The Ends Required to Justify the Means for Sustainable Affordable Housing: A Review on Critical Success Criteria

Abstract

In this time of increasing housing demand and incessant housing supply deficit, the need for critical success criteria (CSC) to qualitatively and quantitatively measure the performance of affordable housing projects has become even more relevant. Though affordable housing has received much attention in the construction industry, success in affordable housing is interpreted differently by different researchers and is an abstract term difficult to be assessed. Besides, limited studies exit on providing a framework for assessing success in affordable housing projects. This paper aims to review the literature on CSC for affordable housing and based on the outcomes, develop a framework for measuring success in affordable housing projects. To this end, CSC-related papers were retrieved from Scopus and the Web of Science databases. A systematic desktop search was employed which culminated in the selection of 34 articles related to CSC for both general construction and affordable housing projects. Based on the literature, 20 CSC of affordable housing were identified and used to develop a conceptual framework of product success, project management success and project success. Practically, the findings of this study could help architects, project managers and planners monitor and control affordable housing projects to ensure successful delivery while also serving as measuring criteria to assess performance of affordable housing projects in meeting households' needs. Theoretically, this study offers an important acumen to the existing literature on CSC for affordable housing and provides useful findings for further empirical studies.

Keywords: Affordable Housing; Success Criteria; Critical Success Factors; Key Performance Indicators

1. Introduction

The objective of affordable housing supply is to ensure that low-income earners have access to adequate housing without cost burden (MacLennan & Williams, 1990). Demand for affordable housing has been expressed both qualitatively and quantitatively. However, the presence of vacant housing amidst housing needs indicates that households' requirements in affordable housing have not been met (Tan, 2008). On the supply side, the problems of loss of equity among developers and inefficient utilization of state resources are the shadowing problems whenever supplied houses are left unoccupied (Susilawati, 2009). To effectively monitor affordable housing projects towards successful delivery as well as meeting household needs, critical success criteria (CSC) are required. CSC are the measures used to judge project success or failure (Cooke-Davies, 2002; Parfitt & Sanvido, 1993). A synonymously used term of CSC is key performance indicator (KPI). According to Kylili et al. (2016), KPIs reflect project's goals in addition to determining the means for measuring and managing a project towards achieving its goals. Chan and Chan (2004) indicated that CSC can also be termed as KPIs. Therefore, in this study, both CSC and KPIs are terms used to measure success or otherwise of affordable housing projects. The factors that contribute to the attainment of project success are termed success factors. Thus, CSC are the ends while the success factors – such as adequate supply of land and subsidies etc – are the means to the ends. Conventionally, the criteria – cost, time and quality – have been widely accepted for measuring project success and are typical examples of CSC (Atkinson, 1999).

Due to dynamism in the construction industry and the ephemeral human needs, determining other novel criteria of project success is very germane. CSC are essential for managing and determining project success. According to Leon et al. (2017), CSC provide vital information for project monitoring and control. They also assist project managers to detect early warnings against potential problems. In Osei-Kyei and Chan (2017), a linear equation model of project success index was developed. This index provided an objective and quantitative approach for measuring success. Moreover, it was stated that the index could be used for relating success level of comparable projects. Similarly, Nassar and AbouRizk (2014) proposed a framework based on CSC to enable managers of construction projects evaluate project performance in a formal and systematic way. More importantly, according to Toor and Ogunlana (2009), a link can be established between CSC which are "the ends" and success factors which are "the means to the ends". Thus, through the identification of the ends of affordable housing, the means to the ends could be determined.

Several researchers have studied project success towards identifying project CSC. However, there is no consensus on a standard set of criteria for measuring this concept. For example, Lim and Mohamed (1999) argued that project success could be looked at from two perspectives. The macro-level viewpoint of success which considers if "…*the original concept tick*" while the micro-level pertains to the conventional project success criteria – time, cost and quality. Assessing project success from the macro view point is conducted by the end-users and the project beneficiaries. The micro level appraisal concerns construction parties (Toor & Ogunlana, 2009). Whereas Baccarini (1999) and Pheng and Chuan (2006) stated that project success consists of project management success and product success, Cooke-Davies (2002) posited that project success is different from project management success. Project success, according to Cookie-Davies, measures the overall objective of the project. From the view of Chan and Chan (2004), there are objective and subjective criteria. The objective criteria are quantitative indices, tangible and more measurable. However, the subjective criteria are qualitative and comparatively difficult to assess. Similarly, Cox et al. (2003) stated that qualitative criteria are not considered as highly reliable performance measures due to the

difficulty in assessing them. According to Westerveld (2003), client's appreciation, contracting partner's appreciation, project personnel appreciation, user's appreciation and stakeholders' appreciation form the main indicators of project success.

More specific to affordable housing, criteria on how to measure success is narrowly considered with much emphasis on price affordability to the neglect of other criteria amidst unresolved debates (Mulliner et al., 2013). For instance, due to interest in simplicity of computation, the price of housing to income ratio is widely recognized and used in international housing policies as a measure of affordability (Bodgen et al., 1993). Another reason for the ubiquitous use of the ratio approach is that it relies on a few accessible variables such as housing cost and the transitory income of household to determine housing affordability. However, Stone (2006) criticized the ratio approach for not considering if the residual income, income after subtracting the cost of housing, is enough to cover the cost of other necessities of life such as clothing, food and education. Moreover, Bogdon and Can (1997) stated that the ratio approach does not account for the quality of housing. Therefore, in a different perspective, Stone (2006) proposed the shelter poverty approach for measuring affordability. This indicator assesses the adequacy of household income to cover the cost of housing and other basic non-housing cost. Though the shelter poverty indicator has its strength, it has some drawbacks like the ratio approach. Bogdon and Can (1997) posited that both rely on the transient income of households and therefore such measures do not reflect the long-term affordability situation of the households. Besides, other important issues such as location, condition of housing and neighbourhood characteristics are overlooked (Mulliner et al., 2013).

Therefore, though the relevance of price affordability as a key success criterion cannot be underemphasised, it is not an exhaustive criterion for measuring success in affordable housing. For instance, Tan (2008) observed that amidst the demand for housing, there was massive housing overhang in Malaysia which were surprisingly affordable to most household. Similarly, Seelig and Phibbs (2006) also found that even though price of housing was a major consideration to renters, priority was given to dwelling features and other external factors even if these priorities could increase the housing rental cost. Elsewhere in the UK, for example, households were reportedly vacating the city Leuven due to lack of access to public green space (Tratsaert, 1998 cited in Van Herzel and Wiedemann, 2003). These quintessential cases show that price affordability of housing, which is conventionally used as a measure of success is not a complete end of affordable housing and solely focusing on this criterion could lead to unmet client's needs (Fisher et al., 2009; Isalou et al., 2014). The problem of unmet client's expectations evident in vacant housing could influence investment in affordable housing negatively. High vacancy rate has often been cited as one of the risk factors that dissuade real estate developers from considering affordable housing in their list of portfolios (Susilawati, 2009).

The limited view on success in affordable housing to only price affordability has often led to the adoption of different means to affordable housing supply which could be the reasons for the associated problems of high vacancy rate and property overhang commonly termed "ghost cities". For illustration, to ensure price affordability of housing, most housing facilities have been developed in urban peripheral where cost of land may be relatively cheaper. The "end" which in this scenario is price affordability of housing could be achieved because of the means – relatively cheaper land supply. However, other required ends might not be met because of the location of such houses. This could cause housing surpluses due to low demand. A typical situation of this was observed in Denmark in the rural areas particularly Jutland which recorded housing overhang (Whitehead & Scanlon, 2007). Similarly, in Mulliner et al. (2013), the low

demand and abandonment of housing facilities in several parts of the North and Midlands in England were attributed to other criteria beyond price affordability of housing. Therefore, the concept of CSC of affordable housing is multi-dimensional and should be assessed based on broad criteria (Mulliner et al., 2013). Moreover, according to Cai and Lu (2015), a more dynamic and comprehensive view is required in evaluating affordable housing towards establishing strategic and tactical policies.

Some studies have been conducted on developing frameworks for the assessment of sustainable affordable housing. For instance, Ibem and Azuh (2011) developed a comprehensive framework for evaluating the sustainability of public housing programmes in developing countries. Though the findings of their study revealed some relevant criteria such as quality and housing satisfaction, most of the findings are success factors or means to the end. For example, access to social infrastructure, privacy in dwelling units, housing near to the place of work/worship and adaptability of housing unit for needs are means to affordable housing and cannot be considered as CSC. Similarly, Pullen et al. (2010) flagged some critical success criteria in their framework. However, the CSC were related only to the end-users (product success) and therefore their framework is far from serving as a holistic assessment tool for the different stakeholders – the end users, developers and the government – in affordable housing. Against this backdrop, this study seeks to develop a comprehensive framework of CSC to aid stakeholders in assessing success for sustainable affordable housing projects.

