THE DEVELOPMENT OF FACILITIES MANAGEMENT-DEVELOPMENT PROCESS (FM-DP) INTEGRATION FRAMEWORK

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Abstract: This paper aims to establish the critical factors for the integration of FM in the development process and to demonstrate the development of the Facilities Management – Development Process (FM-DP) integration framework. The framework will be useful to provide a guideline to enable professionals in FM and/or other professionals in property development industry to optimise the role of FM in the development process. A quantitative approach is adopted in which a statistical analysis was carried out based on the data obtained through the questionnaire survey. The purification of the scale was conducted followed by correlation and MANOVA. The results demonstrate that there are 15 factors to optimise the role of FM across eight (8) stages of RIBA Plan of Work 2013. The literature review reveals that FM has been given a low priority in the property development industry, resulting in FM being inadequately integrated into the development process. There are attempts from the industry and academia to integrate FM in the development process. However, there is a lack of evidence showing the establishment of a systematic generic mechanism for FM-DP integration. The research discovered that there are 15 factors to be considered at distinct stages of the RIBA Plan of Work 2013 to fully harness the role of FM in the development process. The establishment of FM-DP integration framework has satisfied the gap that needs to be filled.

Keywords: Facilities Management, Development Process, Building Information Modelling, Property Development Industry, Statistic Analysis.

1.0 Introduction

This paper presents the quantitative findings of a wider mixed-methods approach in order to develop a facilities management-development process (FM-DP) integration framework. It is based on identified critical strategic issues that limit the integration of FM in the property development industry in the UK. The developed framework potentially serves as a guideline to optimise the value of FM in the property development industry.

FM is a relatively a new discipline in the UK (Pitt & Tucker, 2008), and the responsibility of Facilities Managers is wide-ranging, covering various aspects of human wellbeing and physical infrastructure. Nowadays, the role of FM has moved from 'the boiler room to the

boardroom' (Rondeau *et al*., 2006), which has also positioned the Facilities Manager in a decision-making process in the development project set up. From the property development industry perspective, the Facilities Manager should be integrated at the early stages of the development process, such as the planning and design stage, rather than being called upon at the commissioning and occupation stages. Although the operational level is the Facilities Manager's 'bread and butter', it has become less important, as Facilities Managers should spend their time in conceptual design, planning, technical design, controlling and monitoring (Kincaid, 1994). However, Facilities Managers are frequently neglected from being involved at the early stage of the development process.

It has been argued that the incorporation of FM value at the early stage of the development process would enhance the performance of the property development domain. The Facilities Manager has been acknowledged as an appropriate professional to demonstrate FM value that significantly contributes to the development process in four (4) aspects; decision-making process, innovation, value-added and sustainable development (Tucker & Masuri, 2016). Moreover, the Facilities Manager is in a strategic position to view every activity in the development process, as well as being the person in the middle to facilitate the coordination of various stakeholders in the development project.

The FM-DP integration framework is essential to upsurge the profile of FM as well as to enhance the achievement of sustainable development in property development industry. In addition, the FM-DP integration framework could be a practical mechanism to guide Facilities Managers and/or other professionals to harness the value of FM in the property development industry, which is based on the RIBA Plan of Works 2013 (which is consists of Stage 0: Strategic Definition, Stage 1: Preparation and Brief, Stage 2: Concept Design, Stage 3: Developed Design, Stage 4: Technical Design, Stage 5: Construction, Stage 6: Handover and Close Out and Stage 7: In Use).

Tucker *et al*. (2017) concluded that the factors to integrate FM in the development process can be classified into nine (9) groups of main themes, namely perception, competence, regulations, organisations, knowledge management, management tools, operations, decision making, and sustainability. The main themes contain 35 sub-themes for the measurement of FM-DP integration. Nevertheless, there are four (4) vital areas that are potential to place FM in a strategic position in the development process.

a. The Integration of (BIM) into FM for sustainable development
b. The ability of FM to implement of post-occupancy evaluation (POE)
c. Having familiarity with Government Soft Landings (GSL) concept
d. Knowledgeable with regard to sustainable initiatives

This paper firstly provides a comprehensive literature review of the necessity to develop the FM-DP integration framework, as a result of the absence of a suitable generic mechanism in all stages of the development process. The literature also touches on the strategic critical issues that give potential for FM-DP integration. Secondly, the paper provides the evidence of the statistical analysis based on the data obtained from a questionnaire survey. The purification of the scale was conducted followed by correlation and MANOVA. Thirdly, the paper explains the findings from the quantitative research methodology adopted, prior to

presenting the proposed FM-DP integration framework. The findings obtained from this research form part of a broader sequential exploratory strategy to which the findings of this study is extended from the previous qualitative study conducted by Tucker and Masuri (2016) and Tucker *et al*. (2017).

The paper develops a framework that could be used as a guideline for all professionals in the property development industry, including engineers, to integrate FM in the development process based on the eight (8) stages of the RIBA Plan of Work 2013.

2.0 The Integration of Building Information Modelling (BIM) into FM for Sustainable Development

BIM has been a buzzword in the built environment and has become ordinary in the property development sector (Thomas, 2017). BIFM (2012) has viewed BIM as a one way to create sustainable facilities in the property development project. It has been considered imperative to contribute to sustainable FM. There is a perception that the integration of BIM into FM could provide an encouraging environment for Facilities Managers to carry out their function (Gnanarednam and Jayasena, 2013), and a recent BIFM survey found that 92% of respondents from the FM industry have heard of BIM, with 84% indicating that BIM is already having an impact or will do so in the next five years (Ashworth & Tucker, 2017). However, BIM needs to play its role effectively in knowledge management, particularly in the whole life cycle of the facilities. The potential of BIM to facilitate architects and engineers in design works as well as the construction of the facilities is inarguable. It was claimed that Stage 7 (In Use) will receive the biggest impact if BIM is implemented in the property development project (Pocock *et al*., 2014). Pocock *et al*. 2014 suggested how the building owner and the professionals such as engineers and architects could benefit in the implementation of BIM in their projects.

