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Closing the Loop between Building Sustainability and Stakeholder Engagement: Case Study of an Australian University

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***Abstract*—**Rapid population growth and urbanization is creating pressure throughout the world. This has a dramatic effect on a lot of elements which include water, food, transportation, energy, infrastructure etc. as few of the key services. Built environment sector is growing concurrently to meet the needs of urbanization. Due to such large scale development of buildings, there is a need for them to be monitored and managed efficiently. Along with appropriate management, climate adaptation is highly crucial as well because buildings are one of the major sources of greenhouse gas emission in their operation phase. Buildings to be adaptive need to provide a triple bottom approach to sustainability i.e., being socially, environmentally and economically sustainable. Hence, in order to deliver these sustainability outcomes, there is a growing understanding and thrive towards switching to green buildings or renovating new ones as per green standards wherever possible. Academic institutions in particular have been following this trend globally. This is highly significant as universities usually have high occupancy rates because they manage a large building portfolio. Also, as universities accommodate the future generation of architects, policy makers etc., they have the potential of setting themselves as a best industry practice model for research and innovation for the rest to follow. Hence their climate adaptation, sustainable growth and performance management becomes highly crucial in order to provide the best services to users. With the objective of evaluating appropriate management mechanisms within academic institutions, a feasibility study was carried out in a recent 5-Star Green Star rated university building (housing the School of Construction) in Victoria (south-eastern state of Australia). The key aim was to understand the behavioral and social aspect of the building users, management and the impact of their relationship on overall building sustainability. A survey was used to understand the building occupant's response and reactions in terms of their work environment and management. A report was generated based on the survey results complemented with utility and performance data which were then used to evaluate the management structure of the university. Followed by the report, interviews were scheduled with the facility and asset managers in order to understand the approach they use to manage the different buildings in their university campuses (old, new, refurbished), respective building and parameters incorporated in maintaining the Green Star performance. The results aimed at closing the communication and feedback loop within the respective institutions and assist the facility managers to deliver appropriate stakeholder engagement. For the wider design community, analysis of the data highlights the applicability and significance of prioritizing key stakeholders, integrating desired engagement policies within an institution's management structures and frameworks and their effect on building performance.

***Keywords*—**Building Optimization, Green Building, Post Occupancy Evaluation, Stakeholder Engagement

I. Introduction

BUILDINGS are now considered to be large contributors of environmental deterioration and emissions, responsible for one third of total greenhouse gas (GHG) emissions [15]. Once buildings are built, they last for a very long time. Therefore, appropriate management of buildings, particularly, if they are well designed for low energy use is important. The role of management to manage building performance is therefore, becoming an important aspect of ongoing building performance currently, and is expected to continue in the future. This is specifically applicable to the green building industry which not only uses energy efficient resources during the building's life cycle from design to construction as well from operation to maintenance, green building practices expand to contribute improved performance of the occupants of the building as well. This switch to green buildings is important and happening globally, but what still lacks is the post construction/renovation management. One of the key reasons for this is inappropriate stakeholder engagement within the institutional management structure. This constitutes the social aspect of sustainability, and if not managed effectively it affects the overall building performance and also impacts the other sustainability aspects. This study tries to explore this social gap and comment on the significance of incorporating key stakeholder's feedback through each project phase and integrating performance evaluations into the management framework.

Different stakeholders view the value of a project differently and the main purpose of having appropriate stakeholder engagement mechanisms is to identify and understand the diverse needs and values. Having effective stakeholder engagement in an organization assists in creating an appropriate association within the entire stakeholder chain. It also helps in understanding the stakeholder beliefs and goals and the skill to integrate them with the organization's objectives. Therefore, the main criteria to understand stakeholder management are to identify the stakeholders, and prioritize them and understand their needs.