2. Research Methodology

This study adopted a systematic review of the literature to identify CSC for affordable housing. A similar method was embraced for summarizing and advancing knowledge on green building in the field of construction management (Darko & Chan, 2016) and identifying CSC in construction project management (Chan et al., 2002). Therefore, the research methodology used for this paper is a systematic review of articles published during the past two decades (1998-2017, both years inclusive). Articles were selected from Journals based on Chau's (1997) Journal Ranking in Construction Management. Journals selected for search include: Journal of Management in Engineering, International Journal of Project Management, Construction Management and Economics, Journal of Construction Engineering and Management. Similar selection criterion has been adopted in previous review studies (Hong et al., 2011; Ke et al., 2009). However, it is arguable that there might be new publication outlets which may contain relevant information on CSC for housing projects and general construction projects. Moreover, Chau's list does not include journals that publish much on housing. To address these limitations in previous studies and to broaden the selection criterion, another systematic review was conducted using Elsevier's Scopus search engine. Elsevier's Scopus was selected for three main reasons. First, most of the research papers in the fields of construction, management, business, accounting and engineering are archived in Elsevier's Scopus (Hong et al., 2012). Second, for a literature search, Scopus is the most accurate search engine among others such as PubMed, Web of Science and Google Scholar (Falagas et al., 2008). Third, Scopus has been used in similar review studies in construction-related fields (Ke et al., 2009; Osei-Kyei & Chan, 2015). Despite these noted advantages of Elsevier's Scopus, the results of the search from Scopus were complemented by other search results from Web of Science for a comprehensive coverage of papers on CSC.

Since affordable housing projects are also construction projects, related papers on CSC in construction project management, housing and PPP projects were all reviewed. To identify the relevant papers, the following search keywords were used: "affordable housing", "public housing", "critical success criteria", "success criteria", "key performance indicators",

"construction management" and "construction project management". The search in Elsevier's Scopus was conducted on 7th May 2018 under the "title, abstract, keywords" section with document type restricted to only "articles" and "reviews" for papers published during the past two decades from 1998 to 2017 (both years inclusive). Out of 79 papers, a total of 34 articles were found relevant for the study. This is because though some of the unselected papers had some of the keywords such as affordable housing, public housing, they did not contain data on what defines success in construction projects and affordable housing. The 34-sample size of papers is deemed adequate and suitable for this review study in comparison with sample size used in previous construction-related review studies. For example Osei-Kyei and Chan (2015) used 27 papers for a review study on critical success factors for implementing construction Public-Private Partnership (PPP) projects. The 34 papers were subject to manual content examination to identify the CSC of affordable housing projects.

Finally, bibliometric analysis was conducted for one of the identified Critical Success Criterion – household residential satisfaction. To develop a residential satisfaction scale, the knowledge structure of the literature on residential satisfaction was determined through keyword co-occurrence network analysis. With search terms such as "public housing" and "satisfactions", 97 bibliometric data were obtained from the Web of Science search engine. Then, the data was imported into the VOSviewer software where the keyword co-occurrence network analysis was conducted. The minimum number of occurrences of a keyword in the network analysis was set at five which is the default frequency. Thus, only keywords with a frequency of at least five were included in the network analysis.

3. Results and Discussion

Table 1 shows the results of the review conducted to identify CSC for affordable housing projects. Some of the identified CSC in the literature include cost performance, quality and schedule performance. These are the basic CSC for every project. According to Atkinson (1999), though other CSC have emerged, cost performance, quality and schedule performance – the iron triangle – are still relevant. Aside these three main criteria, other notable CSC include safety performance, productivity/efficiency, environmental performance, reduced occurrence of disputes, risk containment, technology transfer, project team satisfaction, household satisfaction, functionality, technical specification, reduced project life cycle cost, price of housing in relation to income, rental costs in relation to income, cost of transportation in relation to income, take up rate of facility, waiting time of applicants before being allocated a housing unit and sustainable development. In a review study conducted by Chan and Chan (2004), it was concluded that other CSC such as safety, functionality and satisfaction are attracting increasing attention in the construction industry. Similarly, Toor and Ogunlana (2009) found that the traditional measures of the iron triangle are no more the only applicable measures of project performance. Other criteria such as safety, efficient use of resources, satisfaction of stakeholders and reduced conflicts are increasingly becoming important.

Though the CSC appear to be separated, they are interdependent. The neglect of one criterion could have negative repercussion on the others (Pullen et al., 2010). Using System Dynamic Approach, Leon et al. (2017) modelled how these success measures relate to one another. Their study showed that "Safety" has a positive effect on "Team satisfaction" which also has a positive effect on "Productivity". "Time" correlated positively with "Productivity". Moreover, to show this interdependence, studies mostly group the CSC into various categories. In Ahadzie et al. (2008), four clusters were identified. These included environmental impact factors; customer's satisfaction factors; quality and cost; time. Similarly, in a study conducted by Osei-

Kyei and Chan (2017), success criteria were grouped into three main factors: local development and dispute reduction; cost and technical specifications and profit.

Table 1: Critical Success Criterial for Affordable Housing

Author and year	Critical Success Criteria																			
	CSC1	CSC2	CSC3	CSC4	CSC5	CSC6	CSC7	CSC8	CSC9	CSC10	CSC11	CSC12	CSC13	CSC14	CSC15	CSC16	CSC17	CSC18	CSC19	CSC20
Chan and Chan (2004)	X	X	X	X	X	X	X	----	X	X	---	---	---	---	---	---	---	---	---	---
Leon et al. (2017)	X	X	X	X	X	X	X	----	---	---	---	---	---	---	---	---	---	---	---	---
Bassioni et al. (2004)	X	X	X	X	---	---	X	X	---	---	---	---	---	---	---	---	---	---	---	---
Ahadzie et al. (2008)	X	X	X	X	X	---	X	---	---	---	X	---	X	---	---	---	---	---	---	---
Osei-Kyei and Chan (2017)	X	X	X	---	---	---	X	---	---	X	X	X	X	X	---	---	---	---	---	---
Chan et al. (2002)	X	X	X	X	X	X	X	X	X	X	---	---	---	---	---	---	---	---	---	---
Rashvand and Zaimi Abd Majid (2013)	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---
Wang and Huang (2006)	X	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pinter and Pšunder (2013)	X	X	X	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---
Wai et al. (2012)	X	X	X	X	X	---	X	X	---	---	---	X	---	---	---	---	---	---	---	---
Kylili et al. (2016)	X	X	X	X	X	---	---	---	X	---	---	---	---	X	---	---	---	---	---	---
Ngacho and Das (2014)	X	X	X	X	X	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---
Toor and Ogunlana (2009)	X	X	X	X	X	---	X	X	---	X	---	---	---	X	---	---	---	---	---	---
Nassar and AbouRizk (2014)	X	X	X	X	---	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---
Kagioglou et al. (2001)	X	X	X	X	---	---	X	X	---	---	---	---	---	---	---	---	---	---	---	---
Maloney (2002)	---	X	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---
Yeung et al. (2009)	X	X	X	X	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---
Hu et al. (2016)	X	X	X	X	X	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---
Al-Tmeemy et al. (2011)	X	X	X	---	---	---	X	----	X	X	---	---	---	---	---	---	---	---	---	---
Barraza et al. (2004)	X	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cox et al. (2003)	X	X	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Xiao and Proverbs (2003)	X	X	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Lim and Mohamed (1999)	X	X	X	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Atkinson (1999)	X	X	X	X	X	---	X	X	---	---	---	---	---	---	---	---	---	---	---	---
Rankin et al. (2008)	X	X	X	X	X	---	X	X	X	---	---	X	---	---	---	---	---	---	---	---
Cheung et al. (2004)	X	X	X	X	X	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---
Forsythe (2007)	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---
Torbica and Stroh (2001)	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---
Bryde and Robinson (2005)	X	---	X	---	---	X	X	---	---	X	---	---	---	---					---	---
Mulliner et al. (2013)	---	X	---	X	---	---	---	---	---	---	---	---	---	---	X	X			---	---
Hamidi et al. (2016)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X		---	---
Chiu (2007)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---	---
Ibem and Azuh (2011)	---	---	---	X	---	---	---	---	---	---	---	---	---	---	X	X	X	---	X	---
Pullen et al. (2010)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	X

