Delphi Study for Improving Sustainable Construction Project Management in Universities

Luo Huyuan[1], Jay Yang[2]

Abstract

As sustainability becomes an important principle guiding various human activities around the globe, the higher education sector is being asked to take an active part in educating and promoting sustainability due to its moral responsibility, social obligation and its own needs to adapt to new circumstances. There is a global trend of higher education institutions embarking on responses to the sustainability challenge. On-campus building performance is one of the most important indicators for "sustainable universities", because buildings carry substantially environmental burden such as considerable consumption of raw materials and energy as well as huge amount of waste generation and greenhouse gas emission. Plus, much research proves that building performance can impact on students and staff's awareness about and behaviours related to sustainability.

The past studies rarely discussed about sustainable construction projects in universities' unique context. Universities are labelled with distinct characteristics such as complex governance, multiple cultures and juggling missions and so on. It is necessary and meaningful to examine the project management system in terms of universities' organizational environment. Thus, this research project applies Delphi study to identify primary barriers to green technology application in on-campus buildings, critical factors for sustainable project success, key actions in project phases and strategies for project improvement. Through three rounds of questionnaires among panel experts, the authors obtain a profound understanding of project delivery system in universities. The research results are expected to provide sustainability practitioners with holistic understanding and generic information about sustainable construction project performance on campus as an assistance tool.

Keywords: sustainability, high education, on-campus building, project management, Delphi study

1. Introduction

[1] PhD candidate; Faculty of Science and Engineering; Queensland University of Technology; hu.luo@student.qut.edu.au

[2] Professor; Faculty of Science and Engineering; Queensland University of Technology; j.yang@qut.edu.au

Sustainability, acknowledged as the heated topic over decades, provides universities an opportunity to confront their core values, their practices, their entrenched pedagogies, the way they program for students' learning, the way they think about resources and allocate these resources and their relationship with the broader community (Wals & Jickling, 2002). Universities have the greatest capacity to define, analyse and examine sustainability issues while taking a leadership role in developing creative ways to respond to them (Newman & Abrams, 2005). In the modern society universities are able to better catalyse the necessary transition to a sustainable world because they have access to the leaders of tomorrow and the leaders of today so that what they do matters to the wider public (Orr, 1992).

The conversation of sustainability in the institutes of higher education has evolved from statements and declarations to implementation of sustainable practices in colleges and universities. Solely relying on lectures, discussions and experiments are inadequate to change students' attitudes or awareness about sustainability even though these methods can increase students' knowledge about the environment to an extent (Tung et al., 2002). Higgs and MacMillan (2006) stated that sustainable facilities and operations promote sustainability education by modelling sustainable practices, and providing hands-on opportunities to try sustainable practices, increasing students' ownership and stewardship of their environment. The most visible sustainability initiative is growing interest in green buildings, where facility construction and renovation seeks to match some definitions of sustainable practices (Kovac, 2009). Green buildings have accumulated significant motivation for universities because of environmental benefits, cost savings (Wilson, 2005), improvement in students' test scores (Pelletier, 2006), reduction in staff turnover (Kats, 2006), and increasing student health and attendance rates (USGBC, 2008).

Few studies reveal details about sustainable project delivery of green buildings in universities. The inadequacy of deep and specific discussion about construction projects on campus has a negative impact on actual project performance. In order to rectify this problem, it is necessary to investigate project management process in universities to equip practitioners with action plans and optimal strategies. This research expects to obtain a full understanding of project management system in universities. By means of exploring barriers to sustainable construction project, critical factors for project success and key actions in project stages, the author finally identifies a set of strategies for project improvement. The research findings will be used as a guidance manual for universities to remedy their project delivery process to achieve the target of "green building" on campus.