2.1.1 Building owners

a. Create policies that focus on BIM.
b. Improve staff competencies in BIM.
c. Develop information system in compliance with BIM standards to ensure consistency in BIM application at all development stages.
d. Develop appropriate client requirements for BIM to be connected with the supply chain.
e. Expand BIM usage based on the condition of existing assets prioritised by asset criticality.

2.1.2 Engineering and Built Environment Professionals

a. Create BIM standards with the consideration of all data needed / anticipated during the building life cycle.
b. Take a 'whole life-whole system-whole industry' approach in creating BIM standards.
c. Encourage learning environment in organisations particularly in enhancing the competencies and professional qualifications in BIM.

By the same token, BIM will also add value to the FM discipline by optimising the cost of operation and maintenance cost of the facilities. Hence, BIM is advantageous in fulfilling the

economic dimension of sustainability. From an environmental sustainability perspective, BIM can support FM in identifying the most effective opportunities for improving the implementation of green buildings and carbon reduction (Aaltonen *et al*., 2013). More specifically, the benefits that can be gained by FM from BIM according to Abdullah *et al*. (2014) is illustrated in Figure 1.

Figure 1 The benefits to FM from using BIM in the development process. Source: Abdullah et al. (2014)

Although BIM is often associated with new development projects, it is important to remember that development projects in turn become workplaces where people need to be productive in optimising the buildings' functionality. This is emphasised by (Smith *et al*., 2011), who state that 'it is important to provide workplaces that positively influence the workforce' (p.209). Volk *et al*. (2014) pointed out that BIM can have a significant contribution to existing facilities, particularly in sustainability assessments and ratings. There is also a need to expand BIM beyond design stage (Stage 2, Stage 3 and Stage 4) and to consider using BIM for FM activities at Stage 7 (R. Liu & Issa, 2013). Nevertheless, there are technical, informational, organisational and legal issues that need to be resolved. For this, Eastman *et al*. (2011) and Peglow (2010) suggest the relevant action that needs to be considered to encourage the integration between FM and BIM.

To conclude, BIM is a new way of communication and collaboration between Facilities Managers and other professionals in the property development industry. As BIM created values to FM (Becerik-Gerber *et al*., 2012), this research envisaged the presence and pertinence of BIM as one of the best practices that could uphold the integration of FM in the development process.

3.0 The ability of FM to implement of post-occupancy evaluation (POE)

Another sub-theme that is anticipated to have major potential contribution to place FM in a strategic position in the development process is the ability of Facilities Manager to respond to building occupants' feedback through the implementation of post-occupancy evaluation (POE). As emphasised by Elmualim *et al*. (2005), POE will strengthen the role of Facilities Managers across the entire development process. POE is a continuous systematic process in assessing the performance of the building in seven (7) elements namely productivity, cost effectiveness, accessibility, functionality, aesthetics, safety and security and sustainability (Okolie & Adedeji, 2013). The objectives of conducting POE is to enhance building design practice, which improve the function of the facility to support the operation of the organisation to achieve their business objectives. POE is a learning process from past experience, evaluate it and to make a decision to employ it in a new modern building design.

Nevertheless, it is claimed that the property development sector is learning deliberately at Stage 7 (In Use) due to improper relationship with the users (Grayson, 2003). Okolie & Adedeji (2013) stressed that POE is a key factor for better planning and design provided that the information collected is interpreted and analysed thoroughly. Another benefit of conducting POE is increasing the reputation of the designer for taking users' needs into account and create opportunity for repeat business and referrals. For the builders, they could prepare a realistic work program based on the client's requirements, meanwhile, the users will also benefit from a more satisfying and safer workplace (Pearson, 2003). Pearson (2003) listed out the process of POE in four (4) steps:

a. Analysing the experience
b. Identifying the lessons learned
c. Generalising the findings
d. Apply the learning to other situations

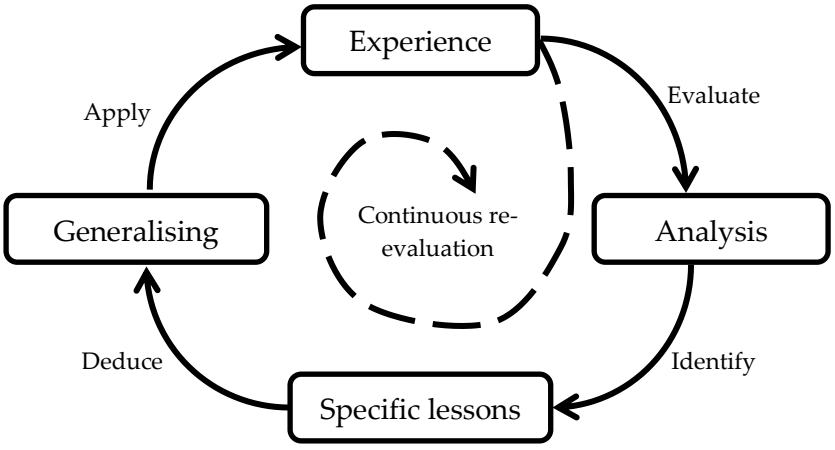

Figure 2 The feedback cycle through POE. Source: Pearson (2003)