In order to incorporate stakeholder feedback, prioritization of stakeholders is highly crucial. Literature states that it is

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necessary that decisions are made by those who are expected to bear the main impacts [16] of the outcomes or outputs of the decision making process. Also, it is necessary to effectively ensure that all stakeholders are aware of any trade-offs inherent in any management decision. Building occupants not only influence an organization but also claim its services and can jeopardize activities when not consulted/engaged or if the process is not undertaken properly. The study by Heerwagen [11] clearly states that a better indoor environment in green buildings positively impacts occupants' productivity and satisfaction. Research shows that there is a correlation between occupant's control of building design with the job satisfaction and comfort [10]. The social aspects can be linked to increased financial outcome and positive image of the organization. Overall green building advantages ranges from environmental to economic to social benefits and largely applicable to wide spectrum of users [12]. Hence, this study included evaluation of the key building users i.e., academic and non-academic staff (not students as in Australian universities they are considered as transient population as are not restricted to attend regularly and using the same building through their studies) satisfaction levels to assess the building's overall performance management.

II. Background

A. Green Building: Benefits and Occupant Satisfaction

Even though the majority of existing green building assessment tools are voluntary [6], existing evidence suggests that adopting green building rating tools in the real estate market has continued to grow in prominence. The reason being is the several benefits attached to green buildings in comparison to design and construction of standard buildings. While environmental aspects is the primary advantage for design and construction of green buildings [8], the energy and water saving efficiency over the operational life-cycle reduces costs for the owner [9], [10]. Unlike the first generation rating tools whose major emphasized on environmental and economic performance of the buildings, the second generation tools aimed at wider sustainability agenda [6] focusing on social benefits. With greater innovations and technology, the decision makers in green building design are keen to integrate people component to maximize economic and environmental performance of sustainable buildings [10].

The demand for green building has witnessed growth in the past few years; however, the green building industry still remains a niche market [13]. Today, there is a growing recognition of green building design technologies conducive to occupants' comfort and performance than buildings using standard practices [11]. However, measuring the exact financial impact of occupants comfort and performance, and thus creating a healthier and productive environment, often remains a challenge. From a strategic perspective, even though elements such as absenteeism, productivity, and hidden sick days are difficult to measure, improved individual outcome matters if it has higher value [11]. Beyond the design, techniques, materials, the potential of green buildings is broadened when attention is paid to the peripheral components such as human resources or facility management [13]. While direct financial gains such as cost savings in terms of energy and water are easily quantifiable and measurable, indirect benefits, even though difficult to measure have a greater influence in green building business. For example, there is also scope for green buildings to attract and retain high quality employees because of the healthier and enjoyable work environments [11], [14]. The indirect benefits improve organizational reputation and gains competitive advantage over standard buildings. Some current assessment tools have started examining the building management practices to capture patterns that can contribute to the performance of the building [2].

B. Green Building Assessment Tools

The movement for green building rating tools commenced after the development of the Building Research Establishment Environmental Assessment Methodology (BREEAM) in 1990 [2]. In the last two decades, there is an emergence of several environment rating tools for buildings. Some of the major tools worldwide are Leadership in Energy and Environmental Design (LEED) (U.S.A), Promise (Finland) QUANTUM (Netherlands), ECO-PRO (Germany), CASBEE (Japan), Athena (Canada), EQUER (France), and GRIHA (India) etc. The assessment methods for these rating tools vary from the perspective of scope, structure, format and complexity. The environmental assessment frameworks, rating systems can be categorized into qualitative assessment tools, whereas the environmental Life Cycle Assessment (LCA) tools for buildings and building stock can be referred as quantitative assessment tools [3], [4].

Apart from the most commonly used rating tools such as LEED and BREEAM, other assessment tools fall into this category include the Green Building Tool (now known as the Sustainable Building Tool), Green Star, Hong Kong Building Environmental Assessment Method (HK BEAM) or tools adapted to specific countries such as LEED adapted for Canada and Australian Green Star adapted for New Zealand and South Africa. In some instances, the tools are developed into new tool, for example, the Building Assessment Tool (SBAT) influenced by BREEAM and LEED. This qualitative category generally uses an auditing of the building, before scoring the overall performance of that building [4]. The criteria used in qualitative tools are often dependent on wider commitment in terms of time, energy and broad interpretations of the assessors [5]. The category of assessment methods, also known as Life Cycle Assessment tools uses the physical life cycle approach to evaluate the quantitative data on resource use and environmental emissions associated with the system. The quantitative tools often demands greater precision to reduce misinterpretation [4], [6], [7]. Some examples of quantitative assessment tools include Envest from UK, EcoQuantum from the Netherlands and ATHENA from Canada [2].

