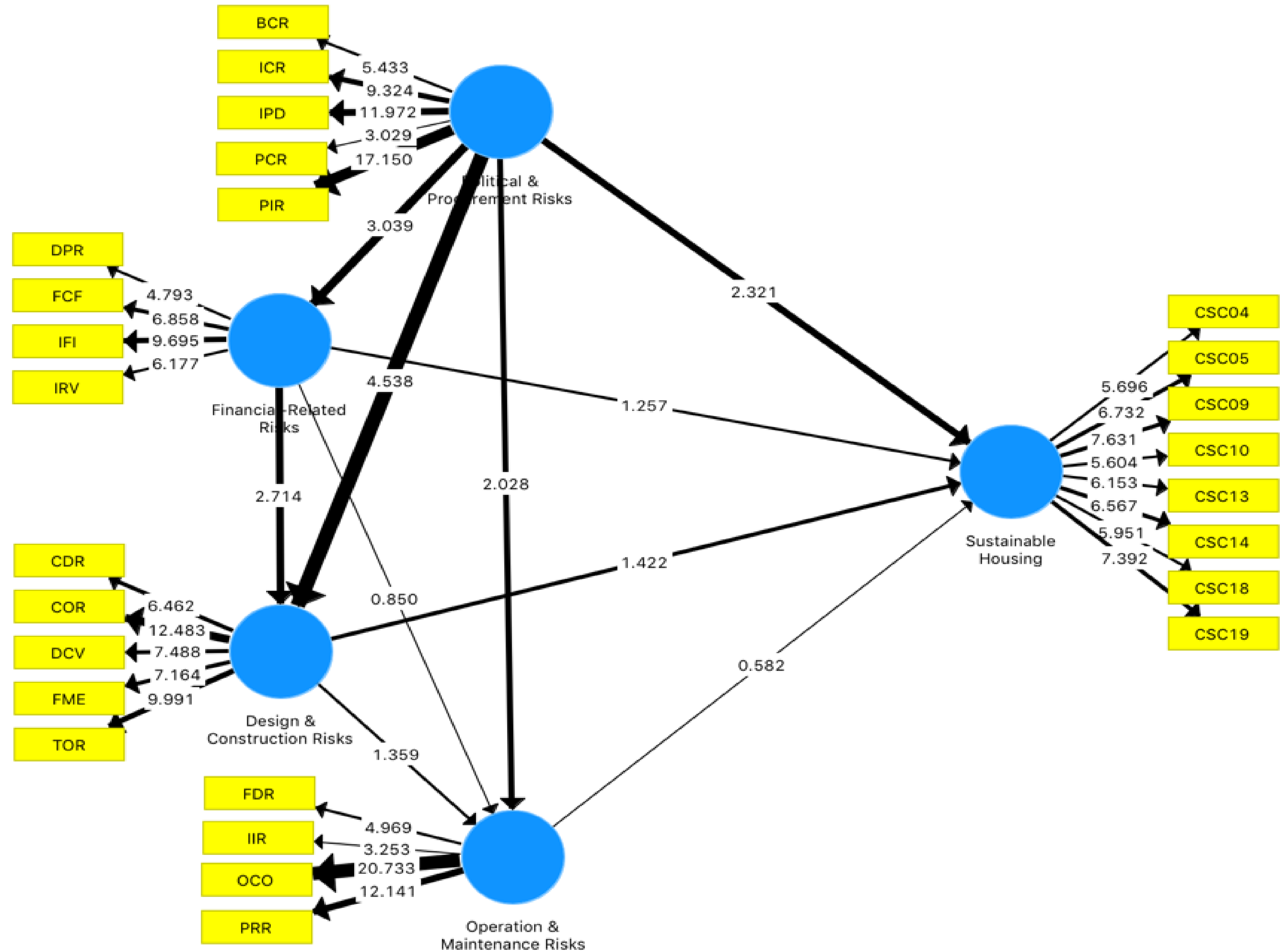

Fig. 3: Results of Bootstrapping Analysis of Structural Model

4.3.3 Assessing the Effect Sizes (f^2)

The influence or impact from one construct (i.e. independent construct) on another (i.e. dependent construct) was examined using effect size (f^2) - which is a measure of the strength of impact that a construct has on another construct in terms of R^2. The f^2 was measured by assessing the changes in R^2 to determine if there is a substantial impact on the sustainable housing construct from any of the risk constructs. Similarly, the f^2 was used to assess the level of impact among the risk constructs. This was achieved by estimating the structural model twice: once with a particular risk construct included (generating $R^2_{included}$) and then with the risk construct excluded (generating $R^2_{excluded}$). The $R^2_{included}$ and $R^2_{excluded}$ are the R^2 values of a dependent construct (i.e. a risk construct or the sustainable housing construct) when an independent construct is included or excluded from the model, respectively. Using the $R^2_{included}$ and $R^2_{excluded}$, the effect size can be calculated based on eqn. (2).

$$f^2 = (R^2_{included} - R^2_{excluded}) / (1 - R^2_{included}) \qquad \text{eqn. (2)}$$

The effect size of a construct is small if $0.02 \leq f^2 < 0.15$; medium, if $0.15 \leq f^2 < 0.35$ and large, if $f^2 \geq 0.35$ (Cohen, 2013). Table 7 illustrates that there is a strong effect size (0.672) for the path between 'political and procurement risks' and 'design and construction risks' while a moderate effect size was estimated for the path between 'political and procurement risks' and 'financial-related risks'. However, small effect sizes were determined for the other paths.