4.0 Having familiarity with the Government Soft Landings (GSL) concept

GSL provide opportunities to enhance the stature of FM. The RIBA Plan of Work 2013 has considered such a situation by introducing GSL, which encourages early engagement of other professionals to work collectively with Facilities Manager who are also responsible for post-occupancy evaluation (POE) during Stage 7 (In Use) (Sinclair, 2013; p. 84). The GSL concept suggests a regular monitoring of the actual building performance during Defects Liability Period (DLP) prevalently two to three years after building completion. Unlike conventional POE, GSL embeds other techniques of POE in all stages of the development process. In addition, GSL helps in strengthening building maintenance planning which is indirectly contributing to effective maintenance works in responding to users' complaints. The building performance information gathered at Stage 7 (In Use) are learnt and applied for the benefit of all stakeholders (Grayson, 2003). On the one hand, GSL will help to understand the role of Facilities Managers in managing building maintenance works. On the other hand, GSL is implemented to ensure the involvement of Facilities Managers across all stages of the development process (BIFM, 2012). In GSL, the clients play a greater role to lead and to outline the remit of all key specialists including Facilities Manager. On top of that, GSL highlighted the responsibility of the client to ensure the people involved in this process are the actual individuals that could contribute meaningfully in the project (BSRIA, 2012).

5.0 Knowledgeable with regard to sustainable initiatives

Looking at the role of FM for the integration between primary and support processes in the organisation, FM has a great potential to contribute to sustainable development. FM has an unambiguous impact to the 'triple bottom line' of economics, sociology and environment (Elmualim *et al*., 2012). FM could influence in sustainable initiatives in different aspects particularly in strengthening primary processes of an organisation, provide space and infrastructure and enhancement of human capital and the system of the organisations (Junghans, 2011). Figure 3 shows the basic structure of Sustainable FM towards 'triple bottom line' of Sustainable Development.

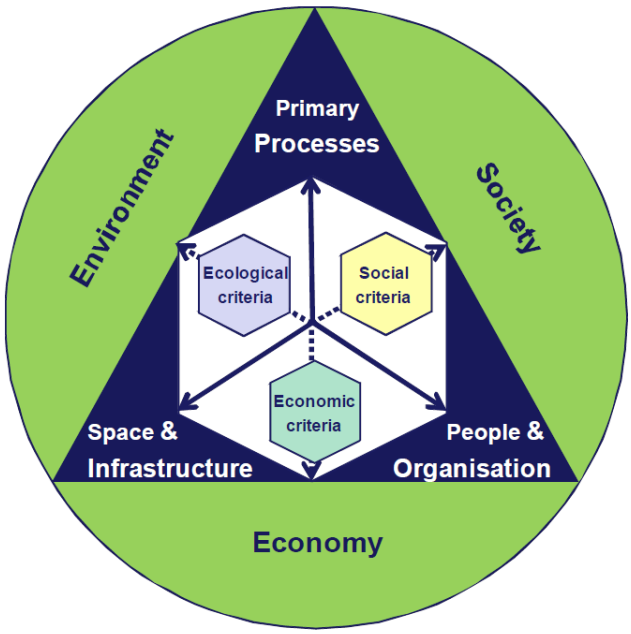

Figure 3 Basic structure of of Sustainable FM towards 'triple bottom line' of Sustainable Development. Source: Junghans (2011)

Junghans (2011) claimed that FM is broadening its capacity from an operational to strategic and tactical role in the built environment. However, the implementation of sustainable FM is questionable. One of the challenges asserted by Elmualim *et al*. (2009) is the inadequate understanding of the key concept of sustainability which would impede the effectiveness of the practice of sustainable FM. Elmualim *et al*. (2010) however, suggested that there are key areas for sustainable FM that are energy efficiency, waste management and recycling, carbon foot print, and health and safety. Nielsen & Galamba (2010) presented a methodology for Facilities Managers to be present for sustainable FM at local society and globally particularly in the issue of climate change and the ecosystem.

There is another bottom line that needs to be emphasised when implementing the sustainability concept in the development process: design (Pitt *et al*., 2009). Earlier stages of the development process including design stage (Stage 2: Concept Design and Stage 3: Developed Design) have a key role in sustainable development. The sustainable development concept covers all aspects of each stage of the development process. For instance, in the design stage, sustainable development covers the application of information and communication technology (ICT) such as Building Information Modelling (BIM), which gives Facilities Managers 'the opportunity to tell the designers what information they really need at the early stages of the project development [process], so it's linking the project to the operation' (BIFM, 2012; p. 8). In Stage 5: Construction, it covers health and safety; while in the Stage 7: In Use, it focuses on reducing operating costs by using CAFM, enhanced corporate image and increased wellbeing of the occupants. In short, inclusion of FM value into the development process encourages the property development industry to learn the principles, techniques, and tools of other domain of sustainability development: lean concept (Koskela, 1992).

6.0 Methodology

The main purpose of this study is to establish an FM-DP integration framework that enable Facilities Managers to be regularly involved in the property development industry and encourage other professionals to optimise the value of FM in all stages of the development process. The research adopted a sequential exploratory mixed methods approach, whereby data was qualitatively explored in the first instance through a literature review and expert interviews, followed by validation of these exploratory findings through an extensive survey, allowing the FM-DP framework to be created. The main methodological activities of this sequential exploratory mixed methods process were as follows:

1. Extensive literature review on link between FM and DP
2. Establishment of critical success factors from the literature review
3. Validation of the critical success factors through expert interviews
4. Testing of the critical success factors through a survey instrument
5. Statistical analysis of the critical success factors to establish key relationships
6. Creation of the FM-DP framework

Activities 1-3 have already been published (Tucker and Masuri, 2016; Tucker *et al*, 2017).

