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Green Building Success Criteria: Interpretive Qualitative Approach

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Abstract

Green Buildings (GBs) are gaining popularity world over. This study aims to investigate the criteria which determine the success of GB projects. This study employs the interpretive qualitative approach. Semi-structured interviews (n=40) across five countries are conducted with experts acting in different roles in GBs. Overall 17 Success criteria and 39 sub-criteria are identified. Some key Success criteria are about meeting the needs of building occupants (n=25), meeting project aspirations (n=16), realising sustainable building operations (n=15), and achieving GB certifications (n=14). The identified criteria are inquired to determine if they are about doing the 'right things', about doing 'things right', or about generating value. The interrelationships among Success criteria and the priorities placed on some Success criteria in GB projects according to the respondents are also discussed. Theoretically, the inquiry of criteria adds depth to the understanding of building project success in general and GB success in particular. Practically, the comprehensive list of Success criteria can be used as a guide on GB projects for performance evaluation and for controlling project performance.

Keywords

Success criteria; Green Building; Qualitative; Interviews; Sustainability; Interpretive

Introduction

There is an increased focus towards the development of energy-efficient and low-emission building projects to deal with the intense urbanisation concerns (Dean et al., 2016, Hoornweg and Freire, 2013). Society is driven towards Green Buildings (GBs) as these buildings consider environmental sustainability and also have an emphasis towards building users (Darko et al., 2017, Balaban and de Oliveira, 2017). In this regard, Kibert (2016) defines GBs as "… healthy facilities designed and built in a resource-efficient manner, using ecologically based principles".

GBs are significantly different from conventional buildings because of the added complexity in their development and operations resulting from their enhanced focus towards sustainability. For instance, in GBs, team collaboration and design integration are highly significant, unlike in conventional buildings (Korkmaz et al., 2011b, Swarup et al., 2011, Ahmad and Aibinu, 2017). GBs are distinct from their traditional counterparts not only because of the difference in the project development process but also because both these building types involve different stakeholder expectations (Sharples, 2011). Since the criteria for determining project success are strongly interlinked with the user's expectations of a project and unlike traditional buildings GBs have a sustainability mandate, it is postulated that GBs may have significantly different Success criteria as compared to their traditional counterparts.

Project Success

For both theory and practice, the understanding of project success stands out as a primary concern. Project success is often defined in terms of Success criteria and Success factors. The scope of this study will be limited to Success criteria only and will not include Success factors. In general, the factors which contribute towards good project performance can be termed as Success factors, while the set of principles used for judging project performance can be considered Success criteria (Ahmad and Aibinu, 2017, Ika, 2009). For instance, end-users' satisfaction can be considered a Success criterion as it

defines success for a product or project. However, collaboration within a project team is a Success factor and not a success criterion, since it enables project success instead of characterising it. A number of previous studies on GB projects have investigated Success factors (Yu et al., 2018, Bilec, 2008, El Asmar et al., 2013, Korkmaz et al., 2010a, Korkmaz et al., 2010b, Korkmaz et al., 2011b, Korkmaz et al., 2011a, Swarup et al., 2011, Carpenter, 2005a, Molenaar et al., 2009a, Enache-Pommer and Horman, 2009a, Hanks, 2015, Gultekin et al., 2013a, Olanipekun et al., 2018, Sang et al., 2018, Hwang et al., 2016, Hwang et al., 2015, Lam et al., 2010, Wang et al., 2013, Venkataraman and Cheng, 2018b, Shen et al., 2017, Robichaud and Anantatmula, 2010, Aktas and Ozorhon, 2015, Li et al., 2011, Bond, 2010, Hwang et al., 2017, Banihashemi et al., 2017, Kiani Mavi and Standing, 2018, Pheng Low et al., 2014, Bakar et al., 2009, Ihuah et al., 2014). On the contrary, Success criteria have not received much attention in previous studies. This study will focus on Success criteria only.

Significance of Success criteria

Success criteria are about bringing the intangible idea of success into the tangible realm. Success criteria are the desired ends that affect the means (in other words Success factors) to achieve these ends (Lichtig, 2005). Hence, for an evaluation of what leads to project success, it is necessary to establish the criteria of project success (Turner, 1999). Wateridge (1998) also recognised the importance of Success criteria in these terms by stating that, “Only when the Success criteria have been defined can project managers consider the appropriate factors to deliver those criteria.” For instance, a project only focussed towards performing well in client-related criteria may adopt a different development approach as compared to a project which also strives to perform well in environment-related criteria. Once Success criteria applicable to a certain project type are determined, it is possible to conduct intermediate or post-completion audits to identify the reasons for project success or failure. Based on the acquired knowledge, remedial actions can be taken for a project or the learnt lessons can be applied to future projects (De Wit, 1988).

Research need

Although the concept of project success remains ambiguous and lacks consensus from literature, it has been accepted as context-specific (Ika, 2009). Previous research conducted on project success has demonstrated the impracticality of developing an exhaustive and generalised list of Success factors and criteria, which are applicable to all projects (Ika, 2009). As projects are unique and significantly vary from each other based on their complexity and scope (Wateridge, 1998, Ika, 2009), the importance of different Success criteria also varies with project type (Müller and Turner, 2007). The Success criteria previously identified in literature may have limited applicability in the case of GB projects. This is because GB projects have some special requirements and stakeholder expectations, and therefore may have some unique Success criteria. Hence, for the identification of Success criteria in GBs, an exclusive focus over these projects will be required.

Owing to the level of complexity, sustainability focus, special development context and stakeholder expectations, it is postulated that GB projects have a specific and dedicated list of Success criteria. Previous studies have been conducted on Success criteria of projects in general (Baker et al., 1997, Baccarini, 1999, Shrnhur et al., 1997, Slevin and Pinto, 1986, Pinto and Slevin, 1988, Belout and Gauvreau, 2004, Frefer et al., 2018) and for construction projects in particular (De Wit, 1988, Lim and Mohamed, 1999, Bryde and Robinson, 2005, Bahia and de Farias Filho, 2010, Al-Tmeemy et al., 2011, Mukhtar and Amirudin, 2016, Adabre and Chan, 2019, Chan and Adabre, 2019). However, there is a lack of studies that exclusively focus on Success criteria of GB projects. Considering the research need in this area, this study aims to investigate Success criteria in GB projects

Research aim and objectives

The aim of this study is to investigate Success criteria in GB projects. To achieve this aim, identifying GB Success criteria is of foremost importance. To explore the role of identified Success criteria, their associations and priorities in practice also need to be discussed.

Accordingly, the specific objectives of this study are:

1. to identify Success criteria of GB projects
2. to identify associations among Success criteria
3. to investigate priority placed on these success criteria in practice.

Green buildings are also known as sustainable or high-performance buildings. A distinction can be drawn between sustainable buildings and green buildings, based on the reasoning that the former has more consideration towards socio-economic aspects than the later (Berardi, 2013). This study relies on the Green Building definition by EPA (2016) and does not distinguish between sustainable buildings and green buildings. For the purpose of this study, GBs are considered as building projects developed using sustainability principles. These projects may or may not have GB certifications.

The structure of the paper is such that first the theoretical framework is reported. This is followed by an account of previous research. Afterwards, the methodology is presented. Results are presented in three parts. First, the Success criteria identified from interview data are presented. The associations among the Success criteria are then explained, followed by priorities of Success criteria in GBs. Results are followed by an interpretation and discussion of findings.

Theoretical framework: Effectiveness, Efficiency and Value-Generation

While it is hard to find agreement among the concepts of project success in literature, there is a consensus that project success involves effectiveness and efficiency (Ika, 2009, Belout, 1998). Drucker, a renowned American author, described effectiveness as to 'do the right things' and efficiency as to 'do things right'. While both the concepts are important, effectiveness takes precedence over efficiency (Drucker, 2003, Chevalier, 2008). The concepts of effectiveness and efficiency can be used to define project success (Belout, 1998). Accordingly, success criteria for a project can be about 'doing the right things' (for instance, delivering the project according to specified quality standards) and 'doing things right' (for instance, delivering the project within specified budget). The Success criteria

identified in this study will be analysed to determine if they are related to the concept of effectiveness or efficiency.

