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Designing of Facilities Management Sustainable Parameters for Improving Operational Efficiency

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Abstract. Sustainability practice in facilities management (FM) is becoming a crucial principle throughout the life-cycle of project development mainly at post-occupancy phase. FM collaboration would be productive to support sustainability through improvement of sufficient training and skills coupled with practice culture between designers and facility managers. Systematic review of literature and questionnaire survey was conducted to establish the most important design parameters, and these were separated into four categories of people, process, economy and social. Statistical package for the social sciences (SPSS) and relative significance index (RSI) with rank analysis techniques were then used to further explore the significance and influence of each design parameters in sustainable practice of FM. The top five most design parameters were recognised and highlighted in the design process included: "cost-effectiveness", "value of asset" "environmental" and "practiced culture". Finally, "design adaptability" and "health and safety". The study concludes with development of a conceptual model for integration of design parameters to guide facility managers for appropriate actions.

Keywords: Facilities Management; Sustainable Design; SPSS; RSI; Malaysia

1. Introduction

Traditionally, the principal focus of FM has long time been on controlling and reducing cost for physical asset and now changed towards the creating added value (Jensen and van der Voordt 2016). Facilities management has now given a focal core interest around the world to be more proficient and successful management activity, as competitive pressure escalates on organizations (Fraser

2014). FM is not only focused strategic importance in buildings but also in powerplant, manufacturing, refineries, mining, etc. By 2020 diversity and fragmentation will be witnessed in the construction industry due to different cultural values, processes and interests of the many organizations involvement (Abbas et al. 2009). Recently, researchers have shown an increased interest in high value of building and facilities; both commercial and private customers of such facilities never admit reactive actions however expect a proactive approach (Fraser 2014) (Myeda, Kamaruzzaman, and Pitt 2011).

The past 15-20 years have seen increasingly rapid advances in the field of facilities management, before that this sector have been considered as a necessary evil by the business leaders and managers of all forms (Zio 2009) (Fraser 2014). However, in recent years, this thinking has increasingly been substituted as a strategic issue in all kind of organization. Recent evidence suggests that all business leaders are increasingly materialize their interest on “strategic and financial” importance of the maintenance function for all physical assets (Khazraei and Deuse 2011). Fraser (2014) has attempted to explain the key role of FM team is maintaining and improving the built product quality and cost-effectiveness level, finally constitute an operating budget scheme for any organizations.

In recent years, it is an increasingly important area for most organization, they are imperative to take the opportunity of FM program to optimize their productivity in the same time maximize the overall effectiveness of all building components. In another major study, Fraser (2014) added just-in-time and quality are vitally crucial for operating the facilities services in building. In contrast, building operating cost can be increased and it even may lose the life expectancy without lead an effective maintenance plan. In the new global economy, many organization seeking and adopting the effective as well as reactive approach rather than traditional for facilities management strategies.

Reliability of facilities management is increasingly recognized as a serious in all kind of organization (Abbas et al. 2009). MIT department of facilities building systems design handbook also depicted the reliability level of FM in all construction projects and highlighted the most covered area, as shown in Figure 1. So far, every day billions of people around the world depend on the reliability of facilities services purpose of work, pleasure or place of residence. This indicates a need to understand the various perception of facilities management as critical.

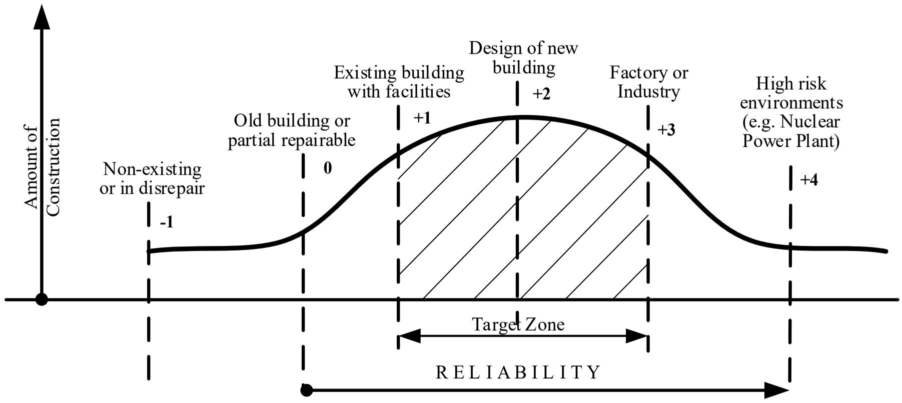

Fig. 1. Existing FM profile in all sectors

Recent developments in the field of facilities management have led to a renewed interest in the concept of added value to the physical resources such as building related facilities and services (Anker Jensen et al. 2012). According to an investigation by van der Voordt and Jensen (2014) and Katchamart (2013), added value of facilities are more perceived as operational efficiency and effectiveness, end user satisfaction and business profitability. Much of the current literature on added value of FM pays particular attention to detect the types of value parameters, Jensen et al. (2012) discovered six different types, called use value; customer user value; economic, social, environmental value, and relationship value. In addition to work Den Heijer (2011) and Riratanaphong (2014) provides three more different value parameters such as productivity, profitability and cost efficiency.

Several previous researches have reported analysis of trends in adding value of FM that demonstrated it covers huge variety of areas, focusing on quality service with affordable costs, efficiency, productivity and creativity (Riratanaphong, Van Der Voortdt, and Sarasoja 2012) (Riratanaphong 2013). The concept of added value in FM have been widely investigated and conclusively shown that it can be interpreted in many ways and inter linked with vast variety of diverse topics. In 2014, Van Der Voordt & Jensen demonstrated most prioritized value incorporated the commitment of FM to the personal satisfaction, the efficiency of the productivity, client fulfilment and maintainability.