Amalgamating the data obtained from the literature review and the interview analysis (activities 1-2), critical factors that encourage the extensive involvement of FM in the development process were developed (activity 3). This approach allowed the researchers to obtain high validity and reliability during the quantitative data collection (activity 4).

With the outcome of the amalgamation process (activity 3), it was concluded that the factors should be evaluated using eight (8) constructs: competences, strategic role, development scheme, strategic value, management tools, knowledge management, post-occupation evaluation and sustainability. From this process, 39 items were generated that formed the initial pool for the survey. Each item was reassigned into two (2) statements; one to measure perceived importance about the qualities Facilities Managers acquire and the other to assess the extent to which the factors would influence the level of integration. An overview of the eight (8) constructs and their items are listed in Table 1.

Table 1 The critical factors of FM-DP integration

Critical Issues/Factors	Code
Competences – FM having possession of required individual skills and knowledge	
1. Having adequate experience in building maintenance	Comp1
2. Having adequate knowledge about construction phases	Comp2
3. Having adequate knowledge in construction procurement	Comp3
4. Ability to give clear instructions to others in the project team	Comp4
5. Get involved in continuous professional development activity	Comp5
6. Ability to anticipate the operational consequences of design and construction decision	Comp6
7. Ability to champion lean construction practice	Comp7
Strategic role – FM having the ability to play an effective role within and outside the organisation	
8. Having a good rapport with client	StrR1
9. Having a good rapport with third party (local authority)	StrR2
10. Having trust from other professionals	StrR3
11. Having a seat at a table in higher management level	StrR4
Development scheme – FM having the ability to adapt to various construction schemes, e.g. Public Private Partnership (PPP) and Government Soft Landings (GSL)	
12. Having familiarity with GSL concept	DevS1
13. Willing to anticipate operational issues in PPP project development	DevS2
Strategic value – FM having the ability to demonstrate strategic value and uniqueness	
14. Understand user's organisational strategy	StrV1
15. Get involved in briefing stage	StrV2
16. Take a leadership role in the client organisation as an advisor	StrV3
17. Proactive in ensuring end users' satisfaction	StrV4
18. Establish Key Performance Indicators (KPI) of FM at all stages	StrV5
19. Actively collaborate with users during handing-over period	StrV6
20. Having chartered status	StrV7
21. Ability to present service level agreement of FM operations at design stage	StrV8
Management Tools – FM having the ability to use reliable tools	
22. Ability to apply life cycle costing in the selection of materials/equipment	MgtT1
23. Ability to apply Building Information Modelling (BIM)	MgtT2
24. Ability to apply Computerised Aided Facilities Management (CAFM)	MgtT3
25. Having familiarity with BRE Environmental Assessment Method (BREEAM)	MgtT4
26. Having mechanism to communicate with end users about their requirements at all stages	MgtT5
Knowledge Management – FM having willingness to learn, share and transfer knowledge	
27. Commitment to training on operational aspects during handing-over phase	KnowM1
28. Proactive in managing design changes	KnowM2
29. Willingness to share information with others	KnowM3
30. Willingness to learn from others (openness to ideas)	KnowM4
31. Having comprehensive facilities maintenance records	KnowM5
Post-occupancy evaluation (POE) – FM being able to exploit POE results to optimise building performance	
32. Ability to implement POE	POE1
33. Ability to lead in handling POE database development	POE2
34. Ability to balance the positive and the negative criticism in the POE reports	POE3
35. Ability to transfer POE outcomes in a project to briefing stage of other projects	POE4

Critical Issues/Factors	Code
Sustainability – FM having the ability to optimise space and demonstrate sustainability philosophy	
36. Ability to take lead in refurbishment works	Sust1
37. Ability to take lead in mobile flexible working patterns	Sust2
38. Involved in selection of construction materials/equipment	Sust3
39. Knowledgeable with regard to sustainable initiatives (Green Agenda, recycling philosophy, etc.)	Sust4

The questionnaire survey was the designed in five-point Likert scale (activity 4). Since this research required respondents from six (6) professional bodies related to the property development industry in the UK, namely Institution of Civil Engineers (ICE), Royal Institute of Chartered Surveyors (RICS), Chartered Institution for Building Services Engineers (CIBSE), Royal Institute of British Architects (RIBA) and British Institute of Facilities Management (BIFM), a purposive sampling technique was employed.

On the other hand, this technique allows the researcher to select the respondents that meet the professional background requirements such as professional body membership, type and sector of organisation, work experience and the level of involvement in the development process. This method also ensures bias in sampling can be minimised (Bryman & Bell, 2011). The questionnaire was distributed mainly using self-administered postal questionnaire and online survey. The demographic profile of respondents is shown in Table 2. With 81.3 per cent of the respondents coming from were civil engineering, quantity surveying, building services engineering, architecture, and facilities management backgrounds.

Table 2 Demographic profile of respondents

Profession	N	%
Civil Engineer	19	12.3
Quantity Surveyor	12	7.7
Building Services Engineer	11	7.1
Architect	13	8.4
Facilities Manager	71	45.8
Other	29	18.7
Sub-total	155	100.0
Missing data	1	
Total	156	

In terms of the level of involvement in the development process, the respondents were divided into eight (8) stages of RIBA Plan of Work 2013. As shown in Table 3 the responses range between 43.59 per cent and 58.33 per cent, which indicates that there is uniformity with the responses of each item regarding participants' involvement in the development process. 50.0 per cent or more of the respondents had been involved in Stage 1, Stage 3, Stage 5, Stage 6 and Stage 7.