2. Literature Review

2.1 Sustainability in Higher Education

Sustainability has been recognized and gaining popularity over the past few decades due to the challenge of environmental degradation, economic recession and social disparity. As a guiding paradigm to instruct the human being's activities in every field, the mostly quoted definition of sustainability is "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987). The Chapter 36 of Agenda 21 clearly pointed it out that "education is critical for

promoting sustainable development and improving the capacity of people to address environment and development issues, and it is also critical for achieving environmental and ethical awareness, values and attitudes, skills and behaviour consistent with sustainable development and for effective public participation in decision-making" (Agenda 21, 1992). The United Nations proclaimed the decade from 2005 to 2014 as "Decade of Education for Sustainable Development" (DESD) to emphasize that education is an indispensable element for achieving sustainable development (United Nations, 2002).

Universities are placed in the best position to provide the most significant educational resources about environmental sustainability (Creighton & Rappaport, 2007). Both in the classroom and by the example of its physical plant, a university can give students an understanding of the interrelationship between making decisions and the natural environment, and thereby model their behaviours and attitudes that encourage environmental responsibility (Creighton, 1998). With the historical tradition of universities, they have responsibility for analysing and challenging ideas and conventions, conducting research, developing new technologies and educating future leaders and citizens (Bakker, 1998). Universities represent one the most powerful tools when approaching sustainable development, due to the academic freedom, diversity of skills and knowledge for developing new ideas, ability to comment on society and its challenges, and engagement in experimentation regarding sustainable living (Cortese, 2003). Therefore, universities are being asked to become leaders and role models in the adoption and communication of sustainable practices (Mcnamara, 2008).

2.2 Green Campus and Building Performance

The four main areas of greening universities are grouped into categories of research, education, campus operations and external community (Cortese, 2003). Of the four areas of practice with respect to delivering sustainability in universities, building a green campus is always top on universities' sustainability agenda and seems to gain the most attention. A sustainable university should have a healthy campus environment, with a prosperous economy through energy and resource conservation, waste reduction and an efficient environment management, and promotes equity and social justice in its affairs and export these values at community, national and global levels (Habib & Ismaila, 2007). Universities campuses are the place where various activities happen every day and connected with green initiatives to impact on the community and society fundamentally. The connection between the educational mission and social role of the university, particularly related to the physical environment, has been used as a rationale for campus greening (Bakker, 1998). The campus environment is a growing concern as it doesn't just affect how students live but also what they learn and how they will change workplaces and neighbourhoods as graduates (Kinzie, 2008).

The ways implementing green initiatives in campus environment vary from one university to another. Among these initiatives, the green building is gaining momentum and universities and colleges globally are nowadays using it to promote campus sustainability. The document titled Blueprint for a Green Campus in 1995, pointed it out that one of requirements for sustainable universities is that to make environmental sustainability a top priority in campus

land-use; transportation, and building planning. The Australian Tertiary Education Facilities Management Association (TEFMA) published an annual benchmark report on environmentally sustainable development which highlighted then enhancement of ecological values and construction projects incorporating principles of “green buildings”. Buildings in the education sector have the potential to offer highly productive, green environments that utilize converged and integrated technology to deliver high quality learning experience for students (Everett, 2008). A research used to prove that green building initiative was enacted with the hope of influencing people’s perceptions about sustainable technologies in buildings and homes and also revealed how behaviour was impacted by sustainability initiatives: specially, how the project influenced student and faculty’s attitudes, information levels and behaviours (Owens & Halfacre-Hitchcock, 2006).

2.3 Campus Facility Implementation and Management

In universities, facility departments directly manage the planning for, construction or leasing of, operations and maintenance of, and disposal of the physical assets of the institution (Adams, 2010). Facilities management units in universities are responsible for the stewardship of all physical assets owned by the institution (Ancarani & Capaldo, 2005). The overarching concept of sustainable development helped develop the concept of sustainable facility management (Shah, 2007). Facility management is on the agenda for change to develop practical sustainability goals (Elmualim et al., 2008). Although the FM profession has been evolving towards sustainability goals, it is not easy at present to make this reality (Elmualim et al., 2009). As a result, there is an urgent need to do research in sustainability issues within FM, and develop tools to enable and facilitate sustainability (Elmualim et al., 2008). In order to meet the challenge of applying sustainability criteria to facility management, there is a need of change management approach to the relationships evolving organizations, employees and facilities (Grimshaw, 1999).