Table 2: Codes and Names of Critical Success Criteria

Codes	Critical Success Criteria
CSC1	Cost Performance
CSC2	Quality
CSC3	Schedule Performance
CSC4	Safety Performance
CSC5	Environmental Performance
CSC6	Team Satisfaction
CSC7	User's Satisfaction
CSC8	Productivity/ efficiency
CSC9	Functionality
CSC10	Technical Specification
CSC11	Technology Transfer
CSC12	Reduced Lifecycle Cost
CSC13	Overall Risk Containment
CSC14	Reduced Occurrence of Disputes
CSC15	Price of Housing in Relation to Income
CSC16	Rental Costs in Relation to Income
CSC17	Cost of Transportation in Relation to Income / Transportation Time
CSC18	Waiting Time of Applicants before being allocated housing
CSC19	Sustainable Development
CSC20	Take up Rate of Facility

3.1 Stages to Success in the Provision of Affordable Housing

Identifying the stages to success of a product could be different from assessing the various stages of success of a product. For example, to ensure successful affordable housing, we argue that the stages to success should start from needs assessment of the intended users. Based on these needs assessment, the next stage is the management of the process or activities towards achieving the needs and other needs beyond the intended users' needs. This stage is the process domain known as project management (Pheng & Chuan, 2006). Finally, managing the process domain well leads to project success – successful affordable housing project (Cooke-Davies, 2002). However, since measuring success is mostly carried out to monitor and control (Leon et al., 2017), it is possible that assessment of the process domain would be conducted before assessment of the product success because the former precedes the latter in the construction of an affordable housing project. Therefore, regarding the stages of success, assessment of the project management success comes first followed by the assessment of the product success.

The CSC at each stage are elaborated with the support of a framework shown in Fig. 1. Project success in affordable housing can be conceptualised as product success and project management success. According to Al-Tmeemy et al. (2011), product success focuses on the effects of the final product. In the case of affordable housing, these effects should be to ensure the satisfaction of the household and the project team members with regard to the completed house (Torbica & Stroh, 2001). Though previous study by Ahadzie et al. (2008) did not consider the life cycle cost of buildings (cost of maintenance, energy cost and other cost of building operation), it is relevant to consider reduced life cycle cost and reduced public-sector administrative cost (especially in the case of rental housing) as critical for assessing success of a housing facility - product success. High life cycle cost could increase public-sector

administrative cost as well as lead to shelter poverty among low-income earners (Stone, 2006). The price of housing, rental cost and transportation cost in relation to household income are also germane in measuring the economic viability of housing (Mulliner et al., 2013). Ultimately, the marketability of the housing facility is very important in determining its success (Al-Tmeemy et al., 2011). A proxy measure for marketability of housing facility could be the take up rate or the renting or purchasing rate of the housing facility.

After assessing success criteria at the product level, the next stage is project management success. This involves success at the delivery or process stage of an affordable housing project. Project management of affordable housing include managing for cost performance, quality performance, safety performance, productivity / efficiency, risk containment and technology transfer (Ahadzie et al., 2008; Al-Tmeemy et al., 2011; Atkinson, 1999). According to Baccarini (1999), the success at the project management stage leads to product success. For example, in an empirical study, Ibem and Amole (2013) noted that quality affordable housing at the project delivery is directly related to household satisfaction- an attribute of product success. Similarly, in Al-Tmeemy et al. (2011), when quality targets are met, the functional requirement and technical specification of the product can be achieved. Therefore, aside the other criteria of project management success, product success in an affordable housing project is a key element of project management success. Thus, integrating product success into project management success shows that the achievement of product success could be influenced by project management success. This is shown in the framework (Fig. 1) as product success being a subset of project management success.

Finally, project success can be measured using the waiting time applicants are expected to spend before they could be allocated to a housing unit (Chiu, 2007) and how an affordable housing project leads to the attainment of sustainable development (Ibem and Azuh (2011). Besides, integrating product success and project management success leads to project success – successful affordable housing supply in meeting household demands. The three stages of success in affordable housing projects are presented in the framework in Fig. 1 in the form of circles for the various phases. The inner circle represents product success, the middle circle represents project management success and the outermost circle represents project success. Thus, for success in sustainable affordable housing projects, product success is a precursor of both project management success and then project success.

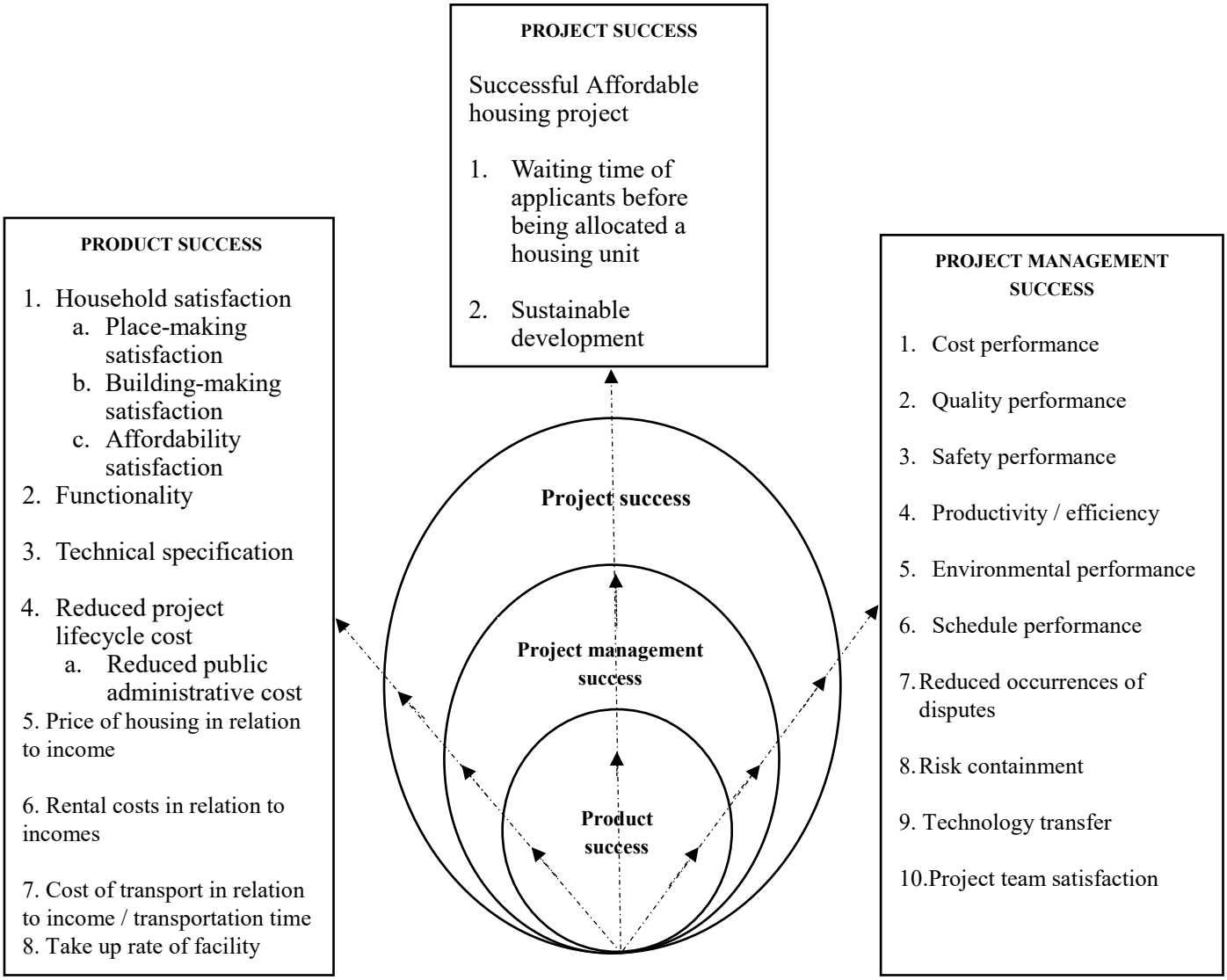

Fig. 1: A Conceptual Framework of CSC for Sustainable Affordable Housing Projects

3.2 CSC as Performance Indicators for Project Management Success

CSC also serve as indicators that can be used for monitoring and controlling project performance at the project management stage (Chan and Chan, 2004). Quantitative assessments through formulae together with qualitative assessment strategies are provided for some of the CSC to enable a comprehensive evaluation of success or otherwise of affordable housing project during the construction stage. These categories are broadly group under the project management success. They include cost performance, quality performance, safety performance, productivity / efficiency, environmental performance, schedule performance, reduced occurrences of disputes, risk containment, technology transfer and project team satisfaction.