This paper going to present the potentials sustainable design parameters in improving building operational efficiency by providing a conceptual model, as the limited number of research papers providing the guideline for FM model creation. Therefore, the objectives are set for this paper to, first, distinguish and categorize the various FM models in the literature, followed by, figure out design parameters in practice, and finally, provide a conceptual model with the key parameters. The sustainable design parameters have been collected from a combination of literature, brainstorming exercise and questionnaire survey with various industry practitioners. This study findings have the potential to narrow-down the concentration on the sustainable design practice that affect the building FM services process during the design development stage of building projects.

2. The Concept of Sustainable Facilities Management

The term sustainable has witnessed to become an important in social and economic issue. Over the past three decades, researchers, scientists, various expertise and social activists have been pointing out the pitfalls of traditional design process of buildings without regard to the harm being done to occupants' comfort and satisfaction as well as global environment. Plaut et al. (2012) reveals that "Sustainability advocates see an immediate, pressing need to move beyond incremental improvements toward profound transformations on pressing economic, social and environmental issues". The impacts of these three issues are well known as the "triple bottom line" for sustainability and these have brought sustainable FM concepts to the building design process for improvement of all sectors in building. In contrast, study by Plaut et al. (2012) indicated that building design practitioners move beyond sustainability concept do not adequately address the interconnectedness between design developments and surroundings environment, nor do they consider comprehensive aspect of social equity, for example education, social engagement and socio-economic diversity.

The effects of built infrastructure on climate change and global environment have widely acknowledged by Global Alliance for Building Sustainably (GABS), Appleby (2013). Another study reveals that organizational competitiveness to be recognised as a fundamental component in sustainable FM practice (Baharum and Pitt 2009). According to IFMA, in present day FM professionals are facing a vital issue named sustainability as rapid development of built infrastructures and suggested they need to be more proficient in the areas of sustainable development and practices. This report also emphasized the importance of FM incorporation in all stages of building project through identifying and enhancing initiatives to minimize operational cost and maximize the nature of building performance. With the same point of view Meng (2014) identified design phase and operation phases are iterative and evolutionary, and inclusively linked. Furthermore, information and knowledge are exchanged between involved various design disciplines and the large number of participants to meet the design interests. These interests are mainly interconnected with financial to obtain a competitive edge over their competitor. To accomplish this financial benefit various industrial sectors is advancing towards sustainable design especially building operation and maintenance is rapidly moving in the sustainability sphere because of its critical operation system (Abbas et al. 2009).

Figure 2 represents the cost benefit curve of extension of service life of building facility system. It assumes below threshold line not economically feasible to operate any building facilities. By performing sustainable FM design can extend the service life and reduce capital expenditure (Hodges 2005). A study by Tucker and Masuri (2016) sustainable FM is all about "being able to manage, implement and deliver an organisation's non-core business services that contribute to the improvement of the economic, social and physical environment and turn into an organisation's core business objectives". On the other hand, now FM has been acknowledged and established as an integrated function that covers buildings and infrastructures operation, management and improvement. It suffices to say consequently, that, the concept of sustainable FM is best defined in terms of "economically efficient, environmentally friendly and socially responsible" for any organisations.

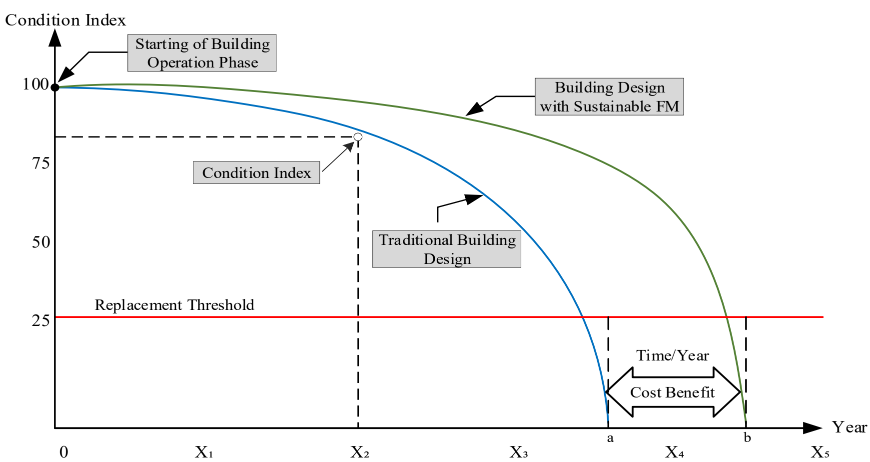

Fig. 2. Cost benefit curve of extension of service life (adapted from (Hodges 2005)

3. The Strategic Role of Sustainable Facilities Management

Previously FM has been regarded as old fashion because of extensive gap of knowledge transformation in all kind of organization, such as real estate, architecture, engineering and construction Kamaruzzaman and Zawawi (2010). Nowadays, FM proven itself like as an umbrella that encompasses with wide-ranging properties and activities, for example real estate, financial management, change management, manpower, health and safety, contract management, domestic services, utilities supplies and building and engineering facilities maintenance.

Sillanpää and Junnonen (2012) indicated that FM offers an extensive variety of services; however, these services are connected because of their purpose of addressing organizational requirements. Also mentioned, FM is observed as a "multidisciplinary or trans-disciplinary" profession dealing with diverse areas of knowledge for example engineering, architecture, design, accounting, finance, space planning and management, and behavioural science. It has been agreed that FM profession is constantly gaining importance for including new development, continuous innovation, and increasing demand and competition in international market (Sillanpää and Junnonen 2012). According to British Institute of Facilities Management (BIFM), the foremost FM organization in the United Kingdom and one of the largest in the world, explains FM encompasses multi-disciplinary activities within the built environment and the management of their influence upon "people and the workplace". Effective facilities management, combining "resources and activities".