3. Research Method

3.1 Justification for Delphi study

The Delphi technique is a widely used and accepted method for gathering data from respondents. Without physically meeting, Delphi study is a systematic, interactive method which relies on a panel of experts to answer questionnaires in two or more rounds, finally to converge towards the “consensus”. Using the Delphi technique, a reliable expert consensus can be obtained because the technique relies on anonymity, controlled feedback, and statistical group response and is thus structured to avoid the influence of dominant individuals on group discussion or group pressure for conformity (Fischer, 1978).

One major advantage of Delphi study is that it can provide in-depth information about the complex problem or issue under consideration (Kalian, 2012). Plus, Delphi study is very suitable for situations when no or limited historical data is available (Gupta & Clarke, 1996). In this case, the research is relatively new in terms of inspecting project management system in universities’ unique organizational context. Delphi study employs group decision-making techniques which carry greater validity than those made by an individual (Brooks,

1979). Among other group discussion methods, the Delphi technique is beneficial because the characteristic of avoiding physically bringing experts together can save travelling cost. This group communication method also avoids the pitfalls of face-to-face interaction such as group conflict and individual dominance (Gupta & Clarke, 1996). The whole anonymous and confidential process with controlled feedbacks enhances the validity of consensus-based findings from experts. Above all, Delphi study is desirable for this research for the purpose of obtaining huge amount of objective information on a new topic.

3.2 Sample Criteria

Contrary to a traditional survey, which would use a random sample to estimate the views held by separate individuals in a target population, the Delphi method uses interactions by a panel with relevant expertise to arrive at a consensus, because the validity of a Delphi study depends not on the number of participants polled, but rather on the expertise of the panel who participate (Armstrong, 1985). The Delphi participants should meet four "expertise" requirements: (1) knowledge and experience with the issues under investigation; (2) capacity and willingness to participate; (3) sufficient time to participate in the Delphi; and (4) effective communication skills (Adler & Ziglio, 1996). In this study, experts are required to have deep understanding of sustainable project management in universities.

With reference to the potential participants' academic qualification, professional expertise and working experience, 29 potential experts were targeted and invited to participate in the Delphi study. Sixteen of these expressed their interest and agreed to participate – a total of 55.2% participation rate. Ludwig (1997) addressed that "the majority of Delphi studies have used between 15 and 20 respondents". The participants were senior practitioners in the area of sustainable activities at universities. They were comprised of Deputy Vice Chancellors, professors, president and regional directors of a leading organisation dealing with sustainability in Australian universities, consultants from government, directors or managers in various departments dealing with sustainable projects. This laid a solid foundation for the validity and reliability of the Delphi data. The various constitution of this panel structure (e.g. academics, practitioners, policy makers, consultants) enables the Delphi study to obtain different perspectives as well. In addition, the panel members have international backgrounds, 3 of whom are from U.K. and 2 from New Zealand. This helps the researcher to have reference to other commonwealth countries' experiences.

Table 1: Profiles of panel members

Participant	Position	Organisation	Professional Area
H1	Professor	University	Research on sustainability and innovation
H2	Deputy Vice Chancellor	University	Leadership
H3	President of a leading organisation	Peak Association	Sustainability in higher education
H4	Vice President of a leading organisation	Peak Association	Sustainability in higher education
H5	Vice President of a leading organisation	Peak Association	Sustainability in higher education
H6	Member of a leading organisation	Peek Association	Sustainability in higher education