TABLE I
EXAMPLES OF EXISTING GREEN BUILDING RATING TOOLS

Name of Rating Tool	Developer, Year	Categories	Versions
BREEAM [20]	Building Research Establishment (BRE) in 1990	1. Energy Use 2. Transport 3. Water 4. Ecology 5. Land Use 6. Materials 7. Pollution 8. Health and well-being 9. Management	1. Offices 2. Housing 3. Healthcare 4. Courts 5. Industrial units 6. Prisons 7. Retail 8. Schools 9. Multi-residential 10.Neighborhoods
LEED [21]	United States Green Building Council (USGBC) in 1993	1. Energy and atmosphere 2. Water efficiency 3. Sustainable sites 4. Materials and resources 5. Indoor Environmental Quality (IEQ) 6. Innovation	1. Offices 2. Homes 3. Neighborhood development 4. Retail 5. Healthcare 6. Schools
Green Star [22]	Green Building Council of Australia (GBCAUS) in 2003	1. Energy 2. Transport 3. Water 4. Ecology and use 5. Emissions 6. Materials 7. IEQ 8. Management 9. Innovation	1. Offices 2. Retail 3. Schools 4. Industrial buildings 5. Mixed use buildings 6. Mixed use residential 7. Healthcare

C. Overcoming the Social and Behavioral Barriers in Green Building Design

The roadblocks to the green building movement are no longer technical or economic, and instead are the unrecognized social and psychological barriers. These obstacles exist both at the individual as well as organizational level [1]. At the individual level, people in different roles typically impact the design or construction of green buildings. These comprise of architects, contractors, consultants, building owners and tenants. At first, it seems the economic and technical solutions to green buildings makes it perfect; however, a researcher from sociology, psychology and political science argues the different stakeholders make decisions based on individual motivations [11]. The organization can also play a critical role in resistance to green construction. Organizations can be served as filters to influence an individual's attitudes and behavior inside the building. Occupants in green buildings become a reflection of the subjective organizational goals, culture and learning and development process. One such key influencer to the organizational level barriers and motivation is leadership. When the topic of organizational performance is a growing interest among designers and building owner, the organization's leadership team plays a significant role as a gateway to shaping the occupants' behavior and attitudes [11].

Communication and collaboration between the researchers, designers and management employees is significant for a successful green construction. This includes the contribution of research by academicians into the practice and contribution of design consults to develop occupant-centric design using the current research [12]. Similarly, to realize the full capacity of green constriction, organizational culture shapes occupants' consciousness, perceptions and behaviors. There are a wide range of strategies that companies can adopt to foster environmental performance in a green building. A well-established reward and incentive system within the organization can trigger environmental behavior and motivation [1]. Developing skills can evoke behaviors. Therefore organizations need to invest in incorporating environmental literacy into existing training and learning workshops for the occupants' to make them aware of their role in handling and managing of the green buildings. The next obstacle that might hinder green building performance is breaking the power bases inside the organizations. Existing power in providing incentives or training to employees might restrict the introduction of new green practices. Thus, it is equally important to recognize that benefits of green buildings are more likely to exist when organization and buildings are treated as integrated system [6]. Heerwagen [11] argues that lack of environmentally driven occupant results is detrimental to resource efficiency and the solution lies in the social and psychological mechanism.

Green behaviors and attitudes have gained increased attention, as it addresses the more elusive connection to green buildings impacts. The strategies to overcome the social barriers constitute either treating the obstacles as an opportunity of creating a change process initiated by the organizations on individuals. Green building is better regarded as a process rather than product [13]. Current building performance assessment methodologies need to be enhanced to consider not only environmental issues, but social and economic issues as well and throughout the lifecycle. To do this, understanding the relationship and influence of stakeholders on these aspects is highly crucial. Once unfrozen, people, organizations, and institutions are likely to be more susceptible to behavioral change and the adoption of green building practices.