On the other hand, International Facilities Management Association (IFMA), considered one of the largest FM body organization in the world, defines Facilities management profession encompasses multiple disciplines to ensure proper functionality of the built environment with the incorporation of "people, place, process and technology". Furthermore, a study by Pitt and Tucker (2008) indicates that the purpose of sustainable FM is to integrate the "non-core services" to adequately strengthen the "core functions and objectives" of any organizations. Now a day, FM is observed as providing services at "strategic, tactical and operational" level of business support to equilibrium among these three levels (Kamaruzzaman and Zawawi 2010).

Previous studies have reported "buffer zone" operates as a shield or cushion between strategic (design) level and operational (implementation) level to improve overall performance and to resist the adverse effect of project disruptions and variability, as illustrated in Figure 3 Meng (2014). Traditionally, a buffer-zone "b0" is allocated as a contingency at the end of the activity to protect any variations and/or uncertainties in design phases, as shown in Figure 3. However, many researches perceived FM professions inclusion in this zone could be useful for absorbing variations and/or uncertainties to facilitate intra-inter dependent relationship in the building projects (Han, Love, and Peña-Mora 2013) (Wan and Kumaraswamy 2012). This involvement resizes the buffer-zone to "b1" and also reallocates additional two coordination-buffer "ca" and "cb" at the beginning and the end of the individual activities. By introducing "ca" in front of the initially planned activity, it is possible to thoroughly review all sustainable design parameters and uncertainties to minimize any interference or conflict prior to the start of activities at time "t0". The buffer "cb" acts as a "self-check" buffer that able to identify any process errors and/or mistakes and technical mismatches related to sustainability in earlier "ca" zone.

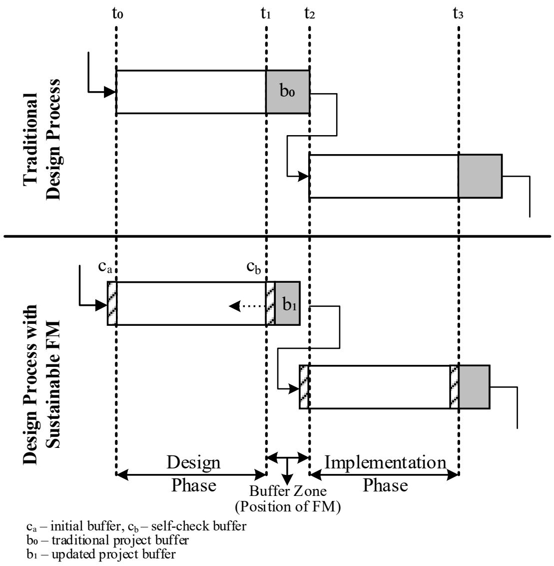

Fig. 3. Action flow of FM in project buffer (Wan and Kumaraswamy 2012)

4. Moving Towards Sustainable Facilities Management

Compared to other professions, for example construction and property, FM is still relatively at beginning stage. Previously FM was considered as caretaking job like old fashion, moving around the office with repairing tools, supervising the renovation works and monitoring the level of cleanliness. However, interestingly, in contrary a study conducted by Rondeau, Brown, and Lapides (2012) found that, FM has recently moved from "the boiler room to the board room" and represents a Figure 4 paradigm shift of FM from 1970s to present.

In recent years, the FM profession has been changing and a key transformation is the increasing adoption of sustainability. Following the rapid development of FM over the past two decades, sustainable FM is becoming increasingly prevalent practice (Meng 2014). Furthermore, he added competitive market all over the world, client satisfaction and future business opportunities are main features for this adoption. In another major study, Cigolini et al. (2009) identified other factors include technological development, economic pressure and cultural change. According to Atkin and Brooks (2014), sustainable facet of FM is becoming more and more significant and they were apparently the first to define the term “sustainable movement” for FM today.

Meng (2014) provides in-depth analysis of the role of FM in sustainable practice showing that FM profession is overall responsible due to the unique position within integrated design team in managing the both building facilities and services. In order to pursue sustainable practice in building project, FM profession should be incorporated from design inception phase to take the overall responsibility of transforming his vast knowledge and experience on a daily basis. Only proper integration of FM can entirely performance their roles that could be ensured the success of sustainable practice in building project (Kibert 2016) (Meng 2014).

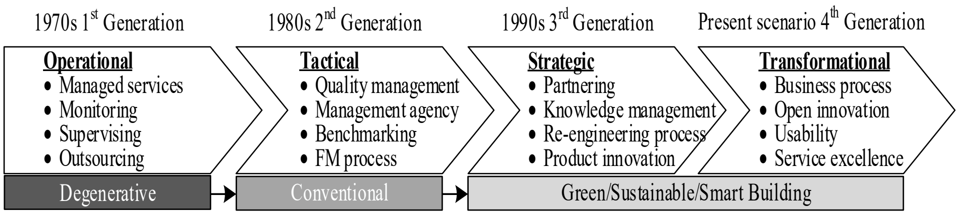

Fig. 4. Paradigm shift in facilities management (adapted from (Plaut et al. 2012))

5. Review of FM Conceptual Model

In the history of development FM, added value parameters have been thought as a pinpoint concern in this industry. Over the past decade most research in FM field has emphasized on measuring the value parameters for successful model creation. In 1998, (Pitt and Tucker 2008) Neely investigated the reason behind this and highlighted the followings: varying nature of work, increasing global competition, level of quality work and external demand. An extensive literature study on fast growing discipline of FM shows various model have been developed, grounded on Balance Scorecard (BSC), Business Excellence Model (BEM), Key Performance Indicator (KPI), and Capability Maturity Model (CMM), etc.