While project success can be conceptualised in terms of 'doing right things' and 'doing things right', it can also be conceptualised in terms of the generation of value. When a project is successfully developed it implies that something valuable is created for someone. 'Value-generation' can be an important perspective in an inquiry related to project success. This perspective implies that as a project outcome, value is created for different stakeholders. Articulated in the 1930s, the view of production as the Value-generation has the basic goal of achieving the best possible value for the customer (Koskela et al., 2002). According to Koskela (2000), the Value-generation view conceptualises production "as a process where value is created through the fulfilment of his [client's] requirements". The key principle of the Value-generation view is to eliminate value losses. According to this perspective, waste is the expense of labouring force which does not produce value (Koskela et al., 2012).

To some extent, environmental sustainability is inherently linked to the concept of 'waste' provided by the Value-generation view. This is because the unwanted outcomes result in waste and these outcomes are not only related to the (main) product but also related to the unwanted by-products of the production process such as harmful emissions, injuries and work-related sickness (Bølviken et al., 2014). When analysing the value, Rooke et al. (2010) provided a distinction between outputs and outcomes (p. 17). Based on this distinction, it can be said that in the value perspective waste is a situation where the 'outputs' of production are not the 'outcomes' (Bølviken et al., 2014). Hence, the adverse environmental footprint of a building qualifies as waste.

Although the Value-generation view by Koskela which is also used in Lean Construction, has considerations towards the client's requirements, this view has limited considerations towards other stakeholders, such as society (Salvatierra-Garrido et al., 2010). Success criteria may associate with value for not only project client and users but also for other stakeholders. The findings of this study

151 will be analysed to determine the Success criteria which result in value for clients and end-users (in
152 other words following Koskela's view of the Value-generation) and which result in the value for other
153 stakeholders such as society and construction industry. This analysis will not only provide an
154 interpretation of study findings (i.e. Success criteria) using the viewpoint of the Value-generation, it
155 will also show the limitations related to the popular view of value advocated by Lean Construction.

156 The concept of Effectiveness, Efficiency and the Value-generation will help interpret the findings of
157 this study.

158 Green Building Success criteria: Previous studies and Point of departure

159 Studies have been conducted previously to investigate the effect of different factors on the
160 performance of GB projects. The performance criteria used in previous studies are shown in Table 1.
161 These criteria include project management-related performance (that is Schedule, Cost, and Quality);
162 environmental, economic, and social sustainability performance; performance in GB certifications;
163 safety performance; technical performance; organisational performance; and public perception of the
164 project.

165 **(Insert Table 1 here)**

166 The studies on GB project success are highly focussed towards project management-related criteria
167 which are schedule (number of studies=8), cost (n=8), and quality (n=6). In terms of the sustainability-
168 related criteria, some studies considered the performance of GB projects at the level of individual
169 sustainability dimension i.e. social sustainability (n=1), economic sustainability (n=2), and
170 environmental sustainability (n=4). However, some other studies considered the sustainability
171 performance in more depth, such as in terms of indoor environmental quality (n=1) and occupant
172 turnover rate (n=1). Many studies (n=7) also used GB certifications as the measure of sustainability
173 performance. GB certifications as a measure of sustainability performance were used in empirically
174 driven studies where it was preferred to assess project sustainability by considering the certification

levels and scores instead of only relying on client's and end-users' perceptions of sustainability performance.

Previous studies as shown in Table 1, were focused on investigating the associations of different factors with sustainability performance. These studies were not aimed to explore Success criteria in GBs. Moreover, previous studies have used GB certifications as criteria of sustainability performance (Table 1). The limitation in this regard is that the GB certifications may not always result in the achievement of sustainable outcomes in a project (Navarro, 2009). Hence, GB certifications partially define the success of GB projects at best.

Previous GB-related studies have used the terms 'performance criteria', 'performance metrics', 'performance indicators' and 'dependent variables', instead of using the term 'Success criteria'. For the sake of clarity, the criteria used in previous studies will be cumulatively addressed as performance criteria while the criteria investigated in this study will be addressed as Success criteria.

The review of previously published literature on GB project success shows that the focus of research studies is majorly towards the investigation of Success factors and not towards the inquiry of Success criteria. While considering GBs as significantly different from traditional construction projects, this study will investigate Success criteria in GBs.

Methodology

Research design

According to Baker et al. (1997), project success can hardly be considered as an absolute concept, and instead occurs as the "perceived success of a project". Different stakeholders may perceive the outcomes of the same project in different ways (Wateridge, 1998). Since a project has a wide variety of stakeholders involved, its Success criteria must represent the views and expectations of all the stakeholders involved (Ika, 2009, Han et al., 2011, Stuckenbruck, 1986). The use of the interpretive approach in research can help incorporate the variety of perceptions of stakeholders regarding project

success, hence providing a comprehensive rationalisation of project success. An important aspect of this approach is the collection of stakeholder opinions from in-depth interviews, relying on the 'richness' of words instead of quantitative indicators only. The use of interpretive approach can open new avenues for the less investigated research areas of project success such as GB project success which is still in its exploratory stages, and therefore can benefit from the qualitatively-driven approach.

This study adopts a constructivist research paradigm which is based on the belief that knowledge of the observed reality is constructed rather than discovered (Levers, 2013). The interpretive epistemology is used in this study based on which the methodology was to gather the opinion of the stakeholders who have been involved in GB project delivery. Instead of limiting the data collection to project managers and clients, other stakeholders such as sustainability consultants, design consultants, and contractors were also interviewed. Semi-structured interviews were used as the data collection method. Since GB projects are significantly different from traditional building projects in terms of their development and have not previously received much research attention in terms of their success criteria, the scope of this study is limited to GB projects only.

Interviews as data collection method

Instead of using questionnaire survey approach, in-depth interview technique was selected as the data collection approach. This was based on accessibility, and the potential to collect valid and reliable data. Although interviews are more time-consuming and expensive to conduct as compared to questionnaires, they are superior in terms of the access to comprehensive and detailed expert knowledge. Also, by using in-depth interviews the implicit information can be conveniently drawn explicitly (Akbayrak, 2000). The factor of potential biasness exists in both questionnaire and interview due to self-reporting (Akbayrak, 2000, Oppenheim, 2000). However, biasness in interviews can be effectively reduced by training the interviewer to make him/her aware of the potential issues, careful articulation of questions, and the matching of the attributes of the interviewer with the sample to be

interviewed (Akbayrak, 2000). Although higher anonymity and confidentiality is offered by questionnaires as compared to interviews (Akbayrak, 2000), these aspects did not become the decision-making criteria, as the discussion in interviews was not of personal nature. Based on these considerations, the in-depth interview technique was selected as the data collection approach.

Interviews are particularly relevant for this study as it is aimed to explore the criteria which define GB project success. This study verifies if the performance criteria used in previous GB-related studies provide a comprehensive articulation of project success and if not, then which criteria are required to systematically define GB success.

To minimise the potential bias, the questions and theme areas to be used in interviews were scrutinised and submitted for research ethics approval by the academic ethics committee. To match the language of the interviewer with that of the interviewees, all the interviews were conducted in English.

Interview sample

Determining the number of interviews in a qualitative study depends on the nature and purpose of research. In general, experts agree that in a qualitative study, saturation is the ideal parameter for determining the sample size (Baker et al., 2012, Morse, 2000). Since the collected data were to be subjected to qualitative analysis, saturation was used as a measure to determine the sample size. Regarding saturation, Guest et al. (2006) realised that 12 interviews are enough for most of the research studies aimed to understand the common perceptions and experiences among a group of relatively homogeneous individuals. However, 12 interviews may not be enough for the studies in which the domain of inquiry is diffuse or vague, and the selected group of participants is relatively heterogeneous. Larger samples may also be required in case the research goal is to assess variation between distinct groups or correlation among variables.