3.2.1 Cost Performance

Cost is defined as the degree to which the general conditions promote the completion of a project within the estimated budget (Bubshait & Almohawis, 1994). The tender figure for an

affordable housing project is the budgeted cost for work to be performed while the actual cost incurred from the incipient stage of the project to completion is the actual cost for work performed. Using the cost performance index (CPI), the cost efficiency of a project can be assessed. A CPI of one (1) means the actual cost of work at completion was as budgeted. However, CPI > 1, means the project was completed below cost budget, otherwise, there is cost overruns. Another measure of cost performance is unit cost, which is the final contract sum divided by the gross floor area. Moreover, the percentage net variation over final cost can be used to measure cost performance (Chan & Chan, 2004).

$$Cost\ Performance\ Index = \frac{Budgeted\ cost\ for\ Work\ Performed}{Actual\ Cost\ for\ Work\ Performed}$$

3.2.2 Quality Performance

Quality has been defined from different perspectives. According to Parfitt and Sanvido (1993), quality is the totality of the features of a product or service to perform satisfactorily as expected. Thus, its features should fit for the intended purpose. This viewpoint of quality concentrates on the functional requirement. Bubshait and Almohawis (1994) defined quality with regard to meeting project established requirements of materials and workmanship – the technical specifications. The third aspect of quality is the aesthetical features of the completed housing unit (Chan et al., 2002). Therefore, quality can be measured as a composite criterion including the following: conform to functional requirement, technical specification, and aesthetical features. Quality is often measured subjectively (Chan and Chan, 2004). However, the quality of an affordable housing project can also be assessed objectively and mathematically. Leon et al. (2017) adopted the Construction Field Rework Index (CFRI) developed by Fayek et al. (2003) to quantitatively measure quality. CFRI is a percentage value of the amount of field rework on a construction project.

$$CFRI = \frac{Total\ direct\ plus\ indirect\ cost\ of\ rework\ performed\ in\ the\ field}{Total\ field\ construction\ phase\ cost}$$

3.2.3 Schedule Performance

Schedule performance is in relation to the duration for the completion of the housing unit. For a successful affordable housing project, delivery on time is essential to reduce the waiting time of low-income earners. Three formulae were proposed by Chan (1997) and Naoum (1994) for measuring schedule performance of projects. Speed of construction is measured relatively as the gross floor area divided by the duration. Although this is very important in measuring schedule performance of affordable housing projects, a more realistic measure will be one that that relates the 'waiting time (w) of applicants before being allocated a housing unit' to the completion time and other variables affecting waiting time. Innovative techniques such as prefabrication, industrialization, pre-stressed panels and polystyrene are strategies for expediting housing completion within time (Ahadzie et al., 2008).

3.3.4 Safety Performance

Affordable housing projects like any construction projects are prone to many worked-related accidents and injuries. The risk of a fatal accident in the construction industry is more prevalent compared to most other industries (Aksorn & Hadikusumo, 2008). Aksorn and Hadikusumo (2008) identified 16 critical success factors for promoting a safety environment at construction sites. These factors were further grouped into four dimensions: worker's involvement, safety prevention and control system, safety arrangement and management commitment. Studies have used different strategies for measuring health and performance of construction projects. Xiao

and Proverbs (2003) simply measured it by counting the number of reportable accidents. In Rankin et al. (2008), reportable incidents and lost time were the criteria for measuring safety of a project. Reportable time is the number of reported incidents measured against the hours worked during construction while lost time is the amount of time lost to incidents measured against the hours worked during construction.

3.2.4 Environmental Performance

Environmental performance is a significant CSC that assesses the impact of a project on the environment. In a study conducted by Yahya and Ibrahim (2012), environmental performance had the highest rating on the level of importance. The criteria for measuring environmental performance include environmental costs, the amount of pollutants burdening the environment as a result of the building project (Kylili et al., 2016). Other strategies have been deployed in measuring environmental performance of buildings. Dunphy et al. (2012) considered the energy savings per annum. In Ngacho and Das (2014), environmental performance of public projects was measured on a 5-point Likert scale using variables such as whether the project has led to air pollution, increased solid waste, depletion of natural resources and if the project utilised environmentally friendly technology.

3.2.5 Reduced Litigations and Disputes

Affordable housing projects are characterised by the involvement of many stakeholders with some contrasting interests and competitive goals. Litigations and dispute in project execution could arise from many sources. According to Chan and Suen (2005), sources of disputes can be grouped into three forms: contractual matters such as payment, variation, extension of time, quality of work, risk allocation, technical specification and unclear contractual terms. The second source of dispute is from cultural matters such as differences in approach to tasks, poor communication and adversarial dispute approach while legal sources of dispute include jurisdictional problems and conflict of laws. Left uncurbed, disputes may derail project completion time, increase project cost, undermine team spirit, breed inharmonious relationship among project stakeholders and lead to legal action for claims. Therefore, lack of /minimised litigations and disputes is the goal of every project. To measure the success of a project regarding disputes, Ngacho and Das (2014) employed a 5-point Likert scale to measure respondents' agreement level on disputes over specifications, dispute due to variations, dispute due to financial claims at completion, whether there were dispute resolution meetings and incidence of trade union agitation.

3.2.6 Technology Transfer

Inadequate knowledge, skills and technology of locale companies might necessitate that housing project should be constructed by foreign companies. In such instance, cross-border technology transfer from the more knowledgeable company to the locale company is very important. Technology transfer concerns the movement of knowledge and technology via some channel from one individual or firm to another (Bröchner et al., 2004). Technology transfer provides construction firms with novel technologies that can transform and complement existing technologies to create better performance level (Landaeta, 2008). To achieve technology transfer, inter-organizational networks are essential to promote the development and transfer of knowledge and resources needed to facilitate learning and innovation among participating firms (Sexton & Barrett, 2004).

3.2.7 Project management team satisfaction

Ensuring project team satisfaction is vital for efficient delivery of project. This could also translate into loyalty and good relationship among the various project stakeholders. Team

members' satisfaction criteria are based on expectation, communication, perception, commitment, dispute reduction, profitability and competency (Rashvand & Zaimi Abd Majid, 2013). Using a Likert scale, team satisfaction could be measured with these variables.

3.3 CSC as Performance Indicators for Measuring Product Success in Affordable Housing Projects

In measuring product success, formulae and scales are provided as indicators for determining the success or otherwise of an affordable housing project. Formulae are presented for price and rental affordability of an affordable house and cost of transportation in relation to income.

3.3.1 Price Affordability and Rental Price of Housing in relation to Income

Housing is affordable if the expenditure relative to income is reasonable or moderate. Using the price affordability ratio, the U.S. Department of Housing and Urban Development (HUD) states that if the total housing cost is at or below 30% of gross annual income, then the house is affordable (Hamidi et al., 2016). According to the World Bank criterion, housing price to income ratio (PIR) between 3 and 6 is considered acceptable (Lau & Li, 2006). However, in the 13th Annual Demographia International Housing Affordability Survey by Cox et al. (2017), median housing prices which are multiples of 3.0 and below of median income are considered affordable; 3.1 to 4.0 of median income are moderately unaffordable; 4.1 to 5.0 are seriously unaffordable and 5.1 and over are severely unaffordable.

$$Price\ Affordability\ ratio\ = \frac{(Total\ cost\ of\ Housing)}{(Gross\ Annual\ Income)}\ X\ 100$$

alternatively,

$$PIR\ = \frac{(Median\ housing\ price)}{(Median\ Income)}$$

Aside using price or income affordability as a measuring standard, purchase affordability considers if a household can borrow enough funds to purchase a house while repayment affordability measures the burden imposed on a household in repaying the mortgage (Gan & Hill, 2009). Similarly, to ensure that households do not pay rent at the expense of meeting other basic needs of life, rent-to-income ratios have been stipulated as basis to aid low-income earners. The Housing and Community Development Act of 1974 fixed rents for federal rental assistance programs at 25 percent of income though it was increased to 30 percent by the Omnibus Budget Reconciliation Act of 1981 and then to 50 percent of income in 1988 (Kutty, 2005). Based on the income affordability standard of 30 percent, it has been a common practise by mortgage lenders in advising borrowers not to let mortgage payment exceed 29 percent of their gross monthly income.