However, in 2008 Lindholm draws attention all researchers in this field by implemented a theoretical model from balance score card methodology. Prior to undertaking the investigation, Lindholm categorizes his findings related to added value elements of FM in following, increase value of assets, innovation, customer satisfaction, efficiency, flexibility, and finally reduce cost. In the model all these mentioned elements contain inside and outside context of the organizations. Apart from Lindholm (2008), there is a research within the context of added value parameters of FM has been measured by Smith and Pitt (2011), the most significant parameters are as follows: cost savings, productivity increase, culture, innovation and perceived success.

The key components of existing four models (BSC, BEM, KPI and CMM) as presented in Table 1. These depicted characteristics are the main considering design parameters for value adding FM model creation. In this discipline strong focus on controlling and reducing property cost, work space related service and newly incorporated another term sustainability.

Table 1. Key components of FM model

	BSC	**BEM**	**KPI**	**CMM**
Objective	Reinforce the organization's operational planning	Describes cause-and-effect of operational process	Focuses on critical aspects of outcomes/outputs	Helps to improve current best practices of organization
Main Focusing Area	• Financial • Customer satisfaction • Business process • Service • Community • Environmental	• Financial • Customer satisfaction • People satisfaction • Impact on society • Policy and strategy • Resources • Process management	• Cost • Quality • Safety • Productivity • Profitability • Customer satisfaction • Safe environment • Service reliability	• Capability • Maturity • Process management

Generally, the term framework in FM practice embodies a multitude of concepts which includes a basic process in existing conceptual framework grounded on input →throughout → output (De Vries et al. 2008). Furthermore, in most recent studies, Jensen & van der Voordt (2016) defines the elaborate process of conceptual framework for added value in FM practice as follows:

Input → Throughput → Output → Outcome → Impact = Added Value

A conceptual framework that describes the possible impact of organizational characteristics on organization's resources. It happens between input and output, and outcomes of the organizations. Organizational manpower and practiced culture both has effect on the choices of facilities and assist to accelerate the work process to generate the better products and facilities services for achieving the customer satisfaction. To achieve this satisfaction there are some contextual impacts such as economy and traditional culture (Riratanaphong and van der Voordt 2015) (Goh et al. 2015).

From the extensive literature study of conceptual model, the sustainable design concept is often included and discussed as well as various parameters. Jensen et al. (2008) has been classified six design parameters as follows: people satisfaction, financial condition, organizational development, productivity, environmental responsibility, and cost efficiency. Other researchers also categorized the parameters with slightly different names as well as different groups and sub-groups, as shown in Table 2. Conversely, the Sarasoja and Aaltonen (2012) also mentioned four different design parameters with a little different term under following headings: people, process, economy and surroundings. In addition, (Jensen and van der Voordt 2015) includes a totally different parameter called environmental sustainability. Table 2 illustrates the main design parameters that were discussed in various FM conceptual model (adapted from Riratanaphong & van der Voordt 2015; Jensen & van der Voordt 2016).

Table 2. Identified various design parameters from FM model

Reference →	**Lindholm (2008)**	**Van Meel et al. (2010)**	**Van der Zwart and Van der Voordt (2013)**	**Jensen et al (2012)**	**Jensen et al. (2008)**	**Lindholm and Aaltonen (2012)**	**De Vries et al. (2008)**	**Den Heijer (2011)**
↓ Category	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
People satisfaction	Customer satisfaction	Focusing on talented staff	User satisfaction	Satisfaction	Satisfaction Culture	Satisfaction	User satisfaction Culture	Users satisfaction Culture
Financial condition	Value of assets		Finance position			Value of assets		Increasing asset value
Organizational development	Flexibility Innovation	Interaction Culture Creativity	Culture Image Innovation	Adaptation Culture Reliability	Adaptability Reliability	Innovation Flexibility	Image Flexibility Innovation	Image Innovation Collaboration
Productivity	Productivity	Enhancing productivity	Improving productivity	Productivity	Productivity	Increase productivity	Production	
Environmental responsibility		Environmental impact		Environmental	Social Environmental	Environmental sustainability		

Cost efficiency	Reducing cost	Reducing cost	Reducing cost	Cost minimization	Reduce cost	Reduce cost	Cost control	Decreasing cost

6. Methodology

In order to translate suitable FM model principles into sustainable design practice, it is important to categorize the design parameters over the whole life cycle of building project. To obtain this the have carried out following activities

a. Reviewing literature in the domain of building design, FM conceptual model and sustainable practice of FM to categorize the parameters that influence the FM model creation which are traceable at design development phase.
b. Before formulating the survey questionnaire, a brainstorming exercise was performed with senior and mid-level FM practitioners, construction practitioners, researchers and academicians to identify the common and potentials design parameters that adversely affect the performance of FM model creation.
c. Developing a questionnaire survey that was administered to 31 various practitioners to determine the relative significance index (RSI) of the identified factors. Table 3 represents the demographic profile of respondents.
d. Analysing the questionnaire survey responses with five-point Likert scale that carefully planned and worded to determine the views of the practitioners, and whether these exhibited commonalities as well.

7. Data Analysis

The results of a through literature review and brainstorming exercise resulted in list 17 design parameters that influence the FM model creation in building project and all drafted into questionnaire tool designed based on Likert scale of importance with the following values: 1 = “Strongly disagree”; 2 = “Disagree”, 3 = “Neutral”; 4 = “Agree” and 5 = “Strongly agree”. The identified sustainable design parameters have been grouped into 4 main categories including: people, process, economy and social; each category has been divided into different sub-groups (10 design parameters). The authors have grouped the design parameters that have a common theme under its respective, appropriate category.