As compared to recommended guidelines, a significantly larger convenience sample of 40 interview participants was used in this study. This relatively large sample size is used because interviews are to be conducted with slightly heterogeneous participants (i.e. GB-related stakeholders having various roles in GB projects and belonging to different regions). Interviews with subject matter experts were conducted in Australia (n=18), Hong Kong (n=7), Singapore (n=12), the UAE (n=1), and the UK (n=2). While the interview participants were mainly experience in GB projects in their regions of belonging, some participants also had the experience of working on GB projects in Mainland China (n=6), Malaysia (n=2), Indonesia (n=1), New Zealand (n=1), Kazakhstan (n=1), Barcelona (n=1), Asia Pacific (n=1), South East Asia (n=1), Canada (n=1), Mexico (n=1), and the US (n=1). The details related to the regional origin, role, and experience of interview participants are provided in the Appendix section (Table 4). These regions were selected because they are on the track of increased development of GBs and also have a significant number of professionals with extensive experience in developing GBs (Analytics, 2016). In addition, different geographical regions were selected to result in a comprehensive list of Success criteria and to observe the difference in findings based on regional variations. As indicated in Table 4, the interview participants are highly experienced building professionals as most of them (n=37) have a minimum of 7 years of experience in developing GB projects. These GB professionals are design/architecture consultants (n=11), engineering consultants (n=9), sustainability consultants (n=9), client/developer team members (n=4), contractor team members (n=4) and facility management professionals (n=2). Two interview participants also had a project management role in GB projects. Up to 17 interviewees had the experience of acting in multiple roles in the development of GB projects.

Although some interviews (n=12) were also conducted by telephone, most were face-to-face (n=29). This is the best choice when participants are geographically accessible to the researcher (2008), as it allows the researcher to have more control and access to rich information. Depending on the availability of participants, interviews lasted between 25 to 60 minutes. The interviews had the mean duration of 43 minutes and the median duration of 42 minutes.

Collection of interview data

The interviews primarily explored the theme of GB-related Success criteria. As a secondary aspect of the work, the themes of GB-related Success factors, drivers, and challenges were also explored. This paper reports on the Success criteria theme. The other themes are beyond the scope of this paper and are reported elsewhere.

In some of the initial interviews, the participants indicated Success factors when asked to mention Success criteria of GB projects. During interview meetings, the interviewer was able to mitigate this confusion with ease. The question was revised and instead of asking participants to mention Success criteria they were asked to define a successful GB project. While reflecting on their personal conceptualisation of GB success, the interviewees would typically respond that "a successful Green Building is the one which has ___, which performs well in ___. The building needs to perform well in these criteria/aspects because ___".

A number of procedures were adopted to ease the access to information, reduce bias in findings, and ensure the quality of the collected data. These include the use of digital recording, the role of the researcher as interviewer and transcriber, the use of a denaturalised transcription approach, the use of interviewee transcript review process, and the use of computer-aided thematic coding for data analysis.

Processing and analysis of interview data

The interview data were analysed using thematic analysis which was used to classify the findings into groups and categories. The thematic analysis helped identify the criteria of successful GB projects. Furthermore, based on the in-depth understanding of GB Success criteria provided in interviews, the importance of different Success criteria was also identified. Content analysis is used to quantitatively interpret the interview data and for conducting frequency analysis. The six steps of conducting thematic analysis as indicated by Braun and Clarke (2006), have been used in this study. Familiarity with the data was developed by reading interview transcripts multiple times, and then the initial codes

were generated, and themes were searched. The identified themes were reviewed by their cross-comparison. This was followed by defining and naming themes which were finally reported.

Considering the ability of thematic analysis to organise and describe the dataset (Braun and Clarke, 2006), it is used for a qualitative analysis of interview data. The thematic analysis in this study is conducted at two levels, that is at the level of explicit meanings of data and at the level of underlying ideas in data. In the semantic approach of thematic analysis, the themes are identified within the explicit meanings of the data. For instance, when discussing Success criteria an interview participant mentioned that supporting the industry through innovation is important for GB project success. Using the semantic approach, this was considered a Success criterion. In latent approach, the analysis goes beyond the semantic content of the data and starts to identify or examine the underlying ideas, assumptions, conceptualisations, and ideologies (Braun and Clarke, 2006). For instance, some interview participants mentioned supporting the industry through innovation (n=1) and promoting green user behaviour (n=2) as success criteria. Upon analysing these responses for underlying ideas, it was realised that the interview participants were mentioning the quality of a building project to act as a source of learning. Based on the analysis of underlying ideas, a building project's ability to act as a source of learning was considered a parent Success criterion with multiple sub-criteria. Since both the levels of analysis are important for this study, thematic analysis in case of this study is conducted at the semantic level while identifying Success criteria and at the latent level while investigating hierarchies of Success criteria. The classification of GB Success criteria resulting from thematic analysis eased the qualitative analysis and also helped interpret findings. The categorisation resulted in 17 criteria and 39 sub-criteria.

In the thematic analysis, codes occur at a primary level and categories or themes occur at a secondary level. Themes are based on the analysis of codes rather than of data (Elliott, 2018). For this study, the interviews were manually transcribed by the researcher and then coded in a computer-based application, NVivo 12, which can systematically code large qualitative datasets (Wiltshier, 2011). Both

the inductive and deductive approaches were used during the coding process. From the codes, themes emerged which were further analysed and reported. Both the thematic analysis and coding process informed each other in a cyclic process. The coding for thematic analysis was also used in conducting the content analysis.

Content analysis is used in this study to transform qualitative data into quantitative data. By systematically evaluating texts, the content analysis method offers the opportunity to convert qualitative data into numbers or percentages (Vaismoradi et al., 2013, Xenarios and Tziritis, 2007) and enables a quantitative analysis of qualitative data (Wang et al., 2013). The method has also been previously used for GB project success research (Wang et al., 2013). Considering the usefulness of content analysis for this research inquiry, it has been adopted in addition to the thematic analysis. Content analysis in this study led to the development of adjacency matrices and the lists/sets of factors which have eventually led to a circle chord diagram visualising associations among Success criteria.

In this study, content analysis has determined the frequency of occurrence of different Success criteria and these frequencies have determined the importance of identified criteria. Counting may serve as a useful indicator for the importance of a given code (Elliott, 2018). For the quantitative analysis of qualitative research data obtained from interviews, the key parameter used in this study is 'frequency' which is based on the counting of codes. Frequency in this study means the number of participants identifying a Success criterion. Since the research data are mostly qualitative, frequency analysis is used to interpret the relative importance of Success criteria.

Results

Success criteria identification

This section provides the findings related to the first objective of this study which is to identify Success criteria of GB projects. In the semi-structured interviews, the most used words in the discussion on GB Success criteria (as shown in Figure 1) include 'building', 'project', 'success', 'green', 'performance',

and ‘needs’. Some other highly mentioned words refer to project stakeholders, for example, ‘users’, ‘people’, ‘client’, ‘occupants’, ‘community’, and ‘human’. The word cloud shows that after social aspects, the most used words refer to the environmental aspects. Economic aspects (for instance, ‘savings’) are least mentioned. Hence, the preliminary analysis indicates that the interview participants did not provide a balanced account of social, economic, and environmental dimensions of GB success.

(Insert Fig. 1 here)

As a result of the thematic analysis of interviews, 56 criteria defining GB project success are identified. These are classified into 17 criteria and 39 sub-criteria, as presented in Table 2.

(Insert Table 2 here)

Individual project team members have different roles and responsibilities in a GB project. Since project success is a subjective concept, a project team member, depending on his/her role and experience in GBs, may develop his/her own perception of project success and allocate different priorities to Success criteria of GB projects. Interpreting findings with respect to the roles of stakeholders is also important because different stakeholders have a different approach to sustainability in building projects (Herazo and Lizarralde, 2016). The perceptions related to project success can also vary geographically as explained. Hence, when asked, an interview participant provides his/her viewpoint of GB success based on his/her subjective experience.

The viewpoints of GB experts belonging to a variety of professional roles have been included in this inquiry. The interview participants are based in five regions, have worked in GB development from 2 to 35 years and have been involved in GB development both as service providers and service seekers. The analysed findings related to the viewpoints of interview findings are shown in Table 2.

The criteria identified by more than 5 participants as shown in Table 2 (Column-O) are about human-oriented development (C-1; n=25), meeting client’s aspirations (C-2; n=16), realising sustainable

operations (C-3; n=15), achieving GB certifications (C-4; n=14), improving environment (C-5; n=9), achieving tangible economic benefits (C-6; n=7), and learning from project experience (C-7; n=6). The criteria identified by the least number of participants are about achieving the maximum potential sustainability (C-14; n=1), sustainability in construction (C-15; n=1), building integration (C-16; n=1), and design innovation (C-17; n=1).