$$Rental\ ratio\ = \frac{Rental\ cost\ of\ housing}{Monthly\ income}\ X\ 100$$

3.3.2 Cost of Transport in Relation to Income / Transportation Time

The price affordability has limitation since it does not consider the cost of transportation which could cause cost burden on household income though housing expenditure may be affordable. Therefore, another measure of housing affordability known as location affordability index or H + T affordability index has been introduced (Fisher et al., 2009; Isalou et al., 2014). The

location affordability index is the summation of housing cost and transportation cost divided by household income, which could be expressed in percentage by multiplying the resulting figure by 100.
Mathematically,

$$H + T\ \ Index\ = \frac{(Rental\ housing\ cost + monthly\ transportation\ cost)}{(Monthly\ Income)}\ X\ 100$$

From the Centre for Neighbourhood Technology (CNT) guidelines, housing is affordable if the location affordability index is equal to or less than 45% of household income or if only transportation cost is not more than 15% of household income (Hamidi et al., 2016). For monthly income, the transportation index is calculated as follows:

$$Transportation\ index = \frac{(Monthly\ Transportation\ cost)}{(Monthly\ Income)}\ X\ 100$$

According to Fan and Huang (2011), transportation assessment with regard to time can be expressed in following formula:

$$Transportation\ Time = \frac{(Needs\ oriented\ travel\ time)}{(Household\ disposable\ time)}$$

The location affordability index has implications on both household's and national policies. This index has been used to advise household in choosing more affordable locations. It has also been utilized in identifying the right locations for sitting affordable housing to reduce travelling cost and time, reduce accident risk, save energy, reduce pollution emission and to improve economic opportunity for the disadvantaged (Isalou et al., 2014).

3.3.3 Reduced Project Lifecycle Cost of Housing

Expenditure on energy from the housing sector is high (Chegut et al., 2016). It has been reported that about 225 billion euro as energy bill and 630 million tons of CO_2 emissions were recorded among European housing sector in 2010, therefore, one of the important sectors to abate the cost of household energy is the housing sector (Chegut et al., 2016). Energy efficiency is key to reducing building life cycle cost. Building green architecture is an approach to ensuring energy efficient affordable housing. Green affordable housing leads to overall cost reduction of energy consumption. It also enhances household satisfaction through the integration of building designs, selection of materials and construction delivery (Chan & Ma, 2016).

For energy efficiency through green building architecture, the following range of strategies and technologies are relevant: Active energy efficient strategies involve improvement on heating, ventilation and air conditioning (HVAC) system, electrical lighting (such as installing compact fluorescent light and daylight sensors for exterior lighting) (Sadineni et al., 2011). Passive strategies are improvements to the elements of a building envelope. According to Sadineni et al. (2011), 31.4% of energy savings and peak load savings of 36.8% from the base case were recorded for high-rise buildings in Hong Kong. This was achieved through passive energy efficient strategies such as extruded polystyrene thermal insulation in walls, white washing external walls, 1.5m overhangs and wing walls to all windows, reflective coated glass window glazing. In Greece, energy consumption was reduced by 20-40% and 20% through thermal insulation (wall, roof and floor) and low strategies in infiltration, respectively.

3.3.4 Household Satisfaction (Residential Satisfaction)

Residential / household satisfaction is the feeling of contentment that one achieves if expectations in a house are met. Households assess residential condition based on their needs and aspirations which are influenced by household's cognitive (objective) and affective (subjective) meaning (Russell & Pratt, 1980). High degree of congruence between the actual and the desired condition leads to high household satisfaction. However, incongruence between housing needs and aspiration may lead to dissatisfaction (Mohit et al., 2010).

Keyword co-occurrence network analysis was conducted to determine the knowledge structure of residential satisfaction. This analysis is relevant towards developing a residential satisfaction scale. Result of the keyword co-occurrence (in Fig. 2) shows that residential satisfaction co-occurred with the keywords such as 'mobility', 'quality of life', 'neighbourhoods', 'community', 'Hope iv', 'redevelopment', 'housing', 'public housing', 'program', 'poverty', 'health' and 'Malaysia'. Except for Malaysia, some of these keywords could influence residential satisfaction. Though there is no explanation in previous studies for the co-occurrence and link between "Malaysia" and "residential satisfaction", it is possible that the high housing overhang in Malaysia (Tan, 2008) could have triggered more academic investigations into residential satisfaction hence the reason for the co-occurrence and link between 'Malaysia' and 'residential satisfaction'.

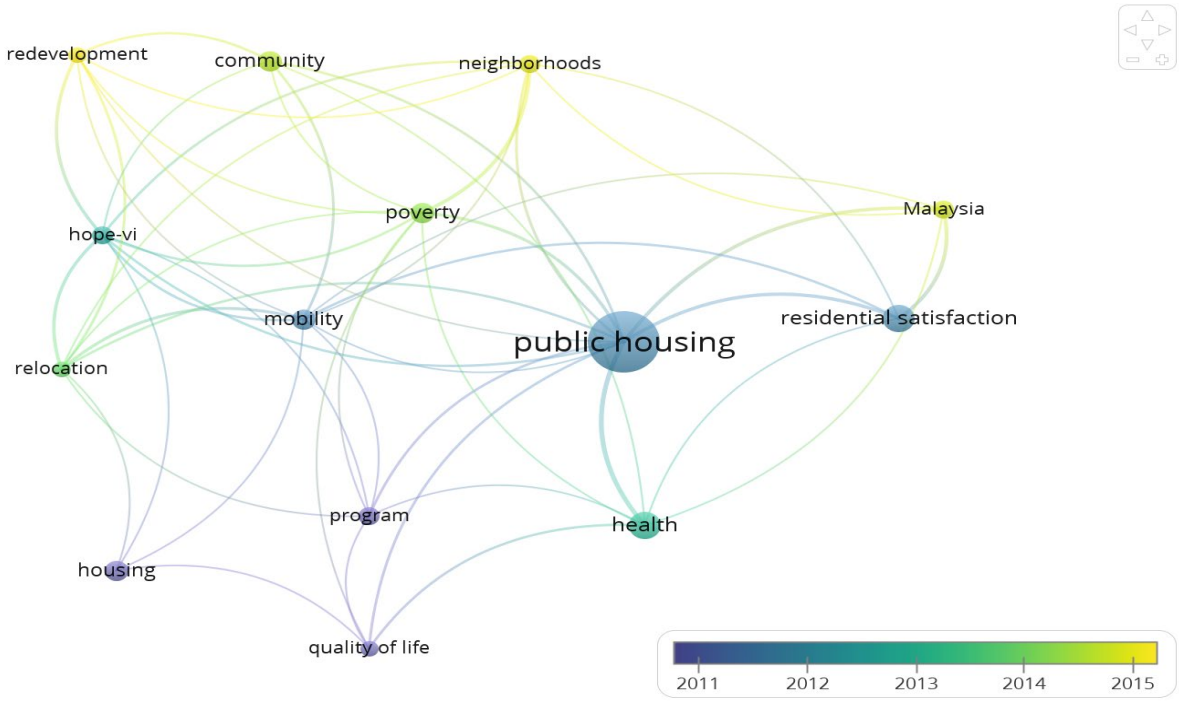

Fig 2: Keyword Co-occurrence of Household Satisfaction in Public Housing

According to Varady and Carrozza (2000), residential satisfaction among tenants includes four main categories: satisfaction with the dwelling unit, satisfaction with the service provided, satisfaction package provided for the rent and satisfaction with the neighbourhoods. Residential satisfaction could also be influenced by the community and neighbourhoods (Berk, 2005; Ghafourian & Hesari, 2017). In Mohit et al. (2010), one's neighbourhood includes the position of their house with respect to their work place, town centre, school, hospital, market, shopping centres, public library, religious building, bus and taxi station. Neighbourhoods can be considered as the place-making factors that lead to place identity, place dependence and place attachment for residential satisfaction (Ghafourian & Hesari, 2017). According to Teck-Hong

(2012), housing satisfaction may depend on the housing tenure programs. Homeownership gives greater sense of control of house, provides one's esteem needs of personal achievement and security. Moreover, homeowners invest in social capital which builds social cohesion and interaction among neighbours.