4.3.4 Assessing the Predictive Relevance (q^2)

The predictive relevance (q^2) was calculated to determine how well the indicators' values are reproduced by the structural model. Unlike the effect size calculation where constructs are omitted, in assessing the predictive relevance, the indicators are rather omitted. The assessment of the predictive relevance (q^2) is through blindfolding which omits data for a given block of indicators and then predicts the omitted part based on the calculated parameters (Akter et al., 2011). The predictive relevance can then be estimated using eqn. (3).

$$q^2 = (Q^2_{included} - Q^2_{excluded}) / (1 - Q^2_{included}) \qquad \text{eqn. (3)}$$

$$Q^2 = 1 - (\Sigma_D SSE_D) / (\Sigma_D SSO_D)$$

Where D is the omission distance, SSE is the sum of squares errors, and SSO represents the sum of squares total. To set D, the rule of thumb is $5 \leq D \leq 10$. Therefore, in conducting the blindfolding in smart PLS-SEM, a D value of 7 instead of 6 was selected considering that the total number of the loaded risk indicators is 18.

A construct's predictive relevance is small if $0.02 \leq q^2 < 0.15$; medium, if $0.15 \leq q^2 < 0.35$ and large, if $q^2 \geq 0.35$ (Cohen, 2013; Hair et al., 2014). The predictive relevance results of constructs are shown in Table 7. From the results, there is a medium predictive relevance for the path between 'political and procurement risks' and 'design and construction risks'. However, the predictive relevance values of the remaining paths are small.

Table 7: Direct Relationships for Hypothesis Testing

Hypothesis	Relationship	Std Beta	Std Errors	|t-value|^	Decision	f^2	q^2	95% CILL	95% CIUL	P-Values
H1	Political and Procurement Risks -> Financial-Related Risks	0.467	0.147	3.039**	Supported	0.248	0.112	0.210	0.684	0.002
H2	Political and Procurement Risks -> Design and Construction Risks	0.600	0.130	4.538**	Supported	0.672	0.216	0.348	0.770	0.000
H3	Political and Procurement Risks -> Operation and Maintenance Risks	0.332	0.170	2.028*	Supported	0.092	0.027	-0.003	0.577	0.043
H4	Financial-Related Risks -> Design and Construction Risks	0.303	0.110	2.714**	Supported	0.167	0.054	0.147	0.505	0.007
H5	Financial-Related Risks -> Operation and Maintenance Risks	0.117	0.123	0.850	Not Supported	0.008	-0.005	-0.058	0.361	0.396
H6	Design and Construction Risks -> Operation and Maintenance Risks	0.349	0.239	1.359	Not Supported	0.088	0.018	-0.071	0.763	0.175
H7	Political and Procurement Risks -> Sustainable Housing	0.358	0.167	2.321*	Supported	0.124	0.032	0.089	0.594	0.021
H8	Financial-Related Risks -> Sustainable Housing	0.181	0.150	1.257	Not Supported	0.035	0.006	-0.073	0.422	0.210
H9	Design and Construction Risks -> Sustainable Housing	0.342	0.195	1.422	Not Supported	0.037	0.013	0.024	0.670	0.156
H10	Operation and Maintenance Risks -> Sustainable Housing	-0.106	0.159	0.582	Not Supported	0.011	0.000	-0.379	0.143	0.561

p < 0.01 (2.58 (p < 0.01); *p < 0.05 (*1.96 (p < 0.05);
R^2 (Sustainable housing = 0.459)
Effect Size (f^2) are according to Cohen (2013), f^2 values: 0.35 (large), 0.15 (medium), and 0.02 (small)
Predictive Relevance (q^2) of predictor independent construct are according to Henseler et al (2009), q^2 values: 0.35 (large), 0.15 (medium), and 0.02 (small)

4.3.5 Importance-Performance Analysis (IPMA)

In addition to identifying critical risk constructs through the bootstrapping analysis, it is essential to assess the importance and the performance of these constructs on the target construct (i.e. the sustainable housing construct). This could enable decision makers to prioritize the risk constructs and factors based on their importance and potential contribution to the sustainable housing construct's performance if the risk constructs and factors are mitigated. Therefore, the 'importance-performance map analysis' (IPMA) was conducted. In Fig. 4, the x-axis "total effects" depicts the standardized path coefficients ('importance' or 'strength') of the various risk constructs (or risk factors as in Fig. 5) on the sustainable housing construct. The y-axis "sustainable housing" indicates the average values ('performance') of a risk construct (or risk factors as in Fig. 5) on the sustainable housing construct. The 'performance' values are between 0 and 100 (Ringle & Sarstedt, 2016).