The analysis based on the region of origin (Column-L, M, N in Table 2) shows that the participants based in Australia (n=18) identified 41 criteria, participants from Hong Kong (n=7) identified 23 criteria, and participants from Singapore (n=12) identified 36 criteria. In the case of Hong Kong, Singapore, and Australia two of the top three most highlighted criteria are about human-oriented development (i.e. C-1) and meeting aspirations (i.e. C-2). This suggests a high significance of these Success criteria among all three regions. Other than these two criteria, participants from Hong Kong (n=7), have emphasised on project as a source of learning (C-7; n=3); participants from Singapore (n=12) stressed on sustainable building operation (C-3; n=6) and GB certifications (C-4; n=4); and respondents from Australia (n=18) have emphasised GB certifications (C-4; n=8) and sustainable building operation (C-3; n=7).

The analysis based on the professional roles of the majority of participants (Column-G, H, I in Table 2) shows that the Design Consultants (n=11) have identified 35 criteria, Engineering Consultants (n=8) have identified 22 criteria while the Sustainability Consultants (n=11) have identified 24 criteria. Although both the groups had the same number of participants, the Design Consultants identified 11 criteria more than those identified by Sustainability Consultants.

Four criteria (C-1, C-2, C-3, and C-4) are highly focused on by at least 2 out of the 3 groups of professionals (i.e. Design, Engineering, and Sustainability Consultants). These criteria are about ensuring human-oriented development (i.e. C-1), meeting aspirations (C-2), realising sustainable operations (C-3), and achieving certifications (C-4). These criteria also stand out as the top four criteria for both the groups of participants having low to medium experience (n=23) and high to very high

experience (n=17) of GB development as shown in Table 2 (Column-J, K). While 3 criteria and 7 sub-criteria are only identified by participants with high to very high experience, 29 criteria and 14 sub-criteria are only identified by participants with low to medium experience. The criteria only identified by participants with low to medium experience are about building project to act as a benchmark (C-13; n=2), realising sustainability in construction (n=1), and ensuring building integration (C-16; n=1). The criteria only identified by participants with high to very high experience are about achieving the maximum potential sustainability (C-14; n=1), and design innovation (C-17; n=1).

In the case of this inquiry, the diversity in professional roles, experience, and regional belonging of interview participants has helped develop a comprehensive list of GB Success criteria. The comprehensive understanding of project success provided by the GB experts also verifies the importance of using the explorative research design.

Associations among Success criteria

To address objective 2 of the study, the associations among Success criteria were explored. The circle chord diagram as shown in Figure 2 shows the associations among the Success criteria, and is developed based on the interpretation of interview findings. A relationship matrix was developed in which success criteria associations were coded in a tabular format. By using CIRCOS, an online software package for visualising data, the relationship matrix was transformed into a circle chord diagram (Figure 2).

The association among two criteria 'A' and 'B' means that the fulfilment of 'A' helps fulfil 'B' and/or *vice versa*. The criteria associated with more than 10 other criteria are about meeting project aspirations (C-2), achieving the maximum potential sustainability (C-14), project to act as a source of learning (C-7), realising sustainable building operations (C-3), and ensuring that the building project responds to its surroundings (C-12). The high degree of associations among the Success criteria shows that good or bad performance in terms of one criterion can influence the performance of other criteria. While most of the associations among the criteria are positive in nature, some are also

421 negative in nature. A detailed account of some of the associations explicitly indicated by interview
422 participants is provided in the following sections.

423 **(Insert Fig. 2 here)**

424 *Innovation involved in building design*

425 'Innovation involved in building design' (C-17) has a negative association with reliability-related
426 criterion (C-8) since innovation and reliability in design may not be achieved together. According to
427 *AU-M-3*, 'if there is too much focus on the innovation than to develop the base product right, the
428 sustainability outcomes may get compromised.' As innovation results in high expenditures in a project,
429 it can also have negative associations with the criteria related to economic aspects (i.e. C-6 and C-2).

430 Since smart character in a building (C-10) is currently subject to innovation in building systems (C-17),
431 it can also have a negative association with the reliability-related criterion (C-8). Even though the
432 innovation-related criterion (C-17) has a negative association with reliability-related criterion (C-8) and
433 economic sustainability-related criteria (C-6 and C-2), it associates positively with the learning-related
434 criterion (C-7). This is because innovation in project development can result in a learning experience
435 for project stakeholders as well as the construction industry.

436 *Building project acting as a source of learning*

437 The project as a source of learning is a criterion which has both positive as well as negative associations
438 with other criteria. This is because both success and failure in a project can act as a source of learning.
439 According to *AU-M-13*, "People may put a lot of money in certain aspects of the project, and they may
440 not be successful. However, these experiences can be learnt from and the lesson can be used in the
441 subsequent applications of a technology."

Building acting as a human-oriented and occupant-centric development

In case a building is to act as a human-oriented and occupant-centric development (i.e. criterion C-1), the user needs may need to be prioritised over building efficiency. Therefore, this criterion (C-1) can have a negative association with the criterion regarding the balanced building design (i.e. C-11).

Building responding to the variations in use

The ability of a building to respond to variations (C-9) may have a negative association with the tangible economic benefits (C-6) since investing in building design for unforeseen future needs may seem to result in unnecessary expenses. Adaptability in the building (i.e. C-9) may also negatively associate with integration (C-16) and environmental sustainability-related criteria (C-3 and C-5). This is because an integrated building design can result in high system efficiencies but reduced opportunities for variations in building use.

Achieving Green Building development-related certifications

Achieving GB certifications is an important Success criterion in GBs as it may support the project performance in many other criteria as well. While a prevalent opinion is to consider the achievement of GB certifications as a Success criterion, it is also argued that GB certifications may not necessarily guarantee sustainability in GBs (Scofield, 2009). The interview findings have offered reasons for the difference in opinions.

The majority of interview participants agree on the importance of GB certifications as a Success criterion. According to interviewees, fulfilling the requirements of the client is a Success criterion in GBs and since clients require certifications for projects, achieving those certifications also acts as a Success criterion. Owing to the standardised and rigorous methods used for achieving GB certifications, the performance in sustainability-related criteria is facilitated in case a project follows the certification pathway. While reflecting on this aspect, *AU-M-13* said, “Green Star guidelines can be used to guide the sustainable development even if the certification is not required.”

Besides the importance associated with GB certifications, achieving these may not always result in good sustainability performance. While expressing some concerns regarding certifications, a participant from Australia (*AU-M-8*) said, "in a practical way, success in GBs is about achieving a particular number of credits on a GB project, as required for a targeted level of Green Star rating. It may not necessarily bear a correlation with the environmental performance or the efficiency of a project."

For a positive association of GB certifications with sustainability-related criteria, interviewees pointed out that it should be linked to the project objectives. For successful GB development, it matters whether certifications are pursued as 'end results' or as 'means to the ends'. According to interview participants, when certifications in projects are used as the means of developing a GB, the project performs well in terms of sustainability. However, a project focused on achieving certifications as 'end results' may not have a focus on sustainability performance. Furthermore, following GB certifications as a checklist approach instead of following their intended goal can lead to potential neglect of other important criteria such as users' satisfaction. Hence, depending on the way a certification approach is used in GB project development, certifications (C-4) can associate both positively and negatively with other sustainability-related Success criteria (C-5, C-1, C-6).

Success criteria in a GB project are interrelated and resultantly good performance in some criteria results in a good or bad performance in other criteria. Success criteria are not given equal priorities in projects. In reality, some criteria are prioritised and the associations among criteria can be one of the reasons why some criteria are prioritised over the others. The next section provides a detailed account of the criteria prioritised in GBs and the reasons why some Success criteria are prioritised.

Prioritising Success Criteria in Green Building projects

While several criteria can be used to determine the success of GB projects, some criteria may have more importance than others. The third objective of this study is fulfilled by exploring the priorities placed on the GB success criteria.

Need for balanced attention towards sustainability-related criteria

Different dimensions of sustainability are interrelated in GB projects. Underperformance in one dimension can affect the performance of other dimensions. This indicates the need for balanced preferences towards different Success criteria related to sustainability dimensions in a GB. Several interview participants highlight that GBs are different from non-GBs particularly because they tend to provide a similar or better indoor environment but with a reduced environmental footprint. Since the indoor environment, energy use, lifecycle costs and environmental footprint are interconnected, a challenge in developing GBs is to balance these considerations. Balanced attention towards sustainability criteria also implies that the end-users' requirements are not ignored and the comfort and well-being are not sacrificed for energy savings.