Participant	Position	Organisation	Professional Area
H7	Associate Head of school	University	Teaching and research, leadership
H8	Government Consultant	Government	Sustainability policy
H9	Member of Green Roof organisation	University	Green Roof design and engineering
H10	Sustainability consultant in state government	Government	Sustainability consultancy
H11	Deputy Vice Chancellor	University	Leadership
H12	Principal Policy Advisor	University	Policy advice
H13	Executive Director Sustainability	University	Sustainable project management and environmental planning
H14	Executive Director, Finance and Resource Planning	University	Financial management
H15	Associate Director of Operations, Facilities Management	University	Engineering and Maintenance
H16	President of Green Roof organisation	Peak Association	Green Roof and Living Wall's design and consultation

3.3 Process and Data Collection

The three rounds of Delphi surveys were conducted during the period from March to June 2012. These questionnaires will be distributed by email to participants. All the participants will be asked to rate the factors on a Likert-type scale to establish preliminary priorities among the items (Hsu & Sandford, 2007) for both desirability and feasibility. Ratings scale from 1 to 7, with 1 being "disagree" or "insignificant" and 7 being "agree" or "significant". The result of first-round questionnaire will be reviewed by the researcher to design the second questionnaire and summarise items based on the investigation. In Round 2, each Delphi panel member will receive the second questionnaire with summarised items. They will be asked to revise their ratings or specify the reason why he or she wants to remain the same rating. In this round, consensus begins forming and the actual outcomes can be presented among the participants' responses (Jacobs, 1996), as shifts in rating items are allowed. Round 3 is the same process repeating previous rounds.

3.4 Data Analysis and Results

In the Delphi process, qualitative and quantitative analysis can be both involved. Open-ended questions used in the first round to solicit panel members' opinions were analysed in a qualitative way, while the quantitative data was calculated using descriptive statistics, as the detailed description below.

Qualitative data was analysed by content analysis (Burnard, 1991) which involves coding, categorising and theming. In the meanwhile, One of the prominent characteristics of a Delphi study is being able to use statistical analysis which ensures the opinions generated by each panel member are well presented and reduces the potential of group pressure for conformity (Dalkey, 1972), because statistical analysis allows for an objective and impartial analysis.

The major statistics used in the Delphi questionnaire are measures of central tendency (mean, median and mode) and level of dispersion (standard deviation and inter-quartile range) (Hasson et al., 2000). The mean value is the arithmetic average of a set of values which points to the central location of the data; the median is described as the numerical value separating the higher half of a sample from the lower half; and the mode is the value

that occurs most frequently in a dataset (median, 2012). Based on Likert-type scales, the use of the median value is strongly favoured (Hill & Fowles, 1975). The median can inherently reflect the resultant convergence of opinion given that the anticipated consensus of opinion and the skewed expectation of responses are compiled (Jacobs, 1996).

Although the uses of median and mode are favoured generally, the mean is also workable in some cases (Murray & Jarman, 1987). In this study, mean and median were chosen to present the rating factors to the panel members. Standard deviation and Interquatile Range (IQR) were also computed as they are closely linked with mean and median to demonstrate the trend towards group consensus. Standard deviation measures the spread of a dataset. The larger the standard deviation is, the more spread the various data is. The IQR is made robust through comparing the difference between the upper and the lower quartiles. 25% of the measurements are less than the lower quartile and 75% of the measurements are less than upper quartile. Upper quartile minus lower quartile equals the inter-quartile range, with smaller values indicating higher degrees of consensus. According to Linstone and Turoff (2002), an IQR of 1.00 or less can be considered to reach a good consensus on a seven-point Likert scale. An IQR≤1 means that more than 50% of all opinions falls within one point on the scale. In order to achieve a statistically rigorous consensus, this research also looked at the degree of consensus. Accordingly, Kendall's coefficient of concordance (W) was applied to measure the agreement in the ratings. A strong consensus exists for W >=0.7; moderate consensus for W=0.5; and weak consensus for W<0.3 (Schmidt, 1997). The tables below list the final results of Delphi study after three rounds: all items of which IQR <= 1.