7.1 Analysis of the Questionnaire Survey

The SPSS statistical tool adopted for the study included frequency distribution analysis, mean, standard deviation, RSI and rank analysis. This software is a comprehensive system and provides good precision data with automatically calculates statistics (Sarpin 2015). In addition, Conbach's alpha coefficient was used to assess the reliability of data obtained from questionnaire which recognises the most common for measuring the internal consistency of questionnaires data. In the survey respondents were asked to comment on the "importance" of design parameters that may be considered in generating FM conceptual model. To evaluate the overall ranking, the RSI has been adopted as numerous research also applied this technique (Wan and Kumaraswamy 2012). The numerical score of each design parameters was transformed to RSI in order to assess the relative ranking of sustainable design parameters using the following formula:

Relative Significance Index (RSI) = $\frac{\sum_{i=1}^{n} W}{N \times W_{H}}$ where ($0 \leq RSI \leq 1$)

Where Wi is the score of each factor as rated by the respondents ranging from 1 to 5, where 1 is the least and 5 is the most important in the survey; N is the total number of respondents; and WH is the highest score (i.e. 5) adopted in the survey.

8. Discussion of Findings

As a result of the data collection, thirty-one (31) completed questionnaires were responded with the rate of response slightly above forty one percent (47.4%). A low response rate is not uncommon phenomenon in the research of FM discipline, for example 22.9 percent, 14.8 percent and 24.3 percent for Haynes and Price (2004), May and Pinder (2008) and Meng (2011) respectively. The statistical analysis results are summarised in the following.

8.1 Sample Characteristics

By the end of the survey period, data had been collected from respondents and the results obtained from the analysis of demographic information of respondents are presented in Table 3. Majority of the respondents were engineer (37%), 19% facility manager and project manager, and 11% quantity surveyor. Some other respondents (14%) were include academician, business development or directors who could not be readily categorised otherwise. Of the study population, each having good number of on-site experience, as they were in senior and mid-level position to provide more reliable information regarding sustainable practice of FM. 37% of those who were involved in managing in office building, 22% and 19% residential and commercial respectively, while rest were experienced in managing educational, infrastructure and petrochemical project. It is apparent from this table that 41% respondents were bachelor's degree holder, interestingly near to half (48%) of those respondents' master's degree holders with one PhD holder. A minority of respondents (7%) diploma holders.

Table 3. Demographic information of the respondents

Profession		Highest academic qualification		Years of experience in FM		Type of projects	
Engineer	37%	PhD	4%	<5	56%	Commercial	19%
Quantity Surveyor	11%	Master's Degree	48%	5-10	30%	Residential	22%
Facility Manager	19%	Bachelor's Degree	41%	11-15	7%	Office	37%
Project Manger	19%	Diploma	7%	16-20	7%	Educational	4%
Others	14%			>20	0	Others	19%

8.2 Reliability of the Obtained Data

Prior to proceeding with the analysis, The Cronbach's alpha (α) value was calculated, as illustrated in Table 4, to test the internal consistency of the scale in providing appropriate ratings for the design parameters and important factor in design consideration. Pallant (2010) and Yip and Poon (2009) indicated that "$\alpha \geq 0.7$" is acceptable, but values of "$\alpha > 0.8$" are more preferable. In this study, α value for "design parameters" was 0.913 and "important factor for design consideration" was 0.80, which showed strong internal consistency of the scale used and suggested reliable data had been obtained.

Table 4. Cronbach's alpha calculation from SPSS

Reliability Statistics		
	Cronbach's Alpha	N of Items
Design parameters	0.913	10
Factor to be considered for design	0.800	5

8.3 Significance of People Related Parameters

In order to understand the significance of sustainable design parameters to the development of FM conceptual model are characterized by four strands – people, process, economy and social. These were taken as a point of reference to indicate understanding respondents' answers. This group comprises three design parameters including client and user desires, practiced culture, and health and safety as illustrated in Table 5. The responses were very varied as can be seen in Figure 5. More than half (52%) of the respondents were "strongly agree" with the people related all design parameters to be considered in the development of FM conceptual model. On the other hand, above 30% of the responses to "agree" are reported and meanwhile there are no responses to "strongly disagree". As a result, people related design parameters are well accepted by the majority of the respondents as they have realised the significance of sustainability concept incorporation to FM model development. Obviously, better understanding of the clients' objectives is the driving force in the sustainable practice of FM to improve the nature of building performance as analysed by Meng and Minogue (2011); Katchamart (2013); Voordt and Jensen (2014). In another study, client desire has been most significant, but user desire has become increasingly significant day to day van der Voordt and Jensen (2014). Practiced culture is an engagement of FM profession into design process to monitor internal (design phase) and external (post-occupancy phase) activity, however, designers regarded as difficult, boring and lacking in imagination to engage FM concept. This unbalanced "power practice" between designers and FM professions decrease the quality of sustainable practice. To increase the sustainability practice, it is best way to improve the awareness of health and safety issues, and good practice culture (Abbas et al. 2009). The significance indices for all parameters are presented in Table 5 clearly shows that "practiced culture" is ranked as the most significant in this group, with a relative significance index (RSI) 0.88. Others two "health and safety" and "client and user desires" were also calculated RSI 0.87 and 0.86 respectively.