Importance-performance maps were generated for two levels: at the construct level of the risks and at the indicator level of the risk factors. The construct level analysis was performed to identify the risk construct that has the highest importance and potential highest contribution to the sustainable housing construct. IPMA results reveal critical constructs as those that have high importance (high total effect) yet with relatively low performance score on the target construct. These constructs are essential for decision making. For instance, from Fig. 4, the 'political and procurement risks' construct has the highest importance / total effect (0.616) but it has a relatively low performance score (61.880). Therefore, for decision makers to improve sustainable housing in the Ghanaian housing market, this risk construct should be the target. This finding further confirms the results of the bootstrapping analysis from which only the 'political and procurement risks' construct has a significant impact on the 'sustainable housing' construct.

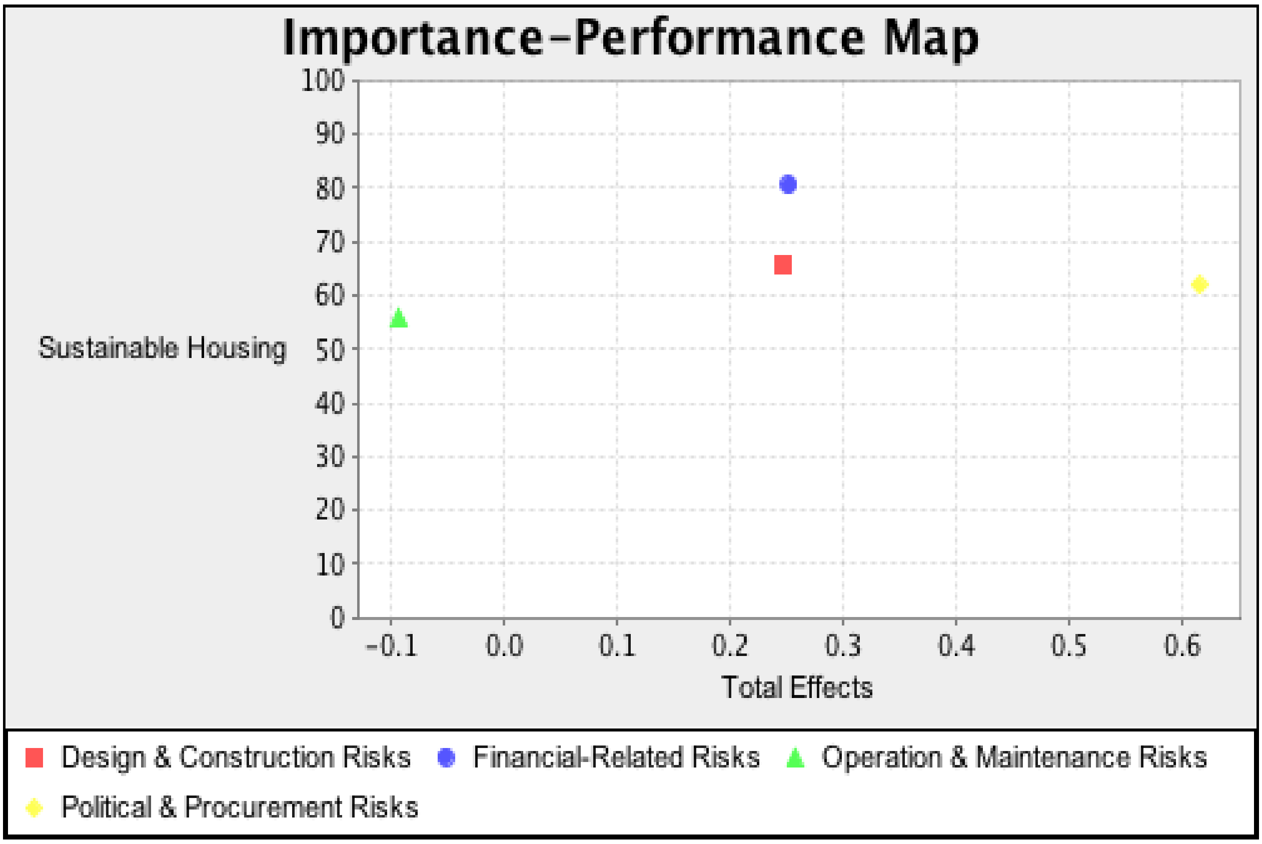

Fig. 4: Results of IPMA on Risk Constructs and Sustainable Housing

Although the construct level analysis of IPMA reveals the critical risk construct, it does not show the relative total effects and performance of the risk factors within the critical risk construct and the other risk constructs. IPMA analysis of the indicators is necessary for specific decision making on the risk indicators. Therefore, IPMA was performed at the indicators level (refer to Fig. 5). Given that δ_I is the maximum performance of an indicator on the target construct, which is 100 (as shown in Fig.5 on the *y* axis) and that the actual performance of an indicator is δ_a, then the potential performance of an indicator, δ_p is determined using eqn. 4. Table 8 reveals the estimated potential performances of all the indicators.