Success criteria priorities depending on project life-cycle stages

A building project has socio-economic and environmental effects not only at the time of its development but also during its operational stage. Therefore, to achieve sustainability performance in GB projects, the Success criteria related to both its development and operation are important. Hence, sustainability in both the project development and operation needs to be prioritised. Such considerations can holistically increase the social value of building assets and reduce the environmental footprint of project development.

Unlike sustainability, the level of importance of some other criteria depend on the stage of project development and therefore the priorities towards such criteria may change as the project moves from inception to completion. For instance, according to *SN-M-4*,

> *"In the whole project, you have to be aware of the changes …… Until the building is developed the quality is managed and monitored. But once the building is operational, user experience begins to matter."*

Some aspects of a project are of strategic importance such as the capacity of a building to adapt to future needs. In case the lifecycle perspective is used in the project, compromising immediate

economic benefits in favour of the adaptability potential for future variations seems like a difficult but important choice. In this regard *SN-M-5* highlighted that, "the concern about Return on Investment [ROI] shouldn't be so high. It's not that the ROI is not important. When you design features which grow over time, the ROI can take care of itself."

Success criteria priorities depending on regional context and industrial development

The priorities towards different building attributes seem to vary from one region to another and this also affects the Success criteria perception for GB projects. According to a respondent (*HK-M-6*) from Hong Kong, "in developed countries, health and well-being are important criteria for selecting a building to buy or rent." Hence, for developed economies, a GB project's success may be determined by its ability to ensure the end-users' health and well-being.

The complexity related to GBs and the ease of their development is subject to change with time as the local construction industry develops. Owing to this, the perceptions of a GB project success can change and subsequently, the preferences towards Success criteria in GB projects can also change.

According to interview participants the construction industry in Singapore tends to be focused on human-oriented and occupant-centric GB development. In the case of Australia, the preferences towards Success criteria have shifted from innovations in GB designs to sustainable operations of GBs. Priorities of GB Success criteria are subject to the regional context as highlighted by participants belonging to Australia, Hong Kong and Singapore.

Success criteria priorities depending on stakeholders

The priorities towards Success criteria are subject to the role of a person in GB project development. Service providers and service seekers associate different priorities to Success criteria of a GB project. Service providers are contractually required to deliver end results and they may not perceive those aspects as Success criteria which are not a part of their job requirement. According to *SN-M-10*, acting as a design consultant for GB projects in Singapore, "from the building consultant's viewpoint, the success concept is quite simple. You need to get the aspired Green Mark certificate and for you, it will

be a successful green building." According to *AU-M-7*, a Green Star coordinator in a contractor's team, "if the building project aims for a green rating system and the target is achieved, then for a builder, it is considered as having success in sustainable outcomes."

Based on the roles and responsibilities of the service providers, they may also develop an understanding of project success at the component level instead of systems level. According to *SN-M-6*, acting as an Engineering Consultant for HVAC systems, "we have been in this industry for quite long. In terms of success, we think of aspects like what is the best air-conditioning efficiency which can be achieved. What is the best thermal comfort which can be achieved? If the building fails to meet the aspired performance, we will be concerned that where the potential problem is."

Being an influential stakeholder, the client's vision of success can determine the final outcomes of a GB project. However, projects have different types of clients and this can result in varying success definitions from one project to another. A key distinguishing aspect among clients is their relationship with the project. A client who develops a project to own and operate it may perceive project success differently as compared to a client who develops the project to sell it. According to a participant (*HK-M-7)*, "in case the project is an owner-occupied building, then clients are concerned about Green Building performance from a life-cycle perspective." While this is the case of developer organisations, which owns and operates the projects upon development, this may not reflect the GB success perception of other developers who are more interested in selling properties than owning them. According to *AU-M-2*, "there are private developers who use sustainability ratings to sell the building in the market, but these developers are not interested in the operational performance of the building. Once the building is off their hand, it's not their problem anymore." While explaining the lack of consideration towards liveability in the building sector in the UAE, *AE-F-2* said, "if we look at the clients and developers involved in a large number of building projects with a focus on selling the projects, they do not care much about liveability aspects in the buildings." While presenting the GB success perception of a typical client, a respondent (*HK-M-2)* stated, "for clients and developers, success often

means to get the certification. In case the targeted certification is achieved, they think that the project is successful." Hence, a variation in a client's perception of GB project success can be related to his/her relationship with the project.

Interpretation and Discussion of findings

While using a qualitative methodology, this study has identified the Success criteria related to GB projects. A detailed inquiry on the difference in the agreement of stakeholders related to GB success was beyond the scope of this inquiry. However, based on a comparative analysis, the inquiry has revealed that different groups of participants may have different opinions related to GB Success criteria based on their experience, their regional belonging, and their role in the GB projects.

Interpretation of findings based on Effectiveness, Efficiency and Value-generation view

While considering the role of effectiveness and efficiency in defining project success, the association of identified criteria with these two concepts is analysed (Column-E, F in Table 2). Most of the Success criteria and sub-criteria (n=47) associate with the 'effectiveness' of GB projects, while some criteria and sub-criteria (n=9) associate with the 'efficiency' of projects. For instance, instead of being an outcome, good indoor environment quality (C-1.04) is a way of achieving the outcome, i.e. sustainability. Hence, it associates with efficiency instead of effectiveness.

Schedule, cost, and quality are the criteria know as 'traditional performance criteria', 'iron triangle', and 'project management criteria' and have received much attention in project success-related studies (Ika, 2009). 'Meeting client's expectations of cost performance' is a criterion related to cost performance. Although quality has not been explicitly identified as a Success criterion, in case quality is considered as 'fitness for purpose', it resembles C-2, i.e. 'meeting project aspirations and client's requirements'. Lastly, criteria related to schedule performance have not been identified in interviews. This highlights that even though some criteria of project success prevail in theory and practice,

589 individuals may not consider those criteria when asked about their practice. The inquiry of project
590 success therefore intrinsically requires the interpretation of stakeholders' definition of success.

591 The value analysis (Column-A, B, C, D in Table 2) shows that 13 criteria and 37 sub-criteria can create
592 value for not only the project clients and occupants but also for the environment, society, and the
593 construction industry. The 'value for clients and occupants' is associated with 7 criteria and 31 sub-
594 criteria; 'value for the environment' is associated with 7 criteria and 9 sub-criteria; 'value for society'
595 is associated with 2 criteria and 2 sub-criteria; and the 'value for Construction Industry' is associated
596 with 2 criteria and 1 sub-criterion. There are 4 criteria and 2 sub-criteria which do not seem to create
597 value for any stakeholder. These criteria are associated with efficiency instead of effectiveness. This
598 means that criteria associated with efficiency may not be directly related to the Value-generation. The
599 detailed interpretation of Success criteria in terms of the Value-generation view and the Waste
600 reduction concept is as follows,

601 • 'Reducing environmental impact and improving environment' is a criterion strongly associated
602 with the concept of Waste reduction. Reduction in greenhouse gas emissions, embodied energy,
603 waste, and water usage means that the waste of resources occurring in the development and
604 operation of a building is reduced;
605 • 'Building acting as a human-oriented and occupant-centric development' is a criterion strongly
606 associated with the concept of the Value-generation. All its sub-criteria create direct or indirect
607 value for the client. Some of these sub-criteria such as 'Users' productivity ensured in building',
608 'Reduced absenteeism ensured in building', and 'Building providing an optimum work
609 environment' imply that the waste of end-users' productivity is reduced in the operational life of
610 the building;
611 • The criterion of 'achieving tangible benefits of sustainability', and its sub-criteria, are about
612 reducing the operation and maintenance costs of a building. Hence, these criteria reduce the
613 waste of economic resources;