Table 5. Assessment of sustainable design parameters

Group	Design Parameters	Mean	SD	RSI	Rank
People	Client and user desires	4.30	0.86	0.86	7
	Practiced culture	4.39	0.77	0.88	4
	Health and safety	4.35	0.76	0.87	5
Process	Design adaptability	4.35	0.87	0.87	5
	Innovation and creativity	3.91	0.93	0.78	10
	Risk management	4.09	0.93	0.82	9
Economy	Cost effectiveness	4.70	0.69	0.94	1
	Value of asset	4.52	0.65	0.90	2
Social	Environmental	4.52	0.77	0.90	2
	Responsibility	4.22	0.78	0.84	8

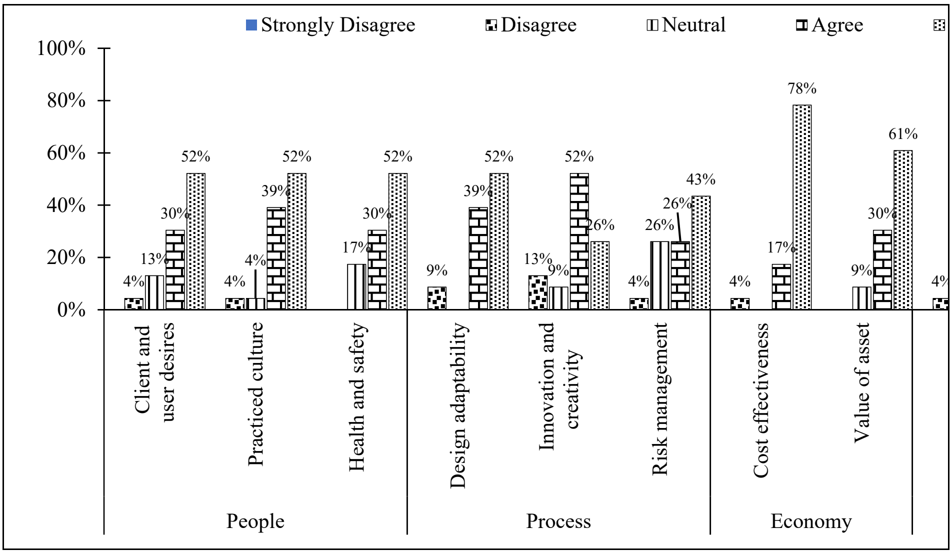

Fig. 5. Survey respondents understanding on sustainable design parameters

8.4 Significance of Process Related Parameters

This group consists of three design parameters divided into followings: design adaptability, innovation and creativity, and risk management as shown in Table 5. The statistical analysis presents the response rate of these three design parameters are variegated as can be observed in Figure 5. The importance of process related design parameters mainly concentrates on "strongly agree" and "agree". "Neutral" and "disagree" are only acknowledged by a few number of respondents, and there are no responses to "strongly disagree". Each parameter(s) has ignored some responses, for example nobody responses on both "neutral" and strongly disagree" for design adaptability, and only "strongly disagree" for risk management. This indicates that the all respondents have agreed in considering these parameters as important for sustainable FM model development. The "design adaptability" has received the most responses (52%) to "strongly agree" and is subject to the least responses (9%) to "disagree". This Response clearly shows that designers to be very practical to design building facility services for adaptability during the early design stage with the aim of achieving the sustainability and it is very hard to achieve without the relevant information from FM team and appropriate integration platform. Traditionally, the designers are more concerned with the aesthetic view and moving onward to the nature of innovation rather than practicality and maintainability (Kalantari et al. 2017). Above point of view is reflected in the responses, "strongly agree" is only rated by 26% of respondent for the importance of "innovation and creativity" parameters in model development while 13% responses to "disagree". Proper incorporation of FM in design process could offer a proactive approach of future uncertainty for handling risk that may endanger or threaten people, built asset, financial resources and cause loss of earning capacity in buildings. Hence, it is clear that FM design considerations should be taken into account to ensure project sustainability. 69% respondents "agree" or "strongly agree" with the importance of "risk management" parameter, while 4% "disagreed" and 26% were neutral of the respondents. From the data in Figure 5 are presented most respondents believe that "process" related design parameters should be part of FM model development to ensure easy and cost-effective maintenance at operational phase. Data from this Figure 5 can be compared with the data in Table 5 which shows that "design adaptability" is perceived as the most significant in this group by the respondents with significant index 0.87. The significant index of others two "innovation and creativity" and "risk management" as calculated 0.87 and 0.86 respectively.

8.5 Significance of Economy Related Parameters

This group includes two parameters related to two sub-headings: cost effectiveness and value of asset as illustrated in Table 5. The result obtained from the statistical analysis of these two design parameters are shown in Figure 5. From the figure, it can be can be seen that by far the highest number (78%) of responses to "strongly agree" for importance of "cost effectiveness" parameter, in contrast there are no responses to "strongly disagree" as well as "neutral" option. However, "disagree" is only acknowledged by a small number (4%) of respondents, while responses to "agree" is identified by merely 17%. This result indicates a common view amongst responses that cost effectiveness is the most prioritized parameters all kind of business organization in terms of capital investment, turnover and operational cost. Obviously, cost reduction is an important mean in building operational phase without regard to the harm being done to occupants' comfort and satisfaction as well as global environment (van der Voordt and Jensen, 2014). Initial capital investment for building facilities is a major concern, however, now a day long term cost impacts for built facilities are measuring and benchmarking in terms of affordability and sustainability. Turning now to the "value of asset" parameter, a little variety of perspectives were expressed by the respondents as shown in Figure 5. It is now essential that a reliable and cost-effective operation system to be engaged in the building for ensure the continued usability, reliability and safety of the assets being managed (Fraser 2014). Therefore, FM experts seeking to expand their knowledge to develop a suitable sustainable model for enhancing their organisations' value. The importance of "value of asset" parameter mainly focused on "strongly agree" and "agree", more than 61% of the respondents identified “strongly agree” to this concept. Same time “agree” is also rated by over one-fourth of respondents (30%). On the other hand, no respondents choose “strongly disagree” and a very small number (9%) agree with “disagree” option. From the Table 5, we can see that “cost effectiveness” resulted in the highest value of RSI 0.94 and for the “value of asset” RSI is 0.90.