Table 2: Rating of barriers to sustainable construction projects in universities

Barriers to Sustainable Project Delivery in Universities					
NO.	Barrier	Average Score	Standard Deviation	Median	Interquatile Range
1	Lack of commitment to sustainability from top management	6.23	0.832	6.00	1
2	Funding and cost	5.77	0.927	6.00	1
3	Split budgets between capital and maintenance	5.69	1.032	6.00	1
4	Lack of human resources in sustainability profession and expertise	5.54	1.127	6.00	1
4	Bureaucratic barriers inertia from academic staff	5.54	0.877	5.00	1
6	A challenge of fitting new untried technology into current capital work program	5.46	1.127	6.00	1.5
7	Ownership and control of various components of infrastructure	5.38	0.870	5.00	1
8	Complexity of organisational environment (e.g. large size, frequent turnover)	5.15	0.987	5.00	2
9	Difficulties in communicating with key stakeholders	5.00	0.817	5.00	0.5
9	Lack of well established cooperation between academic staff and project team	5.00	0.817	5.00	2
9	Exiting gaps between different management levels	5.00	0.913	5.00	1.5
12	Lack of client demand	4.92	0.760	5.00	1.5
12	Lack of understanding about priorities and directions and universities don't have to regard for councils' development control plans	4.92	1.320	5.00	2.5
14	State wide planning controls/ regulations don't require sustainability to be addressed	4.77	1.301	5.00	2.5

15	Lack of assessment framework specific to universities' context	4.62	1.198	4.00	2
16	Ever-changing management system	4.54	0.877	4.00	1

"Lack of commitment to sustainability from top management" is ranked in the first place with a high rating of 6.23, which is closely followed by "funding and finance". The items of "split budgets between capital and maintenance" and "lack of human resources in sustainability profession and expertise" are rank the third and fourth significant barriers respectively. The average rating of all barriers is relatively high, all above 4.5. Overall, consensus is obtained on 8 items (IQR ≤ 1) resulting in an agreement rate of 50 %. In this section, the Kendall's W is 0.335, which belongs to weak-to-moderate range. It is also discovered that most barriers to sustainable project delivery are fundamentally related with organisational issues such as bureaucracy, poor communication and authority gaps.

Table 3: Rating of critical factors for sustainable construction project success

Critical Factors for Sustainable Project Success					
NO.	Factor	Average Score	Standard Deviation	Median	Interquatile Range
1	Top management commitment/support to project	6.69	0.480	6.00	1
2	Clear objective and scope	6.38	0.650	6.00	1
3	Clear project performance criteria regarding sustainability	6.30	0.855	6.00	1
4	Integrated-sustainability planning and design	6.15	0.555	6.00	0.5
4	Project's integration with teaching and research	6.15	1.144	6.00	1
6	Availability of resources (financial, human and technical)	6.08	0.641	6.00	0.5
7	Effective communication/information sharing channels	5.92	0.862	6.00	1
7	Post-occupancy evaluation	5. 92	1.038	6.00	1.5
9	Key stakeholders' participation	5.85	0.555	6.00	0
10	Multidisciplinary/competent project team	5.77	0.439	6.00	0.5
10	Risk management	5.77	0.725	6.00	1
12	Comprehensive contract documentation	5.69	0.751	6.00	1
13	Accurate cost-effectiveness analysis	5.69	0.855	6.00	1
14	Proof and clarity of innovative concepts	5.54	0.519	6.00	1
14	Allocation of these deliverables/accountabilities to individuals	5.54	0.967	6.00	1
16	Absence of bureaucracy	5.46	0.660	5.00	1
16	Cooperation and coordination between academic staff and project team	5.46	1.050	6.00	1
16	Sustainability projects need themselves to be sustainable – e.g. maintenance of green roofs	5.46	1.266	6.00	2
19	Wide community involvement	5.38	0.870	6.00	1
20	Substantial demonstration cases and proper emphasis on past experiences	5.38	0.770	6.00	1
21	Awarding bids to the right designer/contractor	5.15	0.987	5.00	1
22	Up-to-date technology utilization	5.15	0.899	5.00	1
23	Apply to Green Star rating system of GBCA (Green Building Council of Australia)	4.62	1.325	4.00	2.5
24	Run a trial case under controlled condition	4.62	1.044	5.00	1.5
25	Engage environmental/sustainability consultants during all the life cycle	4.38	0.961	4.00	1