Therefore, based on the keyword co-occurrence shown in Fig 2, a scale for measuring residential satisfaction should include variables for satisfaction with the housing facility (such as functional requirement of housing); variables for community and neighbourhood satisfaction (such as sense of belonging to a place, memorable spatial setting, pleasant spatial setting, satisfaction with how environment promotes social interaction and relationship, level of satisfaction with symbolic features linking an individual to a place, one's satisfaction with community identity (Ghafourian & Hesari, 2017)) ; variables for quality of life and health (such as level of satisfaction with the physical comfort in building and surrounding and how satisfied household meets needs without trade off on other basic needs).

3.4 CSC as the Ends to Justify the Means for Sustainable Affordable Housing Projects-Recommendations for Further Study

Studies have shown that a relationship can be established between the "ends" and "the means to the ends" of a project (Cserhati & Szabo, 2014; Kwofie et al., 2016). In Kwofie et al. (2016), on developing a critical success model for PPP public housing delivery in Ghana, CSC as the ends were considered as the dependent variables while CSFs (the means) were the independent variables. Among the project "ends", in their study, include satisfaction of parties, delivering affordable houses, quality housing, timely delivery of project within budget. The "means to the ends" include provision of guarantees by governments, right project identification and project technical feasibility, competitive and transparent procurement process, stable macro-economic environment and efficient and effective financial market. The project ends were measured as a composite dependent variable and then linked in a regression equation to identify the "means to the ends". Though the study by Kwofie et al. (2016) established this link based on the supply aspect of affordable housing, not much studies exist on the demand and supply perspective for end users and developers, respectively. Besides, a comprehensive index, not provided in the study conducted by Kwofie et al. (2016), can be developed from the identified criteria in this study to measure success from the perspective of both the household and developers.

Therefore, it is recommended that using the list of CSC provided in the framework, a mathematical index can be established to measure success at the various stages. Upon determining the index, a mathematical model can be developed to establish a relationship between the index (the ends) as the dependent and the means as the independent variables. For instance, in (Osei-Kyei & Chan, 2017), Fuzzy Synthetic Evaluation model was used to develop project success index for PPPs which was then related to project critical success factors. Similarly, in affordable housing projects, we recommend that a more comprehensive equation between the "ends" and the "means" can be expressed mathematically as shown in equations (1), (2) and (3) to determine the means for affordable housing projects at the various stages.

For the product success stage,

$$Index_{(product\ success)} = \partial_1 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \cdots + \beta_n X_n + \varepsilon_i \quad \text{---- equation (1)}$$

Where $Index_{(\text{Product success})}$ represents the "ends of product success"
∂_1 is the intercept / constant

X_1, X_2, X_3, X_4 and X_n represent the "means to product success"
β_1, β_2, β_3, β_4 and β_n represent the marginal values which indicate the estimated change in the dependent variable, $\text{Index}_{(\text{product success})}$, for a unit change in the independent variables X_1, X_2, X_3, X_4 and X_n
ε_i represents the residual or error term

For the project management success stage,
Similarly, after determining an index for affordable housing project management success, the means and the index can be expressed as in equation (2)

$$Index_{(project\ management\ success)} = \partial_2 + \delta_1 Y_1 + \delta_2 Y_2 + \delta_3 Y_3 + \delta_4 Y_4 + \cdots + \delta_n Y_n + \varepsilon_i \text{ --equation (2)}$$

Where $Index_{\text{(Project management success)}}$ represents the "ends of project management success"
∂_2 is the intercept / constant
Y_1, Y_2, Y_3, Y_4 and Y_n represent the "means to project management success"
δ_1, δ_2, δ_3, δ_4 and δ_n represent the marginal values which indicate the estimated change in the dependent variable, $\text{Index}_{\text{(Project management success)}}$, for a unit change in the independent variables Y_1, Y_2, Y_3, Y_4 and Y_n
ε_i represents the residual or error term

For the project success stage,
Finally, when the project success of affordable housing index is determined, then the means to achieve project success can be obtained as shown in equation (3)

$$Index_{(project\ success)} = \partial_3 + \delta_1 \eta_1 + \delta_2 \eta_2 + \delta_3 \eta_3 + \delta_4 \eta_4 + \cdots + \delta_n \eta_n + \varepsilon_i \quad \text{---- equation (3)}$$

Where $Index_{\text{(Project success)}}$ represents the "ends of project success"
∂_3 is the intercept / constant
η_1, η_2, η_3, η_4 and η_n represent the "means to project success"
δ_1, δ_2, δ_3, δ_4 and δ_n represent the marginal values which indicate the estimated change in the dependent variable, $\text{Index}_{\text{(Project success)}}$, for a unit change in the independent variables η_1, η_2, η_3, η_4 and η_n
ε_i represents the residual or error term

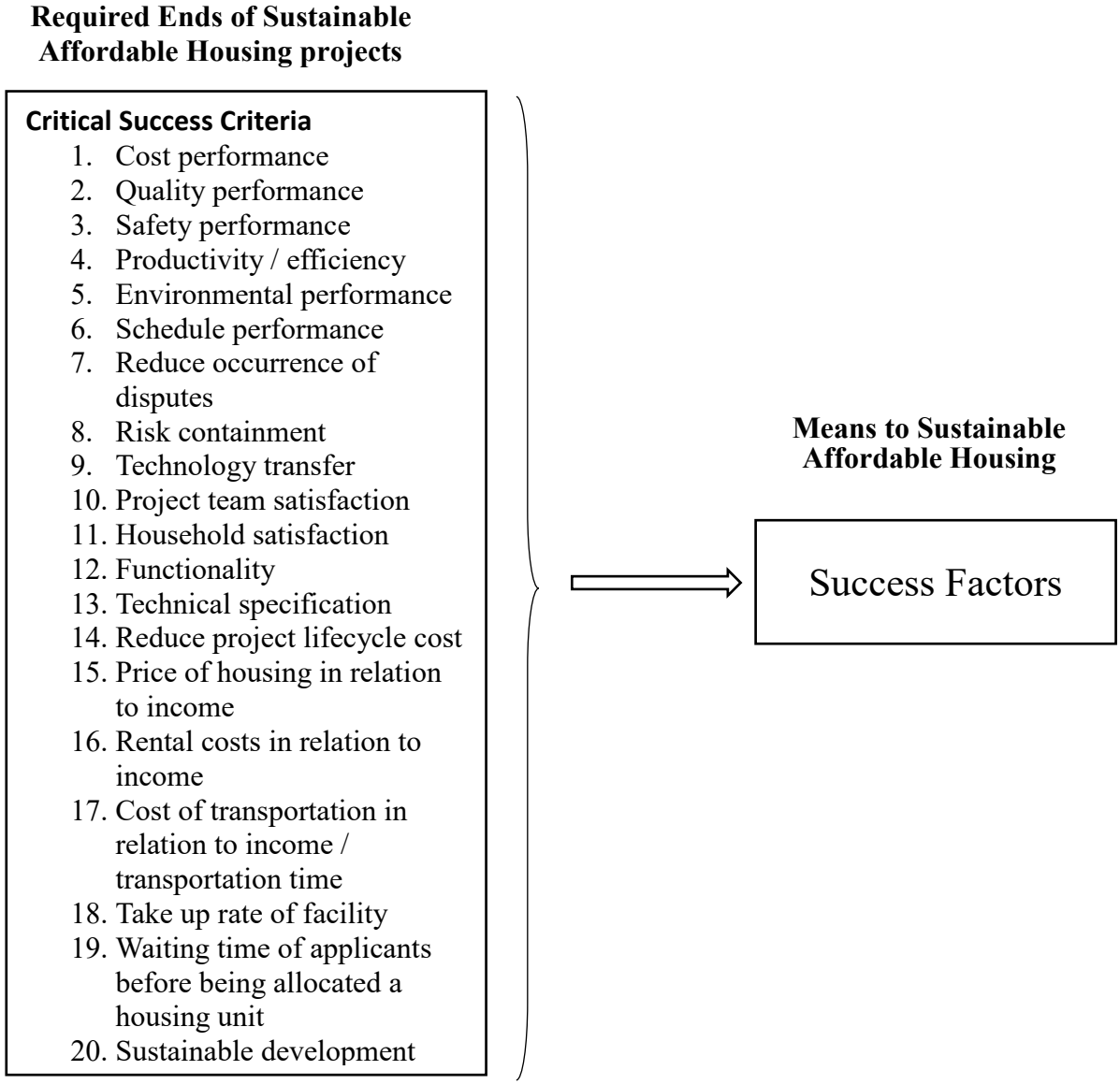

Fig 3: CSC as the Required Ends to Justify the Means

4. Conclusions

Affordable housing supply deficit, both in qualitative and quantitative terms, is a problem worldwide. Monitoring and controlling performance of affordable housing projects to improve housing provision requires critical success criteria (CSC). However, debates on specific success criteria for construction projects and for that matter affordable housing remains unresolved.