8.6 Significance of Social Related Parameters

This group contains of two design parameters described into followings: environmental and responsibility as shown in Table 5. The data analysis presents the response rate of these two design parameters were not very varied as can be seen in Figure 5. It is apparent from the figure that most of the respondents were identified “strongly agree” and “agree” for “responsibility” and “environmental” design parameters. However, there were no responses to “strongly disagree” and a few number of respondents were acknowledged “neutral” and “disagree”.

The “environmental” parameter has received the most responses to “strongly agree” and “agree” above 90% and is subject to smallest amount (8%) responses to “neutral” and “agree”. The identification of this importance explains this parameter’s integration in development of sustainable FM model is highly significant to achieve the sustainability in building projects. Prior studies that have noted the importance of environmental impact, but it is still not acknowledged high priority in many buildings in terms of selection of environmental suitable materials (van der Voordt and Jensen 2014). Since, all over the world the majority of buildings in current use will remain for next 50 years, accordingly it is indeed key role of FM on the operational phase of existing building in achieving sustainability goals. Social responsibility is also under the consideration of sustainable FM. The buildings are considering as an indoor environment where people work and spend their time. Therefore, it is owners’ responsibility to create a healthy environment and good working condition to increase the productivity level of employees and then benefit the employers. To achieve the organisations’ core objectives, it is may be the best cost-effective choice to spend money on improving the working indoor environment that leads to improve employees’ productivity (Abbas et al. 2009). In the 21st century, to meet the above requirements FM professions of high calibre more than ever a need. From the figure it can be seen that, in response to “reliability” parameter, more than two-third (78%) of those surveyed indicated that “strongly agree” and “agree” and a minority of participants (22%) reported to “neutral”. The results obtained from the statistical analysis of relative significant index are presented in Table 5, compare with the data in this group shows “environmental” parameter resulted in the highest significant value of 0.90 and for “responsibility” 0.84.

9. The Benefits of Sustainable Design Parameters Integration

The scientific attention directed towards the establishment of sustainable strategies aiming at restructuring the organisational responsibilities in terms of social and environmental. The focal discussion of sustainable FM in building project is understanding of design limitations to ensure a cost-effective operation and maintenance, in addition, fulfil the client and end-user requirements, reduction of built asset operations impact on the environment and improvement of collaboration culture between designer communities and FM profession. According to Ding (2008) and Bu Jawdeh (2013), sustainability activities in construction can be defined as “reduce-reuse-recycle-and raise awareness”. A separate question was asked respondents at what percent of operation and maintenance cost can be reduced by integrating FM sustainable design parameters during early design stage. Again here, the responses varied widely. From the data in Table 6, it is apparent that seventy-eight percent of the respondents believed proper integration of design parameters in design stage can reduce less-than or equal to 20 percent of operation and maintenance cost. Compare with the data in this Table shows “≤ 20%” resulted highest significant index and mean value 0.83 and 4.13 respectively. However, just over 40 percent responded to “strongly disagree” on both cost saving range 5%-10% and ≤30%. Only a small number of respondents agreed on ≤15% and ≤25% cost can be minimized by integrating this. Overall this result emphasizes that earlier incorporation of sustainable design parameters in design development stage would lead to cost-effective operation and maintenance.

Recent graphs such as Figure 6, highlights that the cost of design changes is higher through the design process without concerning the FM concept. Therefore, the FM professional incorporation draws the project stakeholders together earlier so that the individual parties can coordinate their design input, encouraging a more integrated approach to project design and delivery (McAuley 2016). In contrast Kelantari et al. (2017) concluded that the appropriate time to initiate integration sometimes depended on the complexity, type and volume of the project.

In a separate question, the respondents were asked to indicate which one should be taken into account in designing, the majority (78%) of those who responded to this felt that “maintainability” criteria most significant to ensure cost-effective operation and maintenance, continuous customer satisfaction and minimize the effort of operating and maintaining. Out of the 5 factors, “maintainability” factor was identified as significant with highest mean value and significant index 4.70

and 0.94 respectively, as shown in Table 6. Over half of the participant agreed that "constructability", "functionality" and "occupants comfort" could be considered in the design phase too. Taken together, these results provide an important insight into that successful integration of sustainable design parameters in design process would help in creating better-performing built asset and reducing long-term operating and maintaining expenses.

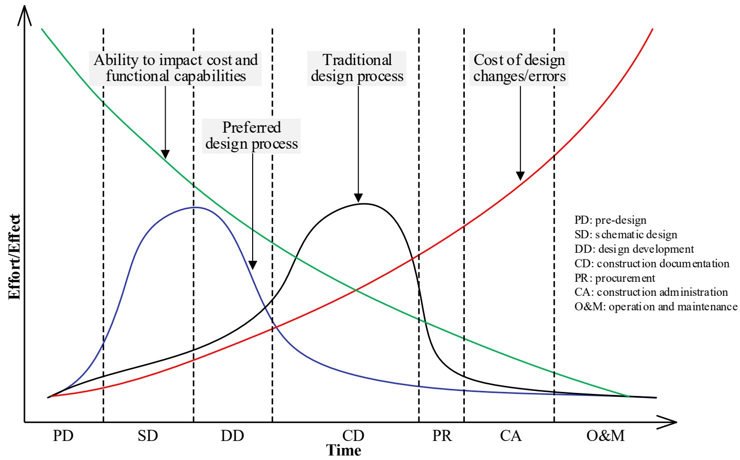

Fig. 6. Integrated approach of FM in building life-cycle (adapted from McAuley (2016))