D. Role of Stakeholder Engagement in Overall Performance Management

A stakeholder is any individual, group or organization that can affect, be affected by, or perceive itself to be affected by a program [17]. Stakeholder engagement is a process of managing the all the stakeholders of a project appropriately according to their role. It includes (i) Recognition of internal and external stakeholders, (ii) Understanding the needs, objectives and role of each stakeholder, (iii) Prioritization of the stakeholders, (iv) Carrying out stakeholder consultations, and (v) Appropriate stakeholder management.

Stakeholder management involves considering feedback, keeping the stakeholders informed at all stages and carrying out post project evaluations to assess the impact of the project(s). Thus, stakeholder engagement needs to be central to the design for any assessment process. Instead of stakeholder engagement being seen as merely being a desirable feature of the assessment process, the assessment process should be seen as a vehicle for facilitating stakeholder dialogue. The effectiveness of the assessment then, among

other things, depends on the success of the stakeholder dialogue in creating those conditions of dialogue where different opinions are respected, reflection and deliberation take place, power is shared and social learning is facilitated. It has been strongly emphasized that sustainability assessment should not be a separate process, but closely integrated with the existing structures and decision making processes within a project.

III. Methodology

Detailed evaluation a Green Star rated building was carried out in order to understand the relationship between building optimization and stakeholder engagement. Table II describes the key features of the case study building considered for the research.

TABLE II
KEY FEATURES OF STUDY BUILDINGS

FEATURES	STUDY BUILDING
Build	New Build (completed 2012)
Faculty	Construction Hub
Green Star Rating	5 Star Green Star (Design v1)
Building Volume	17,000m^3
Gross Floor Area (gfa)	8,640m^2
Number of levels	3
Number of occupants	60; Academic: 48 and Non-Academic: 12

To achieve Green Star certification, buildings are judged on various aspects namely: management, indoor environment quality, energy, transport, water, materials, emissions, land use and innovation. The first element on the certification is management criteria including factors such as building commissioning, having green star accredited professional, building tuning, building guides, appointing independent commissioning agent, environmental and waste management, occupant satisfaction and maintainability (which are the key themes the study is focused on). All these factors evaluate how buildings are intended to be managed in the operation phase. The study building scored 13/14 under management criteria, 16/25 under IEQ criteria and 18/29 under energy criteria in the Green Star Application originally submitted. The specific scores attained and statements made by the buildings in the original Green Star application documents determine the original design intention by the study building. When analyzed, it was observed that the post operation management framework did not correlate to the statements made in the Green Star application. This is another gap which shows that the expected performance is different to the actual performance. One such key statement/process not being followed was Post Occupancy Evaluation (POE). Since the building was completed, no POE had been carried out and this was study was the first such initiative.

POE is a widely recommended concept for evaluating building performance (best recommended after a year of project completion), but because of cost issues, effect on reputation and being time consuming is not integrated in the management structures. This study comments on the significance of POE for capturing stakeholder satisfaction levels and using those results to assist facility managers help building perform better throughout its life cycle. POE findings for the functional performance of the building are presented from four primary sources being:

i. Building Use Studies (BUS) Survey
ii. Direct Observation
iii. Walk in Discussions
iv. Stakeholder Interviews

Findings from the BUS occupant survey provided substantive evidence based data from the users' perspective. Occupant (end user) survey results are summarized in the first part of the Findings section. Feedback and general comments pertaining to the functional performance and delivery process have been explored during the walk in discussions and interviews to assist with the interpretation of the survey data. These have been combined with direct observations and building utility data (obtained from the university) to provide a further window into the overall satisfaction with the building and a summary.

IV. Findings

A. Survey

The BUS standard survey has 63 questions that provide a range of quantitative and qualitative responses pertaining to the perceived satisfaction of the occupants based on 12 lines of enquiry in context to thermal comfort, ventilation, acoustics like noise, productivity, comfort, perceived health, design and needs.