- ‘Realising sustainable and efficient building operations’ is a criterion associated with both the Value-generation and the Waste reduction concept. Sustainable building operations are required by clients in GBs, hence sustainable operations generate value. Sustainable building operations also reduce the waste of resources and energy;
- ‘Building project acting as a source of learning’ is partially associated with the Value-generation concept since one of its sub-criteria may result in value for the client (i.e. ‘Building promoting green user behaviour’) while the other sub-criterion (i.e. ‘Building project supporting industry through innovation’) may not be the desired outcome for a client;
- ‘Building to act as a benchmark’ is a criterion which may associate with the Value-generation concept in case this is the desired outcome for the project client. Even if a building is not developed to be a benchmark, its success or failure can still present lessons for the construction industry;
- The criterion of ‘meeting project aspirations and client’s requirements’ and its sub-criteria are strongly associated with the concept of the Value-generation as by meeting client’s requirements a direct value for the client is created;
- The criterion of ‘achieving good results in a reliable and consistent way’ and its sub-criteria are strongly associated with the concept of Waste reduction. A project performing well on these criteria will continue to create value for the client instead of creating waste scenarios in which the building is not used as intended;
- ‘Building responding to the variations in use’ is a criterion strongly associated with the concept of Waste reduction. A project performing well in terms of this criterion and its sub-criteria will adapt to a client’s changing needs and therefore potential wastes resulting from no-use of the building may be avoided;
- ‘Realising smart character in building’ is a criterion associated with both the Value-generation and the Waste reduction concept. Building smartness can add value for a client and the use of automation can also reduce waste by optimising operational performance (Akram et al., 2016);

- Achieving GB certifications (C-4) and sustainability in construction (C-15) are criteria associated with both the Value-generation and the Waste reduction concept. Since GB certifications can lead to sustainable project development these criteria add value for a client. Even the mere certification is the desired outcome for many clients as highlighted by many interview participants. The natural resource and energy waste is also reduced as these criteria optimise the building performance and reduce the environmental footprint of construction;
- The balanced (C-11), innovative (C-17), and integrative building design (C-16) criteria have no direct association with the Value-generation or the Waste reduction concept. Since these criteria can contribute towards sustainable building outcomes, they indirectly contribute to the generation of value or reduction of waste;
- 'Achieving the maximum potential sustainability in building project' is a criterion associated with both the Value-generation and the Waste reduction concept. This is because within the Value-generation viewpoint, waste occurs when the potentially possible value is not provided (Koskela, 2000);
- 'Building responding to its surroundings' is a criterion with no direct relation to the Value-generation or the Waste reduction concept. Although the criterion and it's sub-criterion, i.e. 'Building integrated well within community' can result in increased value for the community and ecosystem in building's vicinity, there may not be a direct value created for the client.

The analysis of Success criteria reveals that some of the identified criteria are strongly related to the concept of value generation for a client while others are strongly related to the concept of Waste reduction. 'Realising sustainable and efficient building operations', 'Sustainability considered during building construction', and 'Reducing environmental impact and improving environment' are the three criteria exclusively associated with the environment. If Koskela's definition of Value-generation and Waste is considered, the Success criteria resulting in value for the environment will also generate value for the project clients and occupants. This is because generating value for a client involves the concept of avoiding potential waste related to unwanted by-products (i.e. environmental

degradation). Although the popular Value-generation view by Lean Construction explains Success criteria resulting in value for client and environment, it does not explain the criteria resulting in value for society and the construction industry. The criteria of 'Building having a balanced design' and 'Building responding to its surroundings' are not directly associated with the client-oriented Value-generation concept, however, they create value for the environment and society.

Comparison of Success criteria with performance criteria from previous studies

The identified Success criteria are compared against the criteria used in previous GB research (Korkmaz et al., 2010a, Korkmaz et al., 2010b, Korkmaz et al., 2011b, Korkmaz et al., 2011a, Swarup et al., 2011, Carpenter, 2005a, Molenaar et al., 2009a, Enache-Pommer and Horman, 2009a, Hanks, 2015, Gultekin et al., 2013a, Olanipekun et al., 2018). It is worth noting that unlike this research, previous studies were not aimed at identifying GB success criteria. Table 3 shows that some of the criteria occurring in previous GB research are similar to the criteria identified in this study.

(Insert Table 3 here)

Other than the eight criteria shown in Table 3, the remaining nine Success criteria identified in this study do not match with those of previous GB-related research studies. Although these 9 criteria have not been identified as 'Success criteria' in previous studies, they have been investigated by previous studies nonetheless. This shows that to some extent the role of these 9 factors for building projects is acknowledged. For instance, studies have investigated reliability in building projects (Wu et al., 2006); adaptability in buildings (Kincaid, 2000, Pinder et al., 2013); smart character in buildings (Snoonian, 2003); balanced design for buildings (Ibrahim, 2015); responsiveness of buildings to communities (Plaut et al., 2012); innovation in building design (Bossink, 2007); and building projects as a source of learning (Fedoruk et al., 2015). The integrated building design has also been discussed in previous studies but instead of a Success criterion, it has been studied as a Success factor (Bilec, 2008, Molenaar et al., 2009a, Enache-Pommer and Horman, 2009a, Korkmaz et al., 2010a, Korkmaz et al., 2010b, Korkmaz et al., 2011a, Swarup et al., 2011, Korkmaz et al., 2011b, Gultekin et al., 2013a, Hanks, 2015).

691 Eventhough, a dedicated inquiry of GB success criteria is missing in the literature, previous studies
692 have considered the criteria identified in this study as important factors for building projects. Hence,
693 precedence for the factors identified in this study exists in literature even if they have not been
694 considered as Success criteria.

695 Comparison of Success criteria with credit categories of Green Building certification 696 systems

697 Green Building certification systems affect the GB project designs (He et al., 2018) and therefore
698 influence the practice of GB development. To examine the representation of GB Success criteria
699 identified in this study in the practice of GB development, the Success criteria are compared with four
700 GB certification systems, which are Leadership in Energy and Environmental Design (LEED) system by
701 the U.S. Green Building Council, Building Research Establishment Environmental Assessment Method
702 (BREEAM) by the U.K. Building Research Establishment, Green Star system by Green Building Council
703 of Australia, and Living Building Challenge system by International Living Future Institute. The
704 certification systems are comprised of multiple frameworks focused on different project types and
705 life-cycle stages. To compare with the findings in this study the LEED frameworks used are 'Building
706 Design and Construction' and 'Building Operations and Maintenance'; BREEAM framework used is 'UK
707 New Construction'; Living Building Challenge framework used is 'Buildings'; and Green Star
708 frameworks used are 'Design & As-Built' and 'Performance'. These certification systems assess the
709 sustainability performance of buildings using a variety of credit categories, for example, water and
710 energy. From among the overall 17 criteria identified in this study, 12 criteria are associated with 9
711 categories of Green Star, 7 categories of Living Building Challenge, 9 categories of LEED, and 10
712 categories of BREEAM. Some criteria highly associated with the certification systems are 'Reducing
713 environmental impact and improving environment', 'Building acting as a human-oriented and
714 occupant-centric development' and 'Realising sustainable and efficient building operations'. By
715 association, it means that the categories of certification systems provide a complete or partial

716 representation of Success criteria. For instance, 'innovation involved in building design' is a Success
717 criterion associated with the 'innovation' category of the LEED system. The association of Success
718 criteria with categories of certification systems is provided in Figure 3.

719 **(Insert Fig. 3 here)**

720 The LEED, BREEAM and Green Star systems are focused on reducing environmental impact and
721 improving the indoor environment (Doan et al., 2017, He et al., 2018), and therefore the categories
722 from these systems are strongly associated with environmental and human-oriented Success criteria
723 identified in this study. In addition to these goals, the Living Building Challenge also emphasises the
724 local economy. 'Reducing environmental impact and improving environment' is a Success criterion
725 which implies that success is not only about reducing the environmental footprint of the project but
726 also about positively affecting the environment. Owing to these reasons, this criterion is strongly
727 related to the categories of Living Building Challenge, which is a certification system targeted towards
728 creating a regenerative built environment (Thomas, 2016). While the four certification systems have
729 a focus on environmental and social sustainability aspects, they lack a focus on project-level economic
730 sustainability, flexibility, maintainability, and functionality (Doan et al., 2017). This means that
731 although categories of certification systems substantially represent the identified GB Success criteria,
732 a number of these criteria are still not represented in these systems.