Table 6. Cost benefit and factors consideration for integrating sustainable parameter

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	RSI
% Cost Savings	5% - 10%	43%	17%	9%	9%	22%	2.48	0.50
	≤ 15%	9%	30%	17%	30%	13%	3.09	0.62
	≤ 20%	4%	0%	17%	35%	43%	4.13	0.83
	≤ 25%	0%	26%	26%	30%	17%	3.39	0.68
	≤ 30%	39%	26%	9%	9%	17%	2.39	0.48
Factors	Constructability	0%	4%	4%	39%	52%	4.39	0.88
	Maintainability	0%	4%	0%	17%	78%	4.70	0.94
	Functionality	0%	4%	17%	17%	61%	4.35	0.87
	Aesthetics	4%	9%	26%	48%	13%	3.57	0.71
	Occupants' comfort	4%	9%	17%	17%	52%	4.04	0.81

10. Conclusions and Recommendations

The construction industry and FM discipline have greater leverage and are well positioned to lead humanity's quest for sustainability. Therefore, these two industries are in the forefront of accomplishing the sustainability goals with the increasingly rising modern building requirements and targets to tackle the global environment. In present days, both hypothetical and practical sustainable design management are continually developing. So far, however, there has been little impact perceived due to the exclusion of FM throughout the design process, hence better understanding of design parameters for achieving the sustainability is very significant. This study presents a collection of 17 sustainable design parameters thorough extensive review of literature, brainstorming exercise and meeting of senior and mid-level industry professionals. Thereafter, the parameters have been assessed to determine their level of significance. In this study, sustainability parameters are clustered into four main components - people, process, economy and social - for better understanding of the three (environmental, economic and social) bottom lines of sustainability 4 main components are further divided in 10 design parameters.

The questionnaire survey was conducted to recognize insights and understanding of the sustainable design parameters in the practice of FM sector. The results from this present study analysis revealed that the top five most design parameters considerably influential and could be incorporated into the design process to achieve the sustainability are: "cost-effectiveness" and "value of asset" followed by "environmental" and "practiced culture". Finally, "design adaptability" and "health and safety". The identification of the design parameters provides a useful guide for various design professionals and FM practitioners to pursue sustainable practice. Study findings designated that the majority of the respondent strongly agreed the "cost-effectiveness" and "value of asset" as the most significant design parameters and to be integrated in the building design process to operate and maintain the designed-facilities in an efficient way at post-occupancy phase. Figure 7 is a proposed conceptual visual framework indicating the route that a typical project could undergo during the design process in order to achieve the sustainability and maximize the value that sustainable design parameters can add to the building projects.

Achieving the goal of FM sustainable practices in the building projects needs an interplay of four main components: people, process, economy and social. The combination of these main components of design parameters will provide the right approach to sustainable objectives in FM practices. Therefore, inclusion of FM personnel is a unique position to view the entire design development process and offer a long-lasting value for any built asset. From the literature study, the fragmentation of design and construction processes, lack of understanding of the FM and the asymmetry of practical information during the design and operation of facilities impede the acceleration of the sustainability. Indeed, there is a need coherent and effective structures for knowledge transformation within sustainable FM practice and design concepts through FM professionals and design professionals to materialize the sustainability discourses.

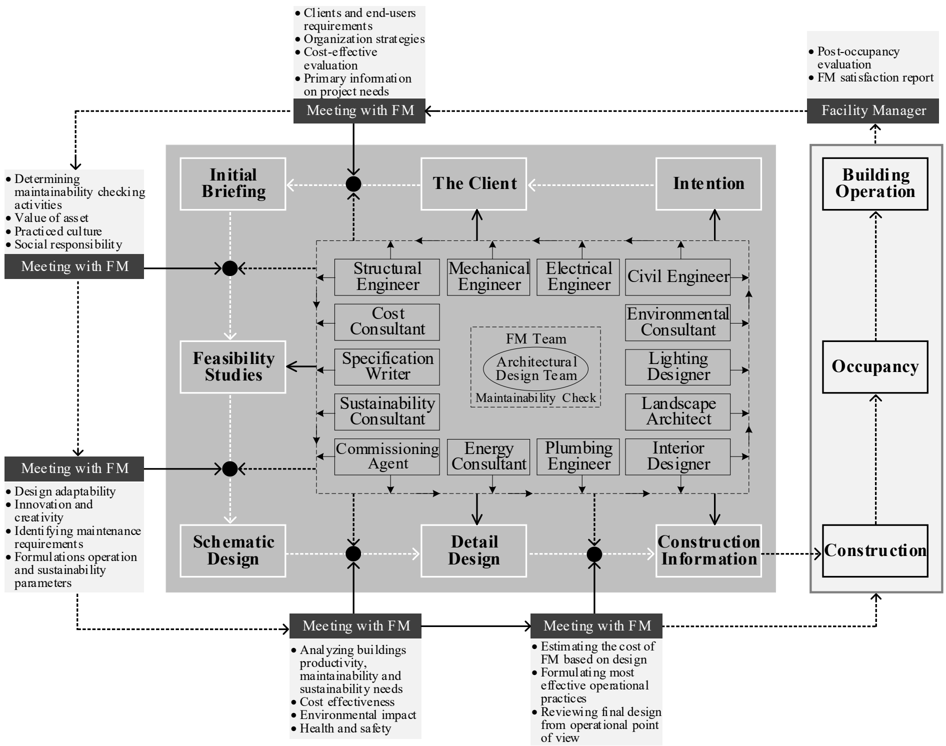

Fig.7. Proposed framework for integrating sustainable parameters in design process

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