Therefore, in this research, a systematic literature review was adopted to identify CSC for monitoring performance of affordable housing projects. Results of the review indicated that in addition to the three traditional criteria – cost performance, quality and schedule performance – safety performance, productivity / efficiency, environmental performance, reduced occurrence of disputes, risk containment, technology transfer, project team satisfaction, household satisfaction, functionality, technical specification, reduced project life cycle cost, price of housing in relation to income, rental costs in relation to incomes, cost of transportation in relation to income, take up rate of facility, waiting time of applicants before being allocated a housing unit and sustainable development are equally important measures of success in affordable housing projects. A conceptual framework was developed based on the identified CSC which were categorized into three stages for measuring success in affordable housing. These success stages include product success; project management success and project success. This conceptual framework simulates the existing dependency among the stages of success, providing a better understanding of how success at one stage could influence the success criteria at another stage.

Though the aim of this study was achieved, there is a limitation which is worth noting. The conceptual framework was developed based on findings from a review study and not on empirical data. It is therefore recommended that future study could use empirical data with real case study to assess the practicalities of these CSC.

Notwithstanding the limitation, this study has two main contributions relevant to academia and to practice: it enhances understanding by demonstrating the interdependence among various stages for successful sustainable affordable housing projects. The developed framework could be used as a model by public housing authorities and real estate developers for measuring success in housing delivery. To academia, this study provides the basis for developing performance index or mathematical model for evaluating success in affordable housing projects.

Acknowledgement

This paper forms a part of a large Ph.D. research project entitled “Affordable Housing Supply: A Comparative Study between Developed and Developing Economies”, from which other papers have been produced with different objectives but sharing common background and methodology. The authors gratefully acknowledge the Research Grants Council (RGC) and the Department of Building and Real Estate of The Hong Polytechnic University for funding this study. The authors are also thankful to the editors and anonymous reviewers for their constructive comments that helped to hone the quality of this paper.

References

Ahadzie, D., Proverbs, D., & Olomolaiye, P. (2008). Critical success criteria for mass house building projects in developing countries. *International Journal of Project Management, 26*(6), 675-687.

Aksorn, T., & Hadikusumo, B. (2008). Critical success factors influencing safety program performance in Thai construction projects. *Safety Science, 46*(4), 709-727.

Al-Tmeemy, S. M. H. M., Abdul-Rahman, H., & Harun, Z. (2011). Future criteria for success of building projects in Malaysia. *International Journal of Project Management, 29*(3), 337-348.

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management, 17*(6), 337-342.

Baccarini, D. (1999). The logical framework method for defining project success. *Project management journal, 30*, 25-32.

Barraza, G. A., Back, W. E., & Mata, F. (2004). Probabilistic forecasting of project performance using stochastic S curves. *Journal of Construction Engineering and Management, 130*(1), 25-32.

Bassioni, H. A., Price, A. D., & Hassan, T. M. (2004). Performance measurement in construction. *Journal of Management in Engineering, 20*(2), 42-50.

Berk, M. G. (2005). The Concept of Neighbourhood in Contemporary Residential Environments: An Investigation of Occupants' Perception.

Bogdon, A. S., & Can, A. (1997). Indicators of local housing affordability: Comparative and spatial approaches. *Real Estate Economics, 25*(1), 43-80.

Bröchner, J., Rosander, S., & Waara, F. (2004). Cross-border post-acquisition knowledge transfer among construction consultants. *Construction Management and Economics, 22*(4), 421-427.

Bryde, D. J., & Robinson, L. (2005). Client versus contractor perspectives on project success criteria. *International Journal of Project Management, 23*(8), 622-629.

Bubshait, A. A., & Almohawis, S. A. (1994). Evaluating the general conditions of a construction contract. *International Journal of Project Management, 12*(3), 133-136.

Cai, W., & Lu, X. (2015). Housing affordability: Beyond the income and price terms, using China as a case study. *Habitat International, 47*, 169-175.

Chan, A. (1997). Measuring success for a construction project. *The Australian Institute of Quantity Surveyors–Referred Journal, 1*(2), 55-59.

Chan, A. P., & Chan, A. P. (2004). Key performance indicators for measuring construction success. *Benchmarking: An International Journal, 11*(2), 203-221.

Chan, A. P., Scott, D., & Lam, E. W. (2002). Framework of success criteria for design/build projects. *Journal of Management in Engineering, 18*(3), 120-128.

Chan, C., & Ma, T. (2016). Energy Efficiency Housing in South Australia – A Gap Analysis between the Expected and Actual Benefits. *Procedia Engineering, 164*, 446-452. doi:10.1016/j.proeng.2016.11.643

Chan, E. H., & Suen, H. C. (2005). Disputes and dispute resolution systems in Sino-foreign joint venture construction projects in China. *Journal of Professional Issues in Engineering Education and Practice, 131*(2), 141-148.

Chegut, A., Eichholtz, P., & Holtermans, R. (2016). Energy efficiency and economic value in affordable housing. *Energy Policy, 97*, 39-49. doi:10.1016/j.enpol.2016.06.043

Cheung, S. O., Suen, H. C., & Cheung, K. K. (2004). PPMS: a web-based construction project performance monitoring system. *Automation in Construction, 13*(3), 361-376.

Chiu, R. L. (2007). Planning, land and affordable housing in Hong Kong. *Housing Studies, 22*(1), 63-81.

Cooke-Davies, T. (2002). The "real" success factors on projects. *International Journal of Project Management, 20*(3), 185-190.

Cox, R. F., Issa, R. R., & Ahrens, D. (2003). Management's perception of key performance indicators for construction. *Journal of Construction Engineering and Management, 129*(2), 142-151.

Cserhati, G., & Szabo, L. (2014). The relationship between success criteria and success factors in organisational event projects. *International Journal of Project Management, 32*(4), 613-624.

Darko, A., & Chan, A. P. C. (2016). Critical analysis of green building research trend in construction journals. *Habitat International, 57*(April), 53-63. doi:10.1016/j.habitatint.2016.07.001

Dunphy, N. P., Little, J., & van der Krogt, R. (2012). *Model for retrofit configuration selection using multiple decision diagrams.* Paper presented at the Proceedings of the 2012 Building Simulation and Optimization Conference. Loughborough, UK: Loughborough University.

Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, web of science, and Google scholar: strengths and weaknesses. *The FASEB journal, 22*(2), 338-342.

Fan, Y., & Huang, A. (2011). How affordable is transportation? A context-sensitive framework.

Fayek, A. R., Dissanayake, M., & Campero, O. (2003). Measuring and classifying construction field rework: A pilot study. *Research Rep.(May)*.

Fisher, L. M., Pollakowski, H. O., & Zabel, J. (2009). Amenity-Based Housing Affordability Indexes. *Real Estate Economics, 37*(4), 705-746.

Forsythe, P. J. (2007). A conceptual framework for studying customer satisfaction in residential construction. *Construction Management and Economics, 25*(2), 171-182.

Gan, Q., & Hill, R. J. (2009). Measuring housing affordability: Looking beyond the median. *Journal of Housing Economics, 18*(2), 115-125.

Ghafourian, M., & Hesari, E. (2017). Evaluating the Model of Causal Relations Between Sense of Place and Residential Satisfaction in Iranian Public Housing (The Case of Mehr Housing in Pardis, Tehran). *Social Indicators Research*, 1-27.

Hamidi, S., Ewing, R., & Renne, J. (2016). How affordable is HUD affordable housing? *Housing Policy Debate, 26*(3), 437-455.

Hong, Y., Chan, D. W., Chan, A. P., & Yeung, J. F. (2011). Critical analysis of partnering research trend in construction journals. *Journal of Management in Engineering, 28*(2), 82-95.

Hong, Y., Chan, D. W. M., Chan, A. P. C., & Yeung, J. F. Y. (2012). Critical Analysis of Partnering Research Trend in Construction Journals. *Journal of Management in Engineering, 28*(2), 82-95. doi:10.1061/(asce)me.1943-5479.0000084

Hu, Y., Chan, A. P., Le, Y., Xu, Y., & Shan, M. (2016). Developing a program organization performance index for delivering construction megaprojects in China: Fuzzy synthetic evaluation analysis. *Journal of Management in Engineering, 32*(4), 05016007.