733 Implications of findings

734 If success criteria are not clear it is hard to identify whether a project is successful or not. Clear success
735 criteria help assessment of project performance by stakeholders and help identify what is needed to
736 improve project management in future projects. The research reported in this study has both practical
737 and theoretical value. Theoretically, the identification of GB Success criteria can inform future
738 research on the dependent variables to measure the success of GB projects. For instance, occupant
739 centric development is a Success criterion identified in this study for GB projects. Future studies can
740 consider Success factors which ensure occupant centric approach during project development. Hence,

741 in theoretical terms, the findings of this study will add depth to the understanding of building project
742 success and particularly GB success.

743 The identification of Success criteria can also benefit practice as project teams may consider a more
744 holistic range of criteria when making decisions related to project development. The criteria list can
745 also be used for the purpose of performance evaluation and for controlling project performance.
746 Moreover, GB certification systems can include the identified criteria in their credit lists to ensure a
747 higher correlation between certification and success.

748 While the exploratory inquiry reported in this study provides a comprehensive list of Success criteria
749 for GBs, it may not inform the criteria applicable on a GB project being developed in a specific context.
750 This is because all the identified criteria may not collectively apply to a GB project. Some criteria may
751 associate more to one project as compared to another project. For instance, 'building responding to
752 the variations in use' is a criterion which is more suitable for projects with long service life. Hence, to
753 tailor the list of Success criteria for practical use in a particular project, the criteria identified in this
754 study may need to be reduced to a relevant range for the project itself.

755 Conclusion

756 An interpretive approach is used to achieve the aim of investigating Success criteria of GB projects.
757 Overall 40 semi-structured interviews are conducted with GB professionals spread across Australia,
758 Hong Kong, Singapore, the UAE, and the UK. Based on interview findings, a comprehensive list of 17
759 Success criteria and 39 sub-criteria is created. The highly mentioned Success criteria in interviews
760 include 'building acting as a human-oriented and occupant-centric development' (n=25), 'meeting
761 project aspirations and client's requirements' (n=16), 'realising sustainable and efficient building
762 operations' (n=15), 'achieving GB development-related certifications' (n=14), 'Reducing
763 environmental impact and improving environment' (n=9), 'achieving tangible benefits of
764 sustainability' (n=7), and 'building project acting as a source of learning' (n=6).

The data analysis has shown that the professional role, years of experience, and the regional belonging of interview participants result in varying viewpoints on GB project success. The use of an interpretive approach has resulted in a list of Success criteria comprised of diverse viewpoints from different GB stakeholders. The majority of the identified criteria are related to effectiveness (n=47) while some criteria are related to efficiency (n=9). Analysis of the Success criteria with respect to the Value-generation viewpoint has shown that the identified criteria are associated with the environment, project clients, end-users, society, and the construction industry. The associations among Success criteria are investigated and while most of the criteria have positive associations with each other, some criteria also have negative interrelationships. Priorities related to Success criteria in GB projects are also discussed.

A limitation of the inquiry in this study is in terms of the participants interviewed. Most of the interviewed stakeholders are Design Consultants (n=11), Sustainability Consultants (n=11), and Engineering Consultants (n=8). This results in an asymmetrical distribution of stakeholders in the sample set which implies that there is a higher number of Success criteria identified by service providers than those identified by service seekers. Future studies can address these limitations by employing a symmetrical data collection across service providers and service seekers. Moreover, future studies can consider the regions not covered in this inquiry because of its limited scope. Future studies also need to investigate Success criteria for GBs belonging to specific sectors, for instance, office, residential, and industrial sector. This paper is part of a larger PhD study which includes other publications involving similar research background and methodologies but with different scope and objectives.

Appendix

(Insert Table 4 here)

Data Availability Statement

Some or all data, models, or code generated or used during the study are proprietary or confidential in nature and may only be provided with restrictions. This includes the interview transcripts and the codes developed using NVIVO application. The data is restricted because it may indicate the personal identity of interview participants.

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Table 1: Sustainability performance criteria used in previous Green Building-related research

	Performance criteria	(Yu et al., 2018)	(Venkataraman and Cheng, 2018a)	(Ahmad et al., 2019)	(Bilec, 2008)	(El Asmar et al., 2013)	(Korkmaz et al., 2010a, Korkmaz et al., 2010b, Korkmaz et al., 2011b, Korkmaz et al., 2011a, Swarup et al., 2011)	(Carpenter, 2005b)	(Molenaar et al., 2009b)	(Enache-Pommer and Horman, 2009b)	(Hanks, 2015)	(Gultekin et al., 2013b)	(Olanipekun et al., 2018)	(Sang et al., 2018)	Sum
Project Management-related performance	Schedule Performance		×	×		×	×			×	×	×	×		8
	Cost Performance		×	×		×	×			×	×	×	×		8
	Quality Performance			×		×	×			×	×		×		6
Environmental sustainability	Environmental sustainability	×	×	×	×										4
	Water Consumption						×							×	2
	Energy Consumption						×						×	×	3
	Consumption of Resources and materials													×	1
Economic sustainability	Economic sustainability	×		×											2
	Business Performance					×									1
Social sustainability	Social sustainability			×											1
	Indoor Environmental Quality						×								1
	Occupant turnover rate						×								1
	Absenteeism						×								1
	Owner and end-users' satisfaction		×				×								2
	Acoustic quality						×						×		2
	Ventilation						×						×		2
	Controllability						×								1
	Lighting						×						×		2
	Thermal comfort						×						×		2
Certification as a measure of sustainability	Achieved certification or achieved points						×	×		×			×		4
	Achieved certification points compared to total points											×			1
	Intended vs. achieved certification or score						×		×		×				3
Technical performance	Technical benefits	×													1
Safety Performance						×	×								2
Organisational relationships			×												1
Public recognition			×												1

Note: Publications (Korkmaz et al., 2010a, Korkmaz et al., 2010b, Korkmaz et al., 2011b, Korkmaz et al., 2011a, Swarup et al., 2011) are part of a single study and are therefore collectively considered.
LEED (Leadership in Energy and Environmental Design) is a popular certification system from the U.S. Green Building Council

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Table 2: Green Building Success criteria identified from interview data

		Theoretical analysis						**Analysis with respect to attributes of interview participants**								
		Value-generation						Participants' role			Experience		Region			
		Environment	Client/Occupant	Society	Construction Industry	Efficiency	Effectiveness	Design Consultant	Sustainability Consultant	Engineering Consultant	Low to Medium	High to Very High	Australia	Hong Kong	Singapore	Overall participants identifying a criterion
								n=11	n=11	n=8	n=23	n=17	n=18	n=7	n=12	n=40
ID	Success criteria	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
C-1	**Building acting as a human-oriented and occupant-centric development**		×	×			×	×	×	×	×	×	×	×	×	25
C-1.01	Users satisfied from building performance		×				×	×		×	×	×	×		×	10
C-1.02	Users' health and well-being ensured in building		×				×	×	×	×	×	×	×	×	×	8
C-1.03	Users' comfort ensured in building		×				×	×	×		×	×	×	×	×	6
C-1.04	Good Indoor Environment Quality ensured in building		×			×		×	×	×	×		×	×	×	4
C-1.05	Building making users happy		×				×	×			×	×	×		×	3
C-1.06	Building providing an optimum work environment		×				×	×		×	×		×	×		3
C-1.07	Users' requirements efficiently fulfilled in building		×				×	×			×		×		×	2
C-1.08	Users' productivity ensured in building		×				×	×		×	×	×	×	×		2
C-1.09	Users feeling related to building		×				×	×			×	×	×	×		2
C-1.10	Users' engagement ensured in building		×				×	×			×	×	×		×	2
C-1.11	Building making public happy			×			×			×	×		×			1
C-1.12	Building adding value to users' life		×				×				×				×	1