Table 3 Respondents' level of involvement in the development process.

	RIBA Plan of Work 2013							
Profession	**Stage0**	**Stage1**	**Stage2**	**Stage3**	**Stage4**	**Stage5**	**Stage6**	**Stage7**
Civil Engineer	7	8	11	13	10	13	6	4
Quantity Sur.	7	8	8	8	7	8	8	3
Build. Serv. Eng.	3	6	5	5	6	5	8	5
Architect	10	12	11	12	10	8	6	4
Facilities Mgr.	30	37	25	25	24	25	46	57
Other	11	11	15	17	18	19	17	16
Total	68	82	75	80	75	78	91	89
Percentage	43.59	52.56	48.08	51.28	48.08	50.00	58.33	57.05

From this response, the dataset was statistically analysed (activity 5) and the FM-DP framework was created (activity 6).

7.0 Results and discussion

The analysis of this study began with refining the instrument scale. It is essential at first to calculate the reliability coefficient to measure the probability of the respondents answering the questions and giving the same results on repeated occasions. From the reliability analysis procedure, it was discovered that the lowest value of corrected item-total correlations was 0.474 for having chartered status, StrV7. Parasuraman *et al*. (1988) recommend that the researcher should drop the items with a low value of corrected item-total correlation and whose removal of the item increased Cronbach's Alpha. Deletion of this item improved the value for Strategic Value to 0.905.

The second analysis conducted for this research was to examine the dimensionality of the instrument. For this, factor analysis is an appropriate method for this study as it has been designed based on the underlying constructs that are expected to produce scores on the observed items (Tabachnick and Fidell, 2007). Examination of the correlation matrix found that the values of 0.3 and above are spread out in the matrix. The value of Kaiser-Mayer-Olkin was 0.928 and the value of Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

In line with the purpose of this analysis, Parasuraman *et al*. (1988) suggest that Principle Components Analysis (PCA) is an appropriate solution in reducing a large number of items down to a smaller number of components. To allow the factors to be correlated as well as to check the degree of correlation between the factors (Pallant, 2010), Direct Oblimin (oblique rotation) approach was selected. Using this approach also facilitates the interpretation of the results. There are (2) criteria used to decide whether or not to discard the item(s) in the analysis: (i) each component comprises fewer than three (3) items (Tabachnick and Fidell, 2007) and/or (ii) the factor loading value is less than 0.4 (Field, 2013). This process is repeated until a clear factor pattern appears and fulfills the above two (2) criteria. Table 4 shows the summary of the cycle of the factor analysis.

Table 4 Summary of the cycle of the factor analysis

Trial cycle	(a) Initial items	(b) Item(s) dropped	Code of dropped item	(a-b) Items remaining	No. of components	Iterations
1st	38	1	Comp5	37	7	26
2nd	37	4	MgtT4, Sust1, StrR2, MgtT1	33	6	16
3rd	33	3	Sust4, StrR5, DevS1	30	5	9
4th	30	-	-	30	5	17

After four (4) trials, a clear factor pattern containing five (5) components and 30 items appeared. The cumulative percentage of variance explained by those five (5) components is 68.41 per cent, which indicates the majority of the variance within this set of data. Table 5 shows the factor loading of the items on the components.

Table 5 Factor loading of the items on the components

Items		Code	Component 1	2	3	4	5
1.	Willingness to learn from others	KnowM4	.926				
2.	Willingness to share information	KnowM3	.834				
3.	Having comprehensive records	KnowM5	.798				
4.	Commitment to training	KnowM1	.781				
5.	Proactive in ensuring satisfaction	StrV4	.725				
6.	Having a good rapport	StrR1	.609			.371	
7.	Actively collaborate with users	StrV6	.606				
8.	Clear instructions	Comp4	.539	.376			
9.	Mechanism to communicate	MgtT5	.507				
10.	Managing design changes	KnowM2	.440	.350			
11.	Operational consequences	Comp6	.410				
12.	Knowledge about construction	Comp2		.924			
13.	Knowledge in procurement	Comp3		.869			
14.	Lean construction practice	Comp7		.581			
15.	Selection of materials/equipment	Sust3		.553			
16.	Experience in maintenance	Comp1		.502			
17.	Ability to implement POE	POE1			-.878		
18.	Handling POE database development	POE2			-.871		
19.	Balance the criticism POE reports	POE3			-.816		
20.	Transfer POE outcomes	POE4			-.726		
21.	Higher management level	StrR4				.705	
22.	CAFM	MgtT3				.648	
23.	Trust	StrR3				.572	
24.	BIM	MgtT2				.525	
25.	Service level agreement	StrV8				.522	
26.	Operational issues in PPP	DevS2				.477	.396
27.	Mobile flexible working patterns	Sust2				.424	-.393
28.	Leadership	StrV3					-.728
29.	Briefing stage	StrV2					-.700
30.	Understand user's strategy	StrV1	.324				-.408
		Eigenvalues	14.538	1.999	1.632	1.265	1.089
		Percentage of variance	48.461	6.662	5.438	4.218	3.631
		Cumulative percentage	48.461	55.123	60.561	64.780	68.410
		Cronbach's Alpha	0.936	0.833	0.925	0.864	0.840

An examination of the content of each component as shown in Table 5 suggests that components 2, 3 and 5 have good commonality, leading the researcher to retain the original name of the construct and its definition. As a result, Component 2 was named Competences, Component 3 Post-Occupancy Evaluation and Component 5 was named Strategic Value. Component 1 demonstrates the combination of 11 items that were extracted from different constructs, in which they have a commonality with the role of knowledge sharing and willingness to learn new knowledge. Therefore, it was decided to name Component 1 as Knowledge Management. After assessing each item in Component 4, there was a need for FM to have the ability to make the most of the resources in order to influence the decision maker in the organisations. Hence, component 4 was labelled as Organisation. Table 6 demonstrates the final naming of the items and concise definition of the construct.