Most factors (22 out of 25) are rated high (5 and above). Among them, 6 factors are above 6 representing the “significant” opinion, which are the same items from Round 2. Plus the ranking of these six most significant factors doesn’t change much except that “seeking for integration with teaching and research” is upgraded from No. 5 to No. 4 which is equal to the ranking of “integrated-sustainability planning and design”. Most of critical factors belong to organisational categories which were commented by interviewees. In relation to the obstacle “lack of commitment from top management”, the most critical factor was identified to be “top management’s commitment”. It can be concluded that the importance of “top management’s commitment” was emphasised throughout the study. Similarly, interviewees often mentioned the insufficient human resource in sustainability team constrains the progress of sustainability implementation in such a large organisation. In response, experts ranked “available resources” the sixth most important factor. The same rule also applies to “absence of bureaucracy” “accurate cost-effectiveness analysis” “corporation between academic staff and operational staff” and “wide community involvement” and so on. A high consensus level is reached in this group. 21 out of 25 items reached an IQR ≤ 1 (percentage is 84%). Responding to the large number of items meeting the criterion of IQR≤ 1, the Kendall’s W is 0.599 which indicates a moderate – to – strong consensus.

Table 4: Rating of Key Actions for Each Stage of Sustainable Construction Project

Key Actions for Each Stage of Project Implementation					
NO.	Action	Average Score	Standard Deviation	Median	Interquatile Deviation
Conceptual Stage					
1	Obtain vision and commitment from the top management	6.67	0.779	7.00	0
2	Set clear and well understood goals and metrics	6.58	0.793	7.00	1
3	Clarify budget	6.33	0.651	6.00	1
4	Identify number and range of idea and stakeholders	6.31	0.855	6.00	1
5	Consult sustainability professionals and experts, integrate sustainability with conceptual planning	5.58	0.996	6.00	1
Planning and Design Stage					
1	Consult sustainability professionals and experts, integrate sustainability issues with planning and design	5.92	0.996	6.00	1
2	Thorough analysis and simulation of different alternatives	5.75	0.866	6.00	1
3	Ensure resources are commensurate	5.67	0.651	6.00	1
4	Clarify time framework and cost	5.50	0.905	6.00	1
5	Monitor planning and design, open discussions and get input	5.67	0.985	6.00	1
6	Low impact score for environmental and social factors	5.58	0.793	6.00	1
Pre-tending Stage					
1	Verification of the design solutions against target	6.17	0.937	6.00	1
1	Specify clear deliverables, cost and budget in detailed proposals	6.17	0.835	6.00	0.75
1	Monitor implementation, consider ongoing operational issues	6.17	0.718	6.00	1