Paper based surveys along with information sheets were distributed to all the academic and non-academic staff of the building. The survey was available for a period of three weeks and followed up after a week. The survey was completed representing 70% as the total response rate. There was an even representation of building occupants across this sample. The sample set includes occupants that were involved in the design process and others that were not, but does not distinguish between them. Fig. 1 represents the summary of findings of the survey:

1. Description of Survey Findings

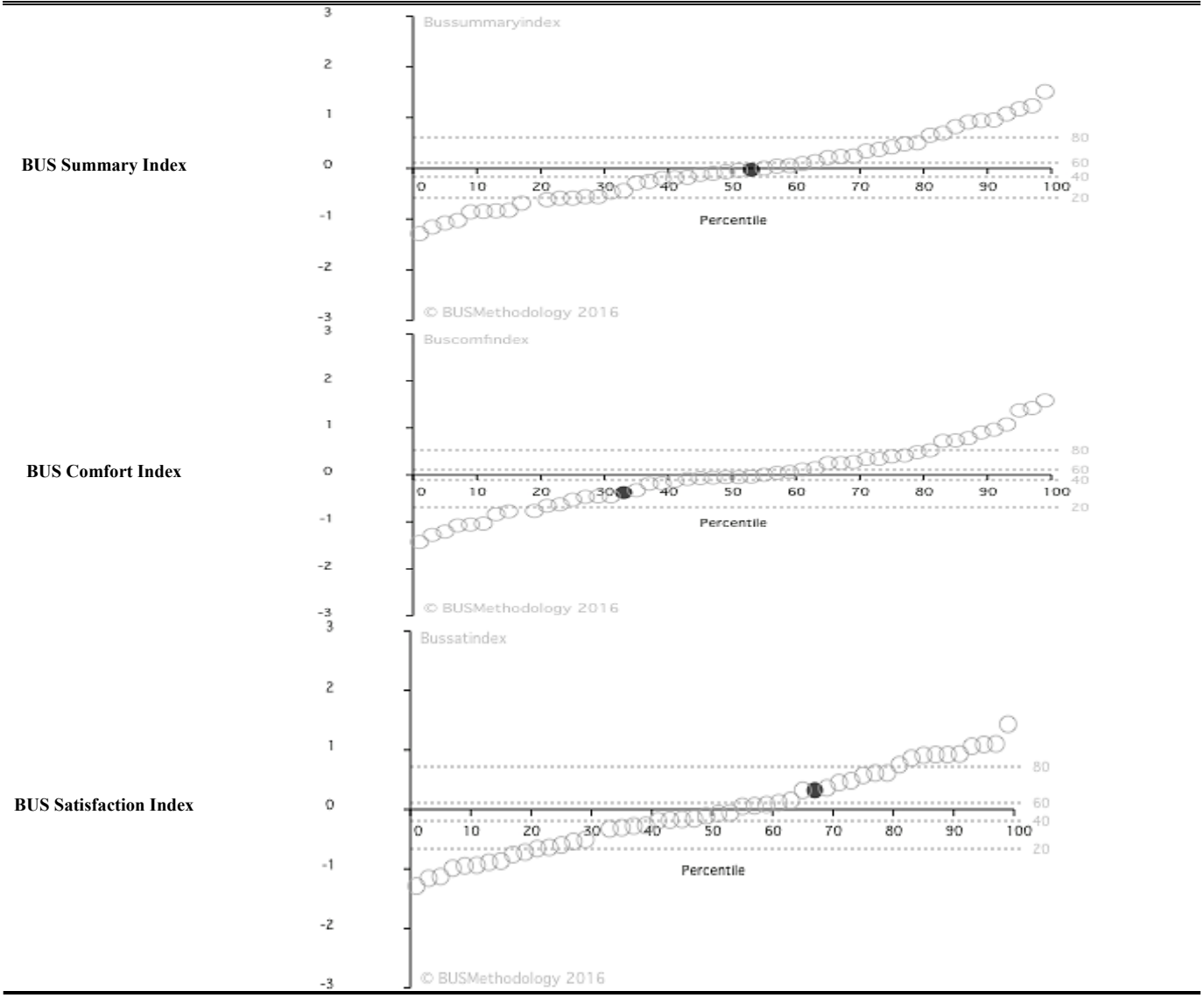
Green Summary Chart 12 key variables. Each measured on a seven-point slider scale: 1= unsatisfactory/uncomfortable/ poor/less healthy; 7 = satisfactory/comfortable/good/more healthy

Color indicated perceived performance against the benchmark data set. There are 3 ratings:

- **Green** building performing better than data set
- **Amber**building is average
- **Red** building under-performing, needs improvement

Table III demonstrates the overall index of the survey findings with respect to summary, comfort and satisfaction of the occupants.