$\delta_p=\delta_I - \delta_a$ ………………………………..……………………………………….....eqn. (4)

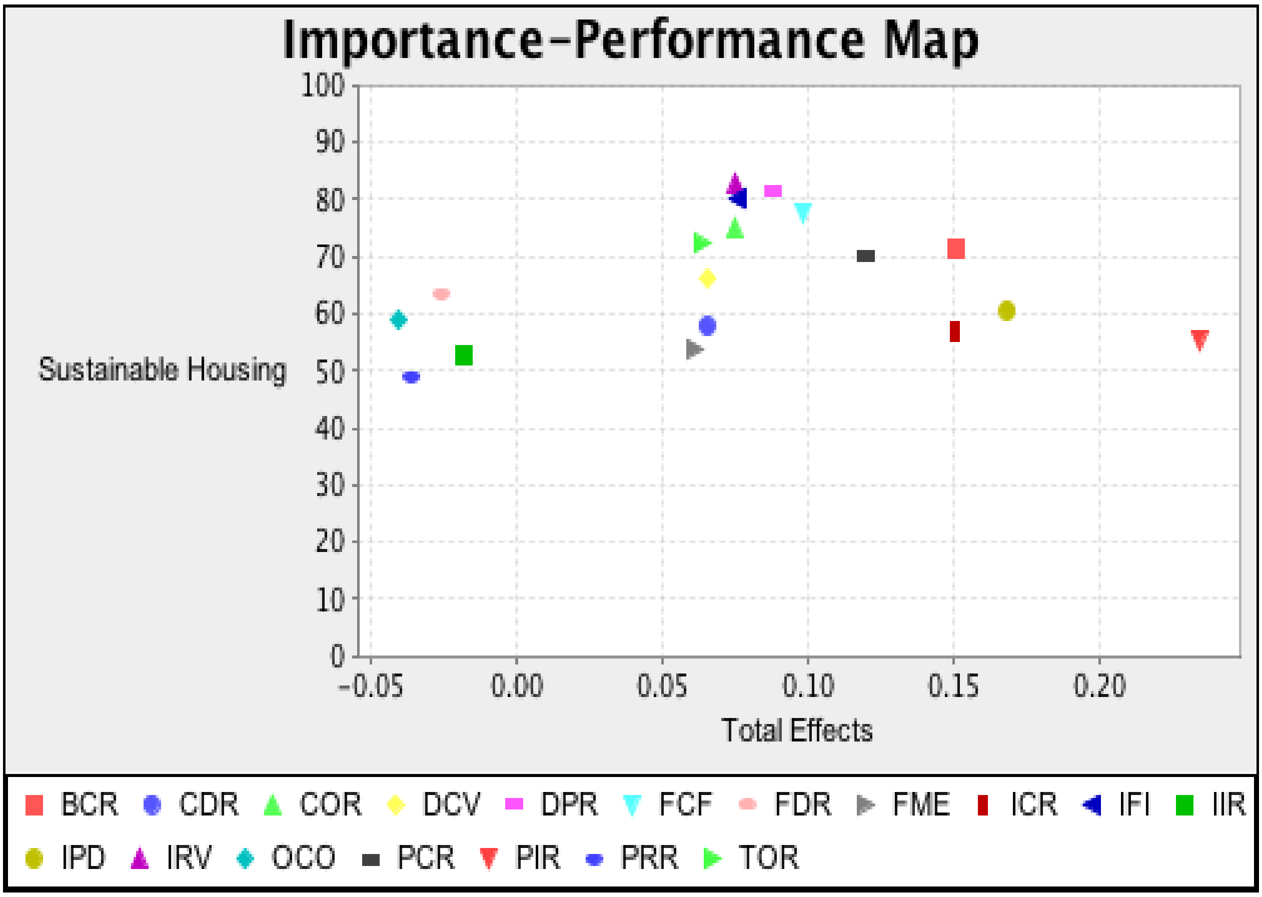

Fig. 5: Results of IPMA on Risk Indicators and Sustainable Housing

Table 8: Total Effect, Actual Performances and Potential Performance of Indicators

Risk Indicators / Risk Factors	Total Effect (Importance)	Performance (δ_a)	Potential Performance (δ_p) $=\delta_I - \delta_a$
BCR	0.151	71.111	28.889
CDR	0.065	57.778	42.222
COR	0.075	75.000	25.000
DCV	0.066	66.111	33.889
DPR	0.088	81.667	18.333
FCF	0.098	77.778	22.222
FDR	-0.026	63.333	36.667

FME	0.061	53.889	46.111
ICR	0.151	56.667	43.333
IFI	0.076	80.000	20.000
IIR	-0.018	52.778	47.222
IPD	0.168	60.556	39.444
IRV	0.075	82.778	17.222
OCO	-0.040	58.889	41.111
PCR	0.120	70.000	30.000
PIR	0.234	55.556	44.444
PRR	-0.036	48.889	51.111
TOR	0.063	72.222	27.778

From the IPMA results of the indicators (refer to Fig. 5 & Table 8), the prioritization of the indicators under the critical risk construct (i.e. political and procurement risks) is as follows: ‘policy instability risk’ (PIR) has the highest total effect but relatively low performance (high potential performance); this is followed by ‘inadequate project design’ (IPD); ‘inadequate competition risks’ (ICR); ‘bribery and corruption risks’ (BCR) and ‘political continuity risk’ (PCR). Thus, in descending order of potential performance, these are the risk factors that require much attention from local policymakers (i.e. the Ministry of Water Resources, Works and Housing, institutions such as AESL, PWD) and international policymakers (i.e. the United Nations and the World Bank) for sustainable housing in the Ghanaian housing market. The discussions of the results are presented in subsequent sections.