Table 6 Label of the items and concise definition for the constructs

Construct / items	**Code**
Knowledge Management – FM having willingness to learn, share and transfer knowledge	
1. Willingness to learn from others (openness to ideas)	KnowM4
2. Willingness to share information with others	KnowM3
3. Having comprehensive facilities maintenance records	KnowM5
4. Commitment to training on operational aspects during handing-over phase	KnowM1
5. Proactive in ensuring end users' satisfaction	StrV4
6. Having a good rapport with client	StrR1
7. Actively collaborate with users during handing-over period	StrV6
Construct / items	Code
8. Ability to give clear instructions to others in the project team	Comp4
9. Having mechanism to communicate with end users about their requirements at all stages	MgtT5
10. Proactive in managing design changes	KnowM2
11. Ability to anticipate the operational consequences of design and construction decision	Comp6
Competences – FM having possession of required individual skills and knowledge	
12. Having adequate knowledge about construction phases	Comp2
13. Having adequate knowledge in construction procurement	Comp3
14. Ability to champion lean construction practice	Comp7
15. Involved in selection of construction materials/equipment	Sust3
16. Having adequate experience in building maintenance	Comp1
Post-Occupancy Evaluation – FM being able to exploit POE results to optimise building performance	
17. Ability to implement POE	POE 1
18. Ability to lead in handling POE database development	POE 2
19. Ability to balance the positive and the negative criticism in the POE reports	POE 3
20. Ability to transfer POE outcomes in a project to briefing stage of other project	POE 4
Organisation – FM having the ability to make the most of resources in order to influence the decision maker	
21. Having a seat at a table in higher management level	StrR4
22. Ability to apply Computerised Aided Facilities Management (CAFM)	MgtT3
23. Having trust from other professionals	StrR3
24. Ability to apply Building Information Modelling (BIM)	MgtT2
25. Ability to present service level agreement of FM operations at design stage	StrV8
26. Willing to anticipate operational issues in PPP project development	DevS2
27. Ability to take lead in mobile flexible working patterns	Sust2

Construct / items	Code
Strategic Value – FM having the ability to demonstrate strategic value and uniqueness	
28. Take a leadership role in the client organisation as an advisor	StrV3
29. Get involved in briefing stage	StrV2
30. Understand user's organisational strategy	StrV1

7.1 Test for Hypothesis 1: To determine the relationship between perceived importance of FM to be considered and the extent to which the FM could integrate effectively into the property development process

Correlation analysis was used to assess the relationship between each construct in perceived importance and the perceived level of integration; there are two (2) possibilities in which the hypothesis can be categorised in terms of null hypothesis (H_0) and alternative hypothesis (H_1).

> Null hypothesis (H_0): There is no relationship between the perceived importance of FM to be considered and the extent to which the FM could integrate effectively in the development process.
>
> Alternative hypothesis (H_1): There is relationship between the perceived importance of FM to be considered and the extent to which the FM could integrate effectively in the development process.

Using Spearman's rho correlation analysis, the output explains that all of the constructs are in positive correlation. However, the attention is given to the constructs between perceived importance (PI) and perceived level of integration (PLOI). Within the same construct, it was identified that the correlation value (ϱ) is between minimum 0.527 and maximum 0.633; hence, the strength of the relationships within the same construct fall under moderate (Dancey & Reidy, 2011) with high significance ($p < 0.01$). On top of that, the cross-construct relationships between PI and PLOI are between weak and moderate with high significance ($p < 0.01$). Only Knowledge Management has a weak but highly significant relationship with Competence ($\varrho = 0.191$, $p = 0.017 < 0.05$). It is proven that there is a relationship between the two measures; therefore, the null hypothesis (H_0) is rejected.

The relationship between constructs within the perceived level of integration is categorised as positively moderate with high significance ($\varrho > 0.40$, $p < 0.01$). Unlike the relationship of constructs within perceived importance, the relationship here falls between positively weak and moderate with high significance ($0.1 < \varrho < 0.6$, $p < 0.01$). The result of correlation analysis shows a positive correlation between perceived importance and perceived level of integration which indicates the presence of FM elements in the development process could contribute a positive impact to property development industry in the UK.

7.2 Zooming in on each item – Test for Hypothesis 2: To determine the difference between the level of involvement in the development stages in terms of perceived importance and perceived level of integration for each item.

The next step was to determine the differences between the level of involvement in the development stages in terms of perceived importance (PI) and perceived level of integration (PLOI) in all of the 30 items. To determine the difference between the level of involvement in the development stages in terms of perceived importance and perceived level of integration for each item, there are two (2) possibilities in which the hypothesis can be categorised in terms of null hypothesis (H_0) and alternative hypothesis (H_1).

> Null hypothesis (H_0): There is no difference between the level of involvement in the development stages in terms of perceived importance and perceived level of integration for each item.
>
> Alternative hypothesis (H_1): There is difference between the level of involvement in the development stages in terms of perceived importance and perceived level of integration for each item.

240 one-way MANOVA tests were performed for each item in all stages of the development process.