TABLE III
SURVEY INDEX DEMONSTRATION



The **graph** shows the building performance benchmarked against other Australian buildings. It allows identification of how each variable performs within the building against the benchmark. The dataset is available on a percentile chart (0-100), allowing quick identification of 'above' or 'below' average characteristics. It also allows to rate building performance against the benchmark dataset.

The **circles** (empty fill) are the values of other buildings (non-residential) in the benchmark dataset. The **x-axis** represents the percentile score (0-100). The **y-axis (left)** represents the variable scale (-1 to +3); the **y-axis (right)** quintiles (sample/population is divided into fifths)

2. Detailed Summary of Findings: Things that Worked Well and Did not Work Well

The major weaknesses identified in the building could be attributed to a range of factors. The lack of a properly documented Functional Brief for the project and poorly structured and managed governance issues were the key challenges faced. Other concerns included late changes to key performance requirements for the building (especially environmental requirements) and not having the opportunity to work through the "building in operation" implications of the environmental related decisions made.

The Part 2 Report documents the occupant satisfaction across a number of areas of the building. In summary, the major weaknesses of the building in the operations that was observed were majorly noise, temperature fluctuations both in summer and winter, and the lack of occupant control over the internal conditions. The other issues included (i) responsiveness to requests for changes to heating and lighting not occurring in a timely fashion blinds reacting too quickly to changes in the external environment, (ii) odor, (iii) too little natural light, (iv) glare, and (v) lack of adequate storage space. More than half of staff (59%) (that responded) say they are dissatisfied with the overall comfort level in the building.

One aspect of the building that is considered to work well is the open plan office space, teaching and learning spaces, student attendance, building design and overall image to visitors.

B. Discussions & Interviews

The walk in discussions and interviews with key stakeholders found a number of challenges, successes and learning - a summary of key outcomes are presented below, with a focus on the role of management in ensuring TBL sustainability outcomes. Things that worked well according to the building and asset managers were the institution's image to visitors, increased student attendance due to better teaching and learning space and individual/group study spaces for students, as well as showcasing a green building within their campus which serves as a best practice model for students enhancing their practical knowledge. Learning was dependent on the technical and managerial aspects, but a few of the general key lessons learned were: (i) realizing the significance of building commissioning, (ii) insufficient stakeholder management, (iii) need for formulating building guides to support the building in operation, and (iv) incorporating evaluation, monitoring and verification techniques in the management structure.

The transcribed interview data was compared to initial Green Star Education Design v1 criteria aspirations as determined in the respective GBCA applications of the respective buildings. This was done to assess the actual versus expected performance management. As mentioned above, the key factor observed was the lack of appropriate management frameworks in the university's guidelines. The management succeeded to keep some of the stakeholders satisfied but failed to satisfy one of the key support systems of the institutions i.e., the staff (core building users).

Overall, the development of the study building has had some success from an environmental, sustainability and financial perspective, although was lacking from an occupant's social and behavioral perspective. However, there are lessons which can be drawn upon for future developments to improve outcomes further. Hence, after the analysis of responses through surveys, walk in discussions and interviews the study recommends to close the loop between effective stakeholder engagement and overall building sustainability engagement and management at each phase of any project to optimize the potential for all the stakeholders and creating an output beneficial and satisfactory for all.