5. Discussion of Results

5.1 Sustainable Housing Construct

From the measurement model results of the sustainable housing constructs, eight indicators were significantly loaded, namely, 'safety – CSC04’; ‘user satisfaction – CSC05’; ‘maintainability – CSC09’; ‘energy efficiency – CSC10’; ‘functionality – CSC13’; ‘technical specification of housing facility – CSC14’; ‘reduced commuting cost of household – CSC18’ and ‘technology transfer/innovation – CSC19’(refer to Figs. 2 and 3). Thus, these are the main CSC of sustainable housing that could be affected by the risk construct and factors.

5.2 Political & Procurement Risk Construct

The ‘political and procurement risks’ construct has five significantly loaded indicators. These indicators together with their loadings include: ‘bribery and corruption risk – BCR (0.652)’; ‘inadequate competition risk – ICR (0.765)’; ‘inadequate project design – IPD (0.832)’; ‘political continuity risk – PCR (0.567)’ and ‘policy instability risk/inadequate government commitment – PIR (0.829)’ (refer to Figs. 2 and 3). From the IPMA results, this construct is the most important with the highest potential of improvement on sustainable housing, if adequately alleviated (refer to Fig. 4). Among the four risk constructs, ‘political and procurement risks’ construct is the key influencing risk construct. That is, it is the risk construct that causes and predicts the other risk constructs. This construct also has the highest level of impact or magnitude on sustainable housing since it is the only construct that has a significant impact on the SDGs. Consequently, its negative impact on sustainable housing is intensified as it originates the other risk constructs. This assertion is also confirmed in a study conducted by Addae et al. (2019) who found that policy factors are critical factors with the highest caused index. Therefore, addressing the ‘political and procurement risks’ construct will mitigate or eliminate the other risk constructs in addition to improving the SDGs in housing.

From the importance-performance map of the indicators within the ‘political and procurement risks’ construct (refer to Fig. 5),‘policy instability risk/inadequate government commitment – PIR’ ranks as the most influencing risk, because it has the highest total effect and highest potential for improving sustainable housing (refer to Table 8). Similarly, Mosannenzadeh et al. (2017) concluded that regulatory instability is a key influencing factor to sustainable development. “Non-effective regulations at local, regional and national level may lead to unclear objective and inconsistent political support” (Mosannenzadeh et al., 2017, p. 198). Policy instability and inadequate commitment to sustainable housing is a major problem in the Ghanaian housing market and has often negatively influenced access to land by successive governments. The state can acquire land from chiefs and family heads through eminent domain. However, inadequate commitment of government in channeling plots of land to public projects (i.e. public housing) is evinced in divestiture of land to other private use (Larbi, 2008). Consequently, there is low level of trust between successive governments and chiefs or heads of family in allocating land for state projects including public housing.

Political continuity risk (engendered by changes in government) could culminate in policy instability. Regulatory instability is caused by fragmented political support for long term policies. Succeeding governments often start new projects while pending projects (which were initiated by previous governments) are often neglected or abandoned. Public housing project abandonment by succeeding governments is due to ‘lack of public participation in public housing projects’ and “low-involvement of key stakeholders including other political parties from the onset of housing project” on the part of the incumbent government (Mosannenzadeh et al., 2017, p. 196). Neglecting the involvement of the public and other political parties in public housing projects reduces the likelihood of consistent political support for project implementation once there is a change of government. This also negatively affects public-private partnerships in ensuring public housing supply. Such partnerships or joint-ventures with previous governments are mostly terminated by successive governments (Osei-Kyei & Chan, 2017).

To appropriately devise policies for tackling this risk indicator, the micro-meso-macro scale model was adopted from Reddy (2013) for further classifying the risk factors. For this scale, micro risks can be tackled at the project’s design level, meso risks at the organizational level and macro risks at the state or civil society level. From this classification, ‘policy instability risk and inadequate government commitment’ can be considered as a macro risk and is best tackled at the state or civil society level. As such, there is the need for promoting governmental interventions through strengthened political commitment. This could entail providing a favorable environment to enhance private sector participation in housing supply. Further improvement in financial enticement (tax reduction), availability of low-interest loans and allocation of land with adequate infrastructure supply could be some of the commitments of government for promoting public-private partnerships in housing supply. In Yuan et al. (2012), an inadequate legal and regulatory framework was identified as the main cause of inadequate government commitments. Therefore, in addition to providing an enabling environment, a legal framework for housing supply is a prerequisite for efficient public-private partnerships. Securing the private sector’s effective involvement is a key solution for sustainable development of housing project (Li et al., 2016).