The findings from the statistical analysis carried out have identified the qualities in optimising the role of FM in various stages of the development process. Overall, 15 out of 30 items showed the differences between the level of involvement in the development stages in terms of perceived importance (PI) and perceived level of integration (PLOI). The analysis has confirmed that FM needs to be integrated as early as Stage 0 (Strategic Definition). Stage 0 contained three (3) sole items of which Item 28 stressed on the quality of leadership of the Facilities Managers, ability to exploit the knowledge of post-occupancy evaluation (POE) (Item 20) and leveraging experience in building maintenance at higher management level in the organisation (Item 16). Meanwhile, Item 23 that is shared with Stage 6: Handover and Close Out, emphasised on the importance of Facilities Managers to gain trust from other professional colleagues through extensive involvement in the various activities of the development process. It is proven that FM needs to be integrated at Stage 0.

There are six (6) items in Stage 1 (Preparation and Brief), Stage 2 (Concept Design), Stage 3 (Developed Design), Stage 5 (Construction), Stage 6 (Handover and Close Out) and Stage 7 (In Use) shared with Stage 4 (Technical Design), which indicates a significant impact of Stage 4 in the development process. In other words, Stage 4 is critical considering its role to interpret the input of previous stages yet influences the product of the following stages. The shared items cover all of the construct groups namely (i) Knowledge Management: having willingness to learn, share and transfer knowledge, (ii) Competence: having possession of required individual skills and knowledge, (iii) Post-Occupancy Evaluation: able to exploit POE results to optimise building performance, (iv) Organisation: having trust to work with others effectively at all levels, and (v) Strategic Value: having the ability to demonstrate strategic value and uniqueness.

The remaining five (5) items are solely fit in Stage 3 (Item 21), Stage 5 (Item 3), Stage 7 (Item 12) and Stage 4 (Item 9 and Item 20) to complete all of the 15 items required to optimise the role of FM in the development process.

A rigorous statistical analysis has successfully transformed the descriptive data into a prescriptive medium as illustrated in **Error! Reference source not found.**, which is called as an FM-DP integration framework.

8.0 The FM-DP framework

In general, the structure of the framework is an alteration from the proposed solution in the implementation of FM for construction (Damgaard & Erichsen, 2009) and the incorporation of the RIBA Plan of Work 2013. Both features have become the foundation for establishing this framework. Furthermore, this framework is prescriptive and directive in its character, which have been designed to illustrate the statistical findings from section 7 in a more visual manner. In brief, the framework is applicable to individual professionals as well as to organisations in optimising the role of FM in the development process.

The framework comprises of three (3) major sections. The upper left section is identified as the circle of integration, which is presented in a form of an illustration comprising eight (8) circles representing stages of the RIBA Plan of Work 2013. The circles contain labels of the stages as well as 15 items of the best practices. It is essential to make a cross-reference to the upper right section and the foundation. The upper right section is called the codes; it contains five (5) colour codes and the titles of the constructs, and 15 descriptions of the items with their coding. For ease of reference, the definitions of the constructs are provided at the bottom part of the codes. The foundation of the framework encompasses the stages and core objectives of the RIBA Plan of Work 2013.

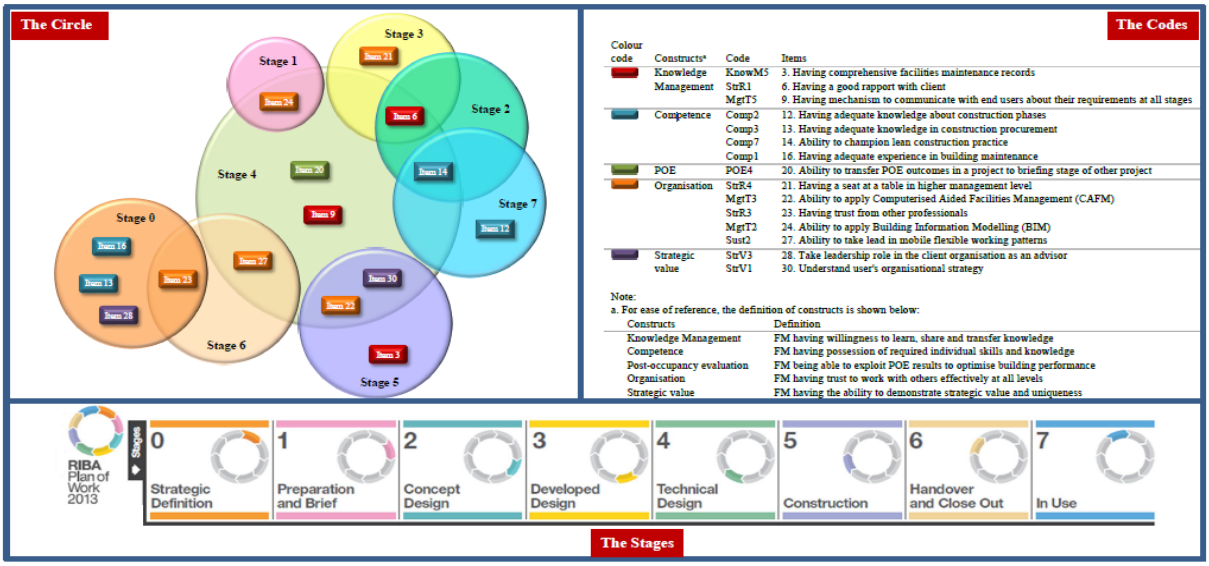

Figure 4 Proposed initial FM-DP integration framework

Figure 5 provides an illustrative explanation of this summary, where the two arrows in the framework indicate the need to cross-reference between the circle, the codes and the stages in

order to fully utilise the framework. The rationale for the existence of the items at each stage is justified supported with the literature and triangulation of the previous qualitative findings.