4	Identify contractors which have sustainability credentials with track record of delivering sustainable projects	5.67	0.888	6.00	1
4	Consult sustainability professionals and experts	5.58	0.996	6.00	1
6	Have Expression of Interest to assess the companies that are available to build the project	5.50	0.905	6.00	1
	Contracting Stage				
1	Including clear requirements and metrics into contracts	6.08	0.900	6.00	1
2	Ensure costs are manageable and risks covered	6.08	0.900	6.00	1
3	Bidders have experience in building sustainable development teams	6.00	1.128	6.00	1
4	Understand expectations of contractors	5.58	0.996	6.00	1
	Project Preparing Stage				
1	Ensure sustainability fits with broader use	6.17	0.937	6.50	1
2	Communication with all teams	6.08	0.900	6.00	1
3	Establish communication protocols, reporting lines	5.83	0.835	6.00	0.75
4	Contractor engagement	5.67	0.887	6.00	1
5	Procedures and processes developed and committed to sustainability	5.58	0.900	6.00	1
	Execution and Operation Stage				
1	Monitor and report against plan	6.17	0.835	6.00	1
2	Low environmental and social impact	6.08	0.900	6.00	1
3	Clarity of project performance	6.08	1.084	6.00	1
4	Partnering, extensive stakeholder input	5.42	0.996	6.00	1
5	Procedures and processes being allowed (audit)	5.42	0.996	5.00	1
	Project Close Out Stage				
1	Confirm sustainability objectives met	6.50	0.905	7.00	1
2	Conduct “lesson learnt” session, monitor and report project process against sustainability plan	6.08	1.084	6.00	1
3	Monitor implementation	6.00	1.279	6.00	1
3	Review what went well and what did not. Reflect what would be done differently	6.00	1.279	6.00	1
5	Certification of key deliverables provided to required standard	5.92	0.996	6.00	0.75
6	Optimum operational instructions clear to user	5.75	0.866	6.00	1
7	Verification of the systems against requirements, continuous project commissioning documentation	5.67	0.985	6.00	1
	Maintenance Stage				
1	Compile post-construction review against sustainability targets	6.42	0.996	7.00	1
2	Continuous comparison of the real behaviour of the building against the targets	6.33	0.779	6.50	1
3	Serviceability and access to skills	5.58	0.996	6.00	1

In terms of rating result of key actions in project delivery, the action indicators in each stage are rated very high above 5. All the action indicators in each stage were rated very high (above 5). There was a huge increase in the number of items reaching consensus. Overall, the consensus was obtained on 41 items of IQR ≤ 1 (the total number of rating items was 58), representing an agreement rate of 70.7%. However, there were differences of consensus achievement between the different phases of project implementation. For example, all the key actions in the “conceptual stage” and “pre-tendering” stage obtained IQR ≤ 1. In contrast, only three key actions in the “maintenance stage” met this standard. For the whole section, the Kendall W is 0.490 which suggested that the degree of consensus for “key actions in each phase of project delivery” was close to moderately strong.

Overall, the consensus level of the whole rating items didn't reach very high. This result echoes the finding from existing literature that it is very difficult to obtain agreement on general issues about "sustainability in universities" due to the complexity of universities and breadth of debates. The discovery from the Delphi study provided a solid proof that the effectiveness of sustainable project implementation is grounded on a desirable organisational environment. The barriers to sustainable construction projects in universities as well as the critical factors for project success highlighted the organisational issues such as leadership, structural inertia and communication more than once. The panel experts also achieved consensus on key performance indicators for each stage of sustainable construction projects' delivery, which specifically take universities' unique characteristics into account. For example, the coordination between academia and project team should be specifically considered when endeavouring to deliver sustainable construction projects.

4. Conclusion

Realising their social responsibility, universities are assuming a lead role in creating a sustainable future for our societies. However, their commitments to date seem confined with research and development. Opportunities to showcase the potential and achievements have not been sufficiently explored, especially in the development and utilisation of built environment on campuses, which are often regarded as microcosms yet influential part of the society. Green building, as a significant indicator for "sustainable university", has been gaining universities' interests. The lack of in-depth understanding of sustainable construction delivery in universities drives the researcher to investigate project management system on campus. The three-round Delphi surveys help to identify 8 main barriers to sustainable construction project and 22 critical factors for project success. The findings reflect that organizational issues are the most significant impediment to sustainable construction project, such as lack of top management's commitments and solid support, funding models, bureaucracy and so on. In response, the critical factors for success address the organizational remedies combined with management improvement. In addition, the key actions identified in each stage of sustainable construction project process in universities offer project team a clear guidance. The synthesized strategies for project improvement are concluded as well. The research findings expect to provide sustainability facilitators in universities with holistic information about sustainable project management process in universities.

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