Inadequate project design was the second risk indicator with both high importance and performance value (refer to Fig. 5). Most housing projects from the formal sector (i.e. public housing projects) are designed and constructed as speculative housing facilities. They are usually designed without the participation of the intended households or potential users of the facilities (Ahadzie et al., 2008; Adabre & Chan, 2019). The problem is that the housing facilities do not often meet the residential needs of the target households. Furthermore, some projects including public housing are often initiated when a term of office of an incumbent government/president is imminent. Commencing projects close to the time of election is frequently used as a strategy for canvassing for votes to serve the remaining tenure. Consequently, the project procurement processes (designing, bidding etc.) are habitually expedited due to limited time. Therefore, essential sustainability measures could be omitted from the project design, which could be attributed to the extensive time and financial resources that such measures require to be integrated into housing projects. This also culminates in inadequate time for competitive tendering. Using the micro-meso-macro scale model to mitigate this risk factor, 'inadequate project design' risk is all-pervasive and could therefore, be best tackled at the project design stage, organizational level and state or civil society level. That is, this risk could be solved through effective interventions at the project design level by the project coordinators (i.e. consultants, contractor and clients) and policymakers. For instance, policymakers could ensure sufficient time and financial resources for project design by the project coordinators. The project coordinators (i.e. the project design team) in turn should ensure "collaborative and participatory planning" among themselves, the target households, the public and the community where the housing facility will be sited. Essentially, this could ensure adequate project design including the integration of sustainability measures for ultimate residential satisfaction. Additionally, public participation in projects could improve commitment of policymakers in ensuring project completion even whenever a change of government occurs. This could prevent abandonment of uncompleted public housing projects (Twumasi-Ampofo et al., 2014).

'Inadequate competition risk' (ICR) and 'bribery and corruption risk' (BCR) both have the same total effect of 0.151 on sustainable housing (refer to Fig. 5 and Table 8). This could be attributed to the fact that both risk factors may be related to inadequate transparency in project procurement. However, ICR has higher potential of performance (43.333%) on sustainable housing than the potential performance of BCR (28.889%). This could mean that effective policies that ensure adequate competition during project tendering or bidding could better enhance sustainable development in housing. A typical policy in this regard is the Public Procurement Act, 2003 (Act 663) as amended with (Act 914), enacted to control the procurement of public goods including public housing projects. The Act seeks to ensure competitive tendering of projects to obtain value for money. However, sole sourcing, ghost tendering and lack of transparency are some of the main risk factors that engulf project procurement at the tendering stage. Consequently, projects are often awarded based on party-ties, political affiliations or on other preferential treatment. Contractors who have expertise in attaining project sustainability requirements (i.e. quality, safety, energy efficiency, aesthetic view and technology transfer) are mostly not awarded contracts if they are not politically affiliated to the ruling party. Sole sourcing and award of projects based on political-party affiliation often result in kickbacks or bribery and corruption in public housing projects. The effects include price inflation of the contract sum to cover for the amount paid as bribes or kickbacks. Alternatively, contractors may cut corners to recover the amount paid as bribes to project coordinators, which could lead to a compromise on the project's technical specification (Manu et al., 2019; Ameyaw et al., 2017). Both 'inadequate competition risk' (ICR) and 'bribery and corruption risks' (BCR) could be tackled at the project's meso (organizational) level. Adequate transparency through disclosures at all stages of project tendering could minimize ‘inadequate competition risks’ by eliminating ghost tendering. Transparent tendering procedures could also abate ‘bribery and corruption risks’.

5.3 Financial-Related Risk Construct

This construct was loaded by four main indicators. The indicators together with their loadings include: DPR – ‘delay payment risk’ (0.618); FCF – ‘fluctuating cost of finance’ (0.840); IFI – ‘inadequate financing institutions’ (0.762) and IRV – ‘inflation rate volatility’ (0.769) (refer to Fig. 2). Similarly, Lundin et al. (2015) concluded that ‘delays in payment to contractor/supplier’, ‘inflation/price fluctuation’ and ‘poor financial/capital market’ were the critical factors that affect state housing projects in Ghana. Further data analysis in this study revealed a significant causal relationship between ‘political and procurement risks’ and ‘financial-related risks’ (refer to Fig. 3). This implies that ‘financial-related risks’ depend on the ‘political and procurement risks’. Thus, the former will arise in projects due to the occurrence of the latter. For instance, political discontinuity due to changes in government, policy instability risk and inadequate government commitment (i.e. irregular disbursement of budgetary allocations to parastatal institutions for payment of contractors) are contributory factors to delay payment risk, fluctuating cost of finance and increasing effect of inflation volatility on contractors’ cash flow (Lundin et al., 2015).

To control some of the financial-related risks (i.e. delay payments, inflation rate volatility and cost of finance), interventions at the macro (national) levels are indispensable. There is the need for a national development plan that includes housing development. Such a plan should be accepted by the nation and by all political parties, and importantly, adhered to strictly by any political party that assumes power. The plan should be manned by an independent and non-partisan institution that is entitled to budgetary allocation within specified periods. This will ensure consistent political support in the long term and prevent delay payment to contractors because of changes in government. Moreover, access to low-interest loans or interest-free loans could enable the institution to provide an enabling environment for public-private partnership for public housing supply.