C-1.13	Reduced absenteeism ensured in building			×			×		×				×			×					1
C-1.14	User needs prioritised over building efficiency		×	×		×							×							×	1
C-1.15	Building bringing people's life close to environment		×	×			×		×					×						×	1
C-2	**Meeting project aspirations and client's requirements**			×			×		×	×		×	×	×		×	×		×	×	16
C-2.1	Meeting the purpose and functional requirements of building			×			×		×	×		×	×	×		×	×		×	×	6
C-2.2	Meeting economic and financial goals			×			×			×				×		×					2
C-2.3	Meeting client's expectations of cost performance			×			×					×		×		×					1
C-2.4	Meeting the regulatory requirements			×			×			×			×			×					1
C-3	**Realising sustainable and efficient building operations**		×	×			×		×	×		×	×	×		×	×		×	×	15
C-3.1	Reduction in energy consumption		×	×			×		×	×		×	×	×		×	×		×	×	7
C-3.2	Achieving green operations-related certification		×	×			×			×			×	×		×					4
C-3.3	Achieving good system efficiencies					×				×		×	×			×				×	2
C-3.4	Transparency in building efficiencies					×						×		×						×	1
C-4	**Achieving GB development-related certifications**		×	×			×		×	×		×	×	×		×	×		×	×	14
C-5	**Reducing environmental impact and improving environment**		×				×		×	×			×	×		×	×		×	×	9
C-5.1	Reduction in water consumption		×	×			×			×			×	×		×	×				4
C-5.2	Reduction in greenhouse gas emissions		×				×		×				×	×		×	×		×	×	3
C-5.3	Reduction in embodied energy		×				×							×						×	1
C-5.4	Reduction in waste		×				×						×			×					1
C-6	**Achieving tangible (economic) benefits of sustainability**			×			×		×	×		×	×	×		×	×		×	×	7
C-6.1	Reduction in Life-cycle Cost			×			×		×				×	×		×	×			×	2
C-6.2	Clearly observable savings resulting from building performance		×	×			×					×		×						×	1
C-6.3	Quick Return on Investment			×			×					×		×						×	1
C-6.4	Achieving better outcomes at no additional cost			×			×			×				×		×					1
C-7	**Building project acting as a source of learning**				×	×	×		×	×			×	×		×	×		×	×	6
C-7.1	Building promoting green user behaviour			×			×		×				×	×			×		×	×	2

C-7.2	Building project supporting industry through innovation					×		×			×			×				×			1
C-8	**Achieving good results in a reliable and consistent way**						×		×	×	×	×	×	×	×	×	×	×	×	×	4
C-8.1	Realising easier maintainability in building			×				×	×				×				×			×	1
C-8.2	Building being practical for day to day use			×				×	×				×				×			×	1
C-9	**Building responding to the variations in use**			×				×	×				×	×	×			×		×	4
C-9.1	Flexibility in workplace			×				×					×		×			×		×	2
C-9.2	Value of building features growing over time			×				×	×				×							×	1
C-10	**Realising smart character in building**	×		×			×		×			×		×	×	×			×	×	4
C-10.1	Building requiring minimal intervention from users			×				×	×				×		×			×			1
C-11	**Building having a balanced design**						×		×	×			×	×	×	×			×	×	3
C-12	**Building responding to its surroundings**	×						×	×				×	×	×	×					2
C-12.1	Building integrated well within community				×			×	×				×				×				1
C-13	**Building to act as a benchmark**					×		×		×	×		×		×	×					2
C-14	**Achieving the maximum potential sustainability in building project**	×						×			×			×			×				1
C-15	**Sustainability considered during building construction**	×						×		×			×								1
C-16	**Building being well-integrative**						×		×				×							×	1
C-17	**Innovation involved in building design**						×			×				×		×					1
Total number of Success criteria and sub-criteria related to a theoretical aspect and identified by participants having a specific professional role, professional experience, and regional belonging		16		38	4	3	9	47	35	24	22	43	39	41	23	36					
Normalised number of criteria= Number of Success criteria and sub-criteria identified by participants of a specific group / Number of participants of a specific group									3.2	2.2	2.7	1.9	2.3	2.3	3.3	3	1.4				

Notes: The frequency count of identified criteria is shown in Column-O. The frequency of the overarching criteria is shown as the sum of their own frequency as well as the frequency of all the sub-criteria they represent. A similar approach is used for overarching criteria from Column-G to Column-N, although instead of showing the frequency count, these columns show whether a criterion is identified by participants belonging to a particular group or not.

Low to Medium Experience= Up to 13 years of experience in development of GB projects; **High to Very High Experience**= More than 13 years of experience in development of GB projects

1041 *Table 3: Resemblance between the criteria identified in this study and criteria from previous Green Building (GB) research*

		Criteria from previous studies					
ID	**Criteria identified in this study**	Social sustainability	Economic sustainability	Environmental sustainability	Certification as a measure of sustainability	Project Management-related performance	Public recognition
C-1	Building acting as a human-oriented and occupant-centric development	×					×
C-2	Meeting project aspirations and client's requirements	×				×	
C-3	Realising sustainable and efficient building operations			×			
C-4	Achieving GB development-related certifications				×		
C-5	Reducing environmental impact and improving environment			×			
C-6	Achieving tangible benefits of sustainability		×				
C-13	Building to act as a benchmark						×
C-15	Sustainability considered during building construction			×			

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1043 *Table 4: Green Building-related experience of interview participants*

Participant ID	Region where experience based	Other regions where experience based	Role in Green Building projects	Years of involvement in Green Buildings
AE-F-2	UAE		Sustainability Consultant	7
AU-F-10*	Australia		Sustainability manager; Design Consultant	10
AU-F-11*	Australia		Design Consultant (Interior); Green Star Accredited Professional	12
AU-F-4	Australia		Sustainability Consultant	6
AU-F-8*	Australia		Design Consultant	9
AU-F-9*	Australia	Canada; Indonesia; Mexico	Sustainability manager; Planning director; Developer's sustainability consultant	18
AU-M-12*	Australia		Electrical Engineer	10
AU-M-13	Australia		Project Manager; Sustainability Consultant	11
AU-M-14*	Australia		Sustainability Lead; Project Director; Programme Manager	15
AU-M-15*	Australia		Sustainability manager	15
AU-M-16*	Australia		Contractor	14
AU-M-18*	Australia	UK	Sustainability Consultant	35
AU-M-19*	Australia	Hong Kong	Sustainability Consultant; Engineering Consultant	22
AU-M-20*	Australia	Singapore; UK; New Zealand	ESD manager and Design manager with Contractor	14
AU-M-21	Australia		Commercial Specification Consultant	5
AU-M-3	Australia		Engineering Consultant; Sustainability Consultant	28
AU-M-5*	Australia		Design/BIM manager with contractor	10
AU-M-6	Australia		Design Manager; Design Director	15
AU-M-7	Australia		Sustainability Consultant	7.5
AU-M-8	Australia		Project Manager	15
HK-F-1	Hong Kong		Sustainability consultant	2
HK-M-1	Hong Kong		Sustainability consultant	7
HK-M-2	Hong Kong		Sustainability consultant	7
HK-M-3	Hong Kong		Design consultant	10
HK-M-4	Hong Kong	Mainland China	Design consultant	10
HK-M-6	Hong Kong	Asia Pacific; Mainland China	Environmental and Applications Engineer with HVAC manufacturer	15

HK-M-7	Hong Kong	Mainland China	Design consultant	24
SN-F-2	Singapore		Sustainability Consultant; Design Consultant	14
SN-M-1	Singapore		Engineering Consultant (Mechanical)	20
SN-M-10	Singapore	Australia; China	Engineering Consultant; Green Mark Manager	12
SN-M-11	Singapore	Malaysia; UAE	Design Consultant	15
SN-M-12	Singapore	Malaysia; China	Energy Manager	14
SN-M-2	Singapore	US	Commissioning Service Provider; Sustainability Consultant	15
SN-M-3	Singapore		Facilities Management Professional	13
SN-M-4	Singapore		Facilities Management Professional	3
SN-M-5	Singapore	South East Asia	Design Consultant	22
SN-M-6	Singapore		Sustainability consultant; Engineering Consultant (Mechanical)	7
SN-M-8	Singapore		Engineering Consultant; Green Mark Manager	10
SN-M-9	Singapore	China	Engineering Consultant; Green Mark Manager	10
UK-F-1	UK	Kazakhstan; UAE; Barcelona	Sustainability advisor; Design Consultant	10
UK-M-6	UK		Sustainability advisor; Design consultant	11

Note: '*' represents the interviews conducted over the telephone

Fig. 1: Word cloud summarising the responses to the interview theme of GB Success criteria

Fig. 2: Associations among key Success criteria

Fig. 3: Associations of identified Success criteria with credit categories occurring in Green Building certification systems