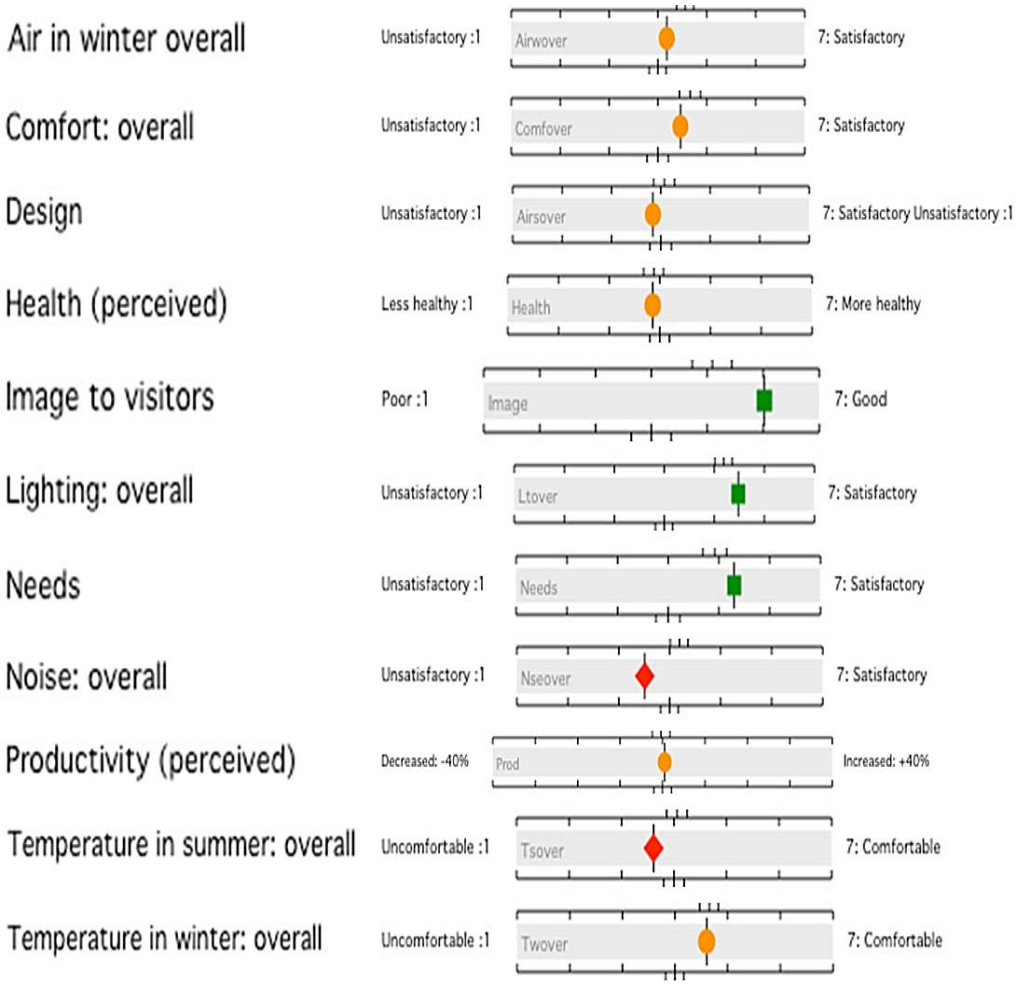


Fig. 1 (a) Summary of the overall variables included in the BUS survey [18]