5.4 Design & Construction Risk Construct

The ‘design and construction risks’ construct has five main reflectively loaded indicators, namely, CDR – construction defects/deficiencies risk (0.739); COR – cost overrun risk (0.848); TOR – time overrun risk (0.777); DCV – design and construction variation orders/alteration and rework due to variations (0.677); FME – force majeure events (0.684) (refer to Fig. 2). This risk construct did not have a significant impact on the sustainable housing construct. Besides, it had no significant impact on the ‘operation and maintenance risks’ construct. However, as a dependent construct, it was significantly influenced by the ‘political and procurement risks’ and the ‘financial-related risks’ with t-values of 4.538 and 2.714, respectively (as shown in Fig. 3). This could imply that ‘design and construction risks’ are caused by the ‘political and procurement risks’ and the ‘financial-related risks’ of which the former has greater impact as evinced in its t-value. Therefore, although policies that seek to mitigate both ‘political and procurement risks’ and ‘financial-related risks’ are recommendable for controlling ‘design and construction risks’, political and procurement risk mitigation strategies are more laudable. “Policy stability such as regulatory and support scheme stability at the national level” (Mosannenzadeh et al., 2017, p. 199) and adequate project design at the project coordinators level are fundamental requirements for controlling design and construction risks. These policies could prevent time and cost overruns as a result of abandoned public housing projects and costly variation orders.

5.5 Operation & Maintenance Risk Construct

Operation and maintenance risk construct was loaded by four main indicators: FDR – fluctuating demand risk (0.700); IIR – inadequate infrastructure supply risk (0.585); OCO – operating cost overruns (0.859) and PRR – privatization risk (of rental stock) (0.815). Between this risk construct and the sustainable housing construct, there was no significant relationship. However, as a dependent construct, it is significantly influenced by the 'political and procurement risks' construct. This could suggest a causal impact from the 'political and procurement risks' on the 'operation and maintenance risks'.

Based on the causal relationship, public housing facilities could be effectively operated and managed through efficient policies that mitigate the 'political and procurement risks'. Those policies could emanate from various policymakers at the meso level (i.e. project coordinators level) and macro/state level (policymakers level). For example, project coordinators (i.e. architects, planners etc.) could ensure adequate project design through participation of the target households or public at the onset of the project design and planning. This will provide useful feedback to the project coordinators for project design and for ensuring residential satisfaction in the completed facilities. Thus, fluctuating demand risk could be alleviated. At the macro level, adequate subsidies on the operating cost of public rental facilities could prevent privatization of rental facilities and its speculative effect. For instance, most of the rental facilities from SSNIT were privatized due to maintenance cost overruns (Ghana Housing Profile, UN-Habitat, 2011). Ensuring the availability and transparent allocation of rental facilities are important for avoiding inequities and for promoting housing affordability in the long run (Yuan et al., 2018; Adabre & Chan, 2020a). Similarly, Li et al. (2016) observed that public rental facilities are not profitable in the short run. This situation is often the reason for privatization of rental facilities as owner facilities. However, they recommended that public rental facilities are profitable and could improve affordability if they are retained for a longer term. Furthermore, subsidies or other financing schemes such as public-private partnerships are required at the national level to ensure infrastructure supply and maintenance of existing dilapidated infrastructure to complement residential facilities for residential satisfaction.

5.6 General Discussion on Risk Networks

The attainment of the UN SDGs in housing has been affected by various risks in the construction industry in general and the housing market in particular. Previous studies have quantified the separate impact of these risks using various analytical techniques that iteratively build upon the inherent weaknesses on previous techniques to improve risk quantification. For example, the FSE technique (and its variant forms) have been deployed as an alternative to subjective descriptive statistical analysis. Similarly, the ISM builds on one of the deficiencies of the FSE for assessing interdependencies among risk constructs although it does not test the significance of the relationships. In addition, the regression analysis and artificial neural networks could be used to assess and to test the significance of interdependencies among risks and project goals, although some limitations are prevalent. Notwithstanding the essences of these analytical tools, an adequate response to mitigate risks requires an adequate understanding of both the interdependencies among the risks and sustainable housing. The novelty of this study lies in adopting the PLS-SEM for assessing the interactions among risks and CSC towards achieving the UN Sustainable Development Goals in housing by 2030.

The conceptual model developed depicts the interdependencies, from which ten hypotheses were established. Questionnaire surveys were used for data collection because surveys are suitable for providing quantifiable results. Views of respondents from the formal sector of the Ghanaian housing market were solicited and Cronbach's alpha illustrated adequate content validity of the data. The measurement model and its assessment of the conceptual model were conducted using the PLS-SEM. Based on the satisfactory measurement model, the structural model estimation was performed to determine the paths and the significance of the interdependencies. The CSC which were significantly loaded within the sustainable housing construct include: household's/user's satisfaction; maintainability of housing facility; energy efficiency; functionality; technical specification of housing facility; reduced commuting cost of household; and 'technology transfer/innovation. These are some of the SDGs in housing which could be affected by the risk constructs in the formal sector of the Ghanaian housing market. These variables cumulatively illustrate the finer nuances and inherent complexities of the problem phenomena under investigation and thus, the need for more refined approaches to model such.