Ibem, E. O., & Amole, D. (2013). Residential satisfaction in public core housing in Abeokuta, Ogun State, Nigeria. *Social Indicators Research, 113*(1), 563-581.

Ibem, E. O., & Azuh, D. E. (2011). Framework for evaluating the sustainability of public housing programmes in developing countries. *Journal of Sustainable Development and Environmental Protection (JSDEP), 1*(3), 24-39.

Isalou, A. A., Litman, T., & Shahmoradi, B. (2014). Testing the housing and transportation affordability index in a developing world context: A sustainability comparison of

central and suburban districts in Qom, Iran. *Transport Policy, 33*, 33-39. doi:10.1016/j.tranpol.2014.02.006
Kagioglou, M., Cooper, R., & Aouad, G. (2001). Performance management in construction: a conceptual framework. *Construction Management and Economics, 19*(1), 85-95.
Ke, Y., Wang, S., Chan, A. P., & Cheung, E. (2009). Research trend of public-private partnership in construction journals. *Journal of Construction Engineering and Management, 135*(10), 1076-1086.
Kutty, N. K. (2005). A new measure of housing affordability: Estimates and analytical results. *Housing Policy Debate, 16*(1), 113-142.
Kwofie, T. E., Afram, S., & Botchway, E. (2016). A critical success model for PPP public housing delivery in Ghana. *Built Environment Project and Asset Management, 6*(1), 58-73.
Kylili, A., Fokaides, P. A., & Jimenez, P. A. L. (2016). Key Performance Indicators (KPIs) approach in buildings renovation for the sustainability of the built environment: A review. *Renewable and Sustainable Energy Reviews, 56*, 906-915.
Landaeta, R. E. (2008). Evaluating benefits and challenges of knowledge transfer across projects. *Engineering Management Journal, 20*(1), 29-38.
Lau, K. M., & Li, S.-M. (2006). Commercial housing affordability in Beijing, 1992–2002. *Habitat International, 30*(3), 614-627.
Leon, H., Osman, H., Georgy, M., & Elsaid, M. (2017). System Dynamics Approach for Forecasting Performance of Construction Projects. *Journal of Management in Engineering, 34*(1), 04017049.
Lim, C., & Mohamed, M. Z. (1999). Criteria of project success: an exploratory re-examination. *International Journal of Project Management, 17*(4), 243-248.
MacLennan, D., & Williams, R. (1990). Affordable housing in Britain and America. *Joseph Rowntree Foundation, York*.
Maloney, W. F. (2002). Construction product/service and customer satisfaction. *Journal of Construction Engineering and Management, 128*(6), 522-529.
Mohit, M. A., Ibrahim, M., & Rashid, Y. R. (2010). Assessment of residential satisfaction in newly designed public low-cost housing in Kuala Lumpur, Malaysia. *Habitat International, 34*(1), 18-27.
Mulliner, E., Smallbone, K., & Maliene, V. (2013). An assessment of sustainable housing affordability using a multiple criteria decision making method. *Omega, 41*(2), 270-279.
Naoum, S. G. (1994). Critical analysis of time and cost of management and traditional contracts. *Journal of Construction Engineering and Management, 120*(4), 687-705.
Nassar, N., & AbouRizk, S. (2014). Practical application for integrated performance measurement of construction projects. *Journal of Management in Engineering, 30*(6), 04014027.
Ngacho, C., & Das, D. (2014). A performance evaluation framework of development projects: An empirical study of Constituency Development Fund (CDF) construction projects in Kenya. *International Journal of Project Management, 32*(3), 492-507.
Osei-Kyei, R., & Chan, A. P. (2017). Developing a project success index for public–private partnership projects in developing countries. *Journal of Infrastructure Systems, 23*(4), 04017028.
Osei-Kyei, R., & Chan, A. P. C. (2015). Review of studies on the Critical Success Factors for Public–Private Partnership (PPP) projects from 1990 to 2013. *International Journal of Project Management, 33*(6), 1335-1346. doi:10.1016/j.ijproman.2015.02.008
Parfitt, M., & Sanvido, V. (1993). Checklist of critical success factors for building projects. *Journal of Management in Engineering, 9*(3), 243-249.

Pheng, L. S., & Chuan, Q. T. (2006). Environmental factors and work performance of project managers in the construction industry. *International Journal of Project Management, 24*(1), 24-37.

Pinter, U., & Pšunder, I. (2013). Evaluating construction project success with use of the M-TOPSIS method. *Journal of Civil Engineering and Management, 19*(1), 16-23.

Pullen, S., Arman, M., Zillante, G., Zuo, J., Chileshe, N., & Wilson, L. (2010). Developing an assessment framework for affordable and sustainable housing. *Australasian Journal of Construction Economics and Building, The, 10*(1/2), 60.

Rankin, J., Fayek, A. R., Meade, G., Haas, C., & Manseau, A. (2008). Initial metrics and pilot program results for measuring the performance of the Canadian construction industry. *Canadian Journal of Civil Engineering, 35*(9), 894-907.

Rashvand, P., & Zaimi Abd Majid, M. (2013). Critical criteria on client and customer satisfaction for the issue of performance measurement. *Journal of Management in Engineering, 30*(1), 10-18.

Russell, J. A., & Pratt, G. (1980). A description of the affective quality attributed to environments. *Journal of personality and social psychology, 38*(2), 311.

Sadineni, S. B., Madala, S., & Boehm, R. F. (2011). Passive building energy savings: A review of building envelope components. *Renewable and Sustainable Energy Reviews, 15*(8), 3617-3631.

Seelig, T., & Phibbs, P. (2006). Beyond the Normative: Low Income Private Renters' Perspectives of Housing Affordability and Need for Housing Assistance. *Urban Policy and Research, 24*(1), 53-66. doi:10.1080/08111140600590858

Sexton, M., & Barrett, P. (2004). The role of technology transfer in innovation within small construction firms. *Engineering, Construction and Architectural Management, 11*(5), 342-348.

Stone, M. E. (1994). Comment on Kathryn P. Nelson's" Whose shortage of affordable housing?".

Stone, M. E. (2006). What is housing affordability? The case for the residual income approach. *Housing Policy Debate, 17*(1), 151-184.

Susilawati, C. (2009). Can risk management boost the supply of affordable housing development and management? *International Journal of Housing Markets and Analysis, 2*(4), 392-402.

Tan, T.-H. (2008). Determinants of homeownership in Malaysia. *Habitat International, 32*(3), 318-335.

Teck-Hong, T. (2012). Housing satisfaction in medium-and high-cost housing: The case of Greater Kuala Lumpur, Malaysia. *Habitat International, 36*(1), 108-116.

Toor, S.-u.-R., & Ogunlana, S. O. (2009). Construction professionals' perception of critical success factors for large-scale construction projects. *Construction Innovation, 9*(2), 149-167.

Torbica, Ž. M., & Stroh, R. C. (2001). Customer satisfaction in home building. *Journal of Construction Engineering and Management, 127*(1), 82-86.

Varady, D. P., & Carrozza, M. A. (2000). Toward a better way to measure customer satisfaction levels in public housing: A report from Cincinnati.

Wai, S., Yusof, A. M., & Ismail, S. (2012). Exploring success criteria from the developers' perspective in Malaysia. *International Journal of Engineering Business Management, 4*, 33.

Wang, X., & Huang, J. (2006). The relationships between key stakeholders' project performance and project success: Perceptions of Chinese construction supervising engineers. *International Journal of Project Management, 24*(3), 253-260.

Westerveld, E. (2003). The Project Excellence Model®: linking success criteria and critical success factors. *International Journal of Project Management, 21*(6), 411-418.

Whitehead, C. M., & Scanlon, K. (2007). *Social housing in Europe*: London School of Economics and Political Sciences.

Xiao, H., & Proverbs, D. (2003). Factors influencing contractor performance: an international investigation. *Engineering, Construction and Architectural Management, 10*(5), 322-332.

Yahya, M. R., & Ibrahim, M. N. (2012). Building maintenance achievement in high rise commercial building: a study in Klang Valley, Malaysia.

Yeung, J. F., Chan, A. P., & Chan, D. W. (2009). Developing a performance index for relationship-based construction projects in Australia: Delphi study. *Journal of Management in Engineering, 25*(2), 59-68.