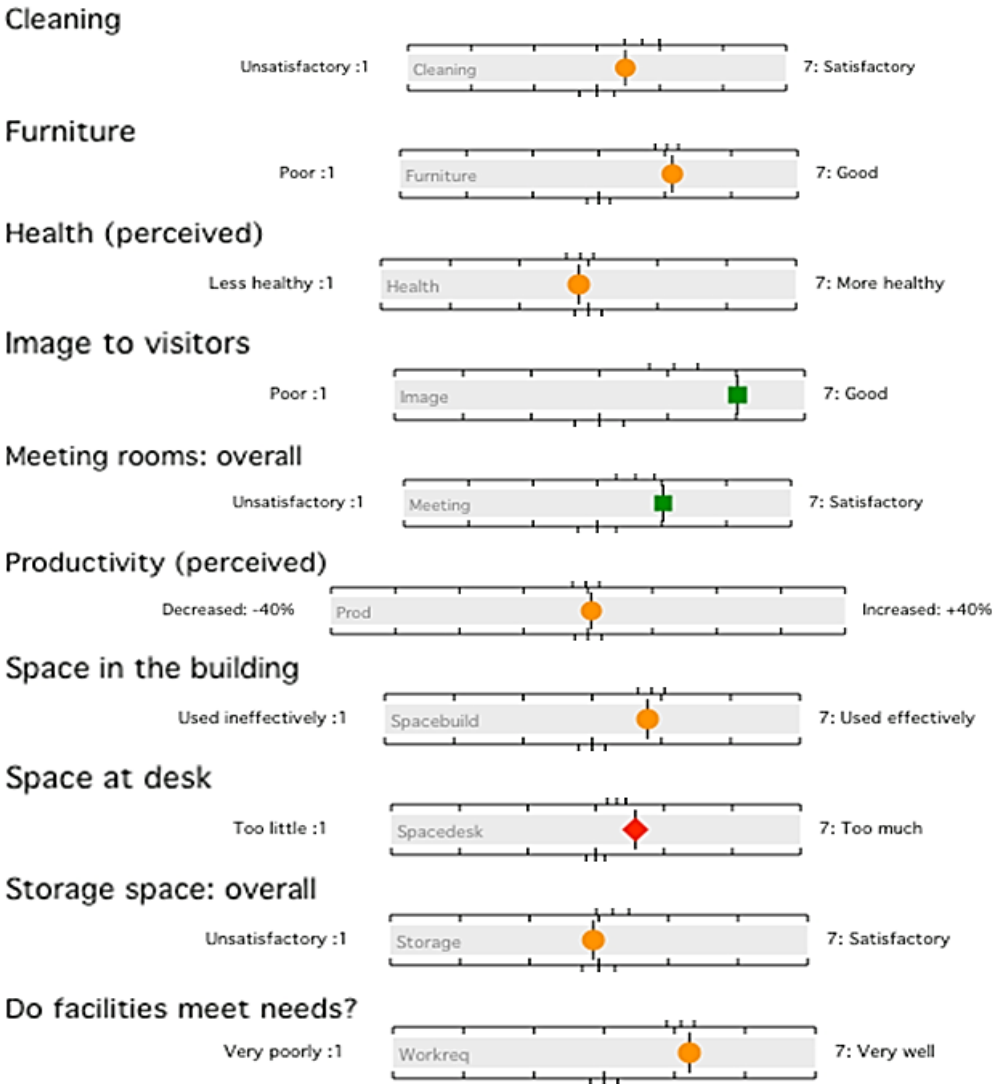


Fig. 1 (b) Summary of the Facility Management variables included in the BUS survey [18]

III. Conclusion

The growth and development of any community impacts the environment drastically. Buildings throughout their lifecycle, from design to operation phase consume many of our natural resources [19]. Hence, creating green buildings are highly crucial, but along with the design, appropriate performance management throughout their lifecycle is also required. This is the reason rating tools were developed world wide (suitable for different countries) with a few differences, adapted to different economies and geographical locations, but technically work on the same underlying principle of achieving overall sustainability. To achieve sustainability, a building needs to be socially, environmentally and economically sustainable. All the three aspects are interrelated and inter-dependent on each other. One cannot achieve overall sustainability if any of the aspect is managed ineffectively and inappropriately.

In order to evaluate the social and behavioral challenges in a green building, this study included post-occupancy evaluation methods recommending that decision to encourage and engage with a building review process should not simply be a part of a property management strategy, but also an important management decision for an organization. A review process promotes capturing valuable data capable of demonstrating measureable return on investment, reflecting, creating dialogue between individuals and teams from multidiscipline service delivery streams, as well as engaging with the end users. Thus, it becomes highly significant to incorporate timely monitored performance management tools within an organization's management structure, and then integrate and communicate the review process as part of broader ongoing reporting. Retaining and sharing the knowledge and lessons learned, then capitalizing and converting this to insights for future projects will be challenging, considering the flux in many organizations in these increasingly uncertain times. Hence, the role of management is highly significant for continuous improvement for any building performance which needs to be fully

recognized. Also, the need of reporting and getting the reporting relationship right in any organization becomes an important consideration. With this perspective in mind, the study includes a discussion on how people in leadership and management roles with their demonstrated capability can effectively balance apparently conflicting project requirements, motivating the occupants and orient their behaviors and successfully manage internal and external stakeholder demands and relationships on complex projects.

Overall this pilot initiative of a Green Star rated academic building study emphasizes on integrating POE services as a streamline line activity that needs to be incorporated in the management structure for new as well as existing building stock. It also highlights the significance of social and behavioral aspects of sustainability that includes appropriate stakeholder engagement at each level of a project and assists facility managers to incorporate such methodologies in their university's management frameworks for future projects.

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