The foregoing analysis on the risk assessment shows that the various risk constructs do not exist independently. Thus, these latent variables and constructs are interdependent and have cause-effect relationship among themselves. From the PLS-SEM analysis on the various risk constructs, only 'political and procurement risks' construct was identified as a critical risk construct. It is the only risk construct that has a significant influence on the SDGs. It also has significant impacts on the other risk constructs: 'financial-related risks'; 'design and construction risks' and 'operation and maintenance risks'. Similarly, Guan et al. (2020) concluded that some of the risk constituents in the 'political and procurement risks' such as 'inadequate project design' and contract ambiguities (i.e. policy instability) are among the risk factors that drive risks in the other constructs. Furthermore, findings of Boateng et al. (2015) corroborate this study's findings since design risk and land acquisition risks were identified as the most important risks. These risks had high correlation with the CSC. Moreover, Ahmadabadi and Heravi (2019) concluded that 'design risks' and 'uncompetitive tender' were some of the risk sources that affect risks in the other categories. Inadequate project design or design risk is a form of information distortion in project procurement, which is a significant source of other risks through its knock-on effects (Kwak et al., 2018). In Kim et al. (2009), 'bribery and corruption risk' was identified as a key risk that could influence overseas construction projects such as public-private partnership housing projects. Thus, from the findings of the previous studies, most of the risks that trigger others risks event belong to the category 'political and procurement risks'. Such findings validate the network or model of this study (refer to Figs. 2 and 3). Akin to previous studies, this study's findings illustrate that the 'political and procurement risks' are the main risk sources that derive or cause the other risks in the different categories. Furthermore, between 'financial-related risks' and 'design and construction risks' the former is the risk source while the latter is the risk event/effect. Based on the results of the risk analysis in sustainable housing, a quadripartite system of government, industry, households and legislative framework is required for effective risk management for the attainment of the UN SDGs in housing.

6. Conclusions

This study developed a model between sustainable housing and risk constructs using responses from a questionnaire survey administered in the formal sector of the Ghanaian housing market. PLS-SEM was employed for statistical analysis of the data. Based on the outcome of the measurement model, the indicators of the sustainable housing construct that could be affected by the risk constructs include: 'safety'; 'user satisfaction on housing facility'; 'maintainability'; 'energy efficiency'; 'functionality of housing facility'; 'technical specification of housing facility'; 'reduced commuting cost of households' and 'technology transfer/innovation'. Among the four constructs of risks, only 'political and procurement risks' have a significant impact on the sustainable housing construct. Besides, as an independent construct, 'political and procurement risks' had significant impacts on 'financial-related risks'; 'design and construction risks' and 'operation and maintenance risks'. Financial-related risks, in turn, had a significant impact on 'design and construction risks'. Accordingly, there are causal impacts from 'political and procurement risks' on the other three risk constructs. Therefore, to mitigate risks to sustainable housing in the Ghanaian housing market, policymakers and practitioners should mostly focus on mitigating the 'political and procurement risks'. This assertion was further buttressed by results of the importance-performance analysis (IPMA) in which 'political and procurement risks' have the highest importance (0.616) and the higher potential performance of 38.12% for improving sustainable housing in Ghana, if adequately alleviated. Moreover, prioritization of the indicators under the 'political and procurement risks' revealed that policymakers should pay utmost attention to 'policy instability risks' followed by 'inadequate project design' then 'inadequate competition risk'; 'bribery and corruption' and 'political continuity risk'. Ultimately, the phenomena under investigation is a complex industrial-econometric issue that this research has sought to disentangle as a first step towards developing risk mitigation measures that allow for socio-economic reform. Such work must be tested in practice to observe the impact of changes made upon the supply of sustainable housing and perhaps using a longitudinal study.

This study's findings have limitations which concern generalization or interpretation. First, data were sourced from only respondents in the formal sector of the housing market. Households such as self-builders were not included among the survey respondents and this could affect the generalization of the research findings. The risk categories (namely 'political and procurement risks' and 'operation and maintenances') could have limited implications on self-built housing facilities or projects, which mostly constitute the informal sector. In addition, the sample size is relatively small which is one of the main reasons for analyzing the data using PLS-SEM. However, with a larger sample size, future study could deploy covariance-based SEM to either confirm the study's findings or otherwise. Future research could include responses from self-builders or only responses from self-builders to provide comprehensive information for decision making.

Despite these limitations, the study's findings could be important for research informed policymakers and practitioners for ensuring sustainable housing for sustainable urban development. The current pandemic has illustrated how governments internationally turn to the scientific community in a crisis to engender confidence in the voting public. Importantly, the study reveals the risk construct that triggers other risk constructs (causal-effect relationship) and the significant risk construct that influence sustainable housing. The study's findings also informs policymakers and practitioners of the risk construct that requires judicious resource allocation to ensure sustainable housing. Moreover, the importance-performance analysis at the indicator level of the risk factors showed the prioritization of the risk factors under the critical risk construct. This further provides specific direction on the risk factors that require utmost policy interventions from local policymakers and supranational institutions.

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