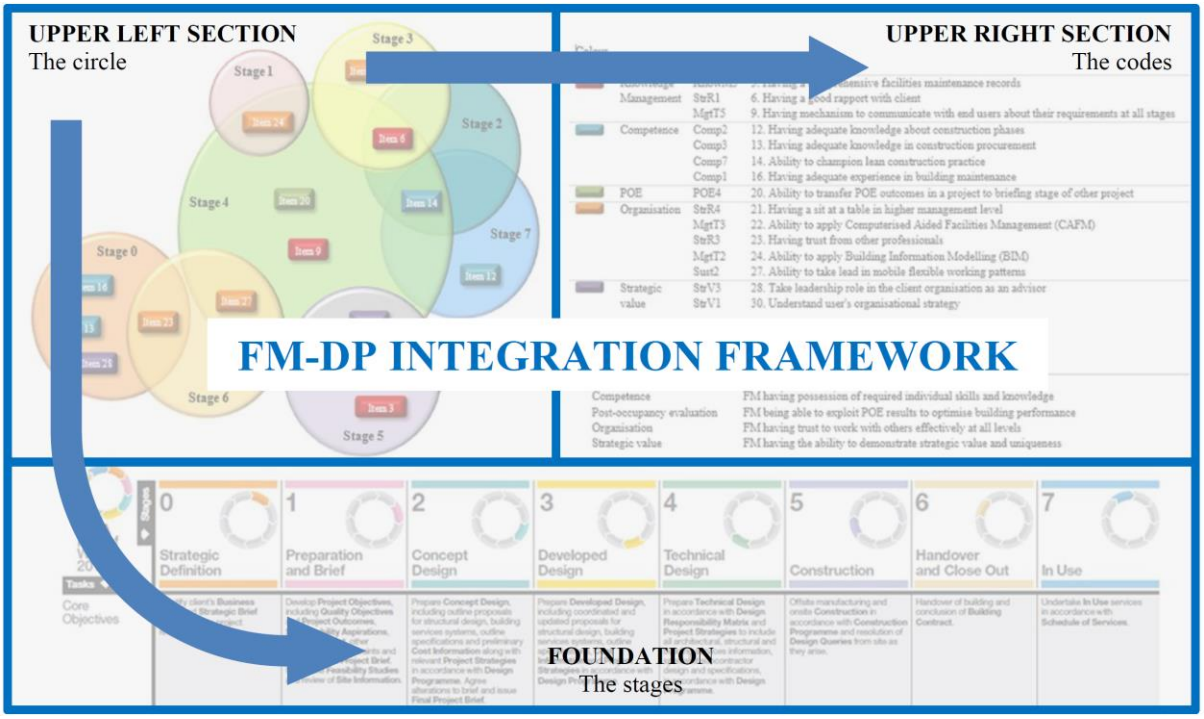

Figure 5 Interpretation of the FM-DP integration framework

5.0 Conclusion

This paper discovers that FM has a promising position in the property development industry. The integration of FM into the development process is a strategic approach to enhance the performance of the organisation as well as improving the operation of the facilities. It can be anticipated that FM has a brighter future in the development process coupled with a potential contribution that FM can offer to achieve sustainable development. Nevertheless, FM is expected to play an important role and integrate with other professionals in the development process to improve the buildability and operability of facilities. This study revealed that there are 15 qualities that need to be considered across RIBA Plan of Work 2013 for a better integration of FM into the development process. A rigorous statistical analysis in this study has successfully transformed the descriptive data obtained in the literature review and semi-structured interviews into a more tangible form: FM-DP integration framework, as shown in **Error! Reference source not found.**. A summary of the key findings of the study are:

- FM is still a relatively new field in the wider development process, which results in an improper perception towards the role of Facilities Managers in the development process.
- FM was synonymous with maintenance works and soft services such as cleaning, catering and security during the "In Use" stage of RIBA Plan of Work 2013 of facilities.

- There is an encouraging view that FM needs to be considered in the wider development process to enhance the performance of the building or facilities in terms of buildability and operability
- There are 35 factors perceived to be barriers for the integration of FM into the development process, which can be divided into nine (9) categories, namely perception, competence, regulations, organisations, knowledge management, management tools, operations, decision-making and sustainability.
- The validated framework consists of 15 items that are considered as best practices needed to encourage FM-DP integration. The items were grouped into five (5) categories, namely knowledge management, competence, post-occupancy evaluation, organisation and strategic value
- From the statistical analysis, and visualisation of the FM-DP framework, it suggests that these 15 items are most impactful and integrated into stage 0 "Strategic Definition" and stage 4 "Technical Design" of the RIBA Plan of Work.

Finally, the study provides a significant contribution to knowledge to academia and industry. Table 7 below summarises the main contributions:

Table 7 Contribution to knowledge

Contribution to academia	The findings of previous studies are arguably subjective, resulting mainly from qualitative study. Exploratory sequential mixed methods that involve qualitative and quantitative approaches have resulted in more reliable results. The statistical analysis conducted in this research has produced objective findings as well as a catalyst for the formation of an innovative new framework. This research creates a new view of the role of Facilities Managers throughout the development process. This research was able to identify the challenges to optimise the role of FM in the development process, and at the same time, the potential contribution of FM in the wider property and construction industry.
Contribution to industry	Some practices for FM-DP integration have long been implemented in the industry. However, this has never been properly documented. The emergence of the FM-DP framework is something that has been long awaited, in which such practices have been registered in a form of a tangible document known as the FM-DP integration framework, ingrained with statistical rigour to justify its findings. The development of the framework increases awareness amongst property and construction professionals about the potential contribution of FM in enhancing the buildability and operability of facilities.

	The framework would be a guideline for professionals to optimise the role of FM in the development process and is likely to be used by various professionals such as facilities managers, engineers, quantity surveyors, project managers, and architects.

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