# Information management in the facilities domain: investigating practitioner priorities

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## Abstract

**Purpose** – Effective information management can help real estate operators improve asset performance during use, reducing environmental impact. The purpose of this exploratory study is to identify and prioritise key drivers, challenges and opportunities relating to information management, from the point of view of a diverse cohort of facilities practitioners, with the aim of guiding future research direction and contributing to a comprehensive domain understanding.

**Design/methodology/approach** – Nine interviews are conducted across a broad sample of real estate sectors, the respondents including six facility managers and three data managers. A thematic analysis results in the identification and ranking in terms of importance of 44 emergent themes. These themes are then grouped into abstracted categories for analysis and synthesis.



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**Findings** – This study indicates that systemic rather than technical issues are the greatest barrier to effective information management for facilities practitioners, the interviews providing examples of practical measures which address these challenges, promoting lifecycle thinking. Alignment is also found between the facilities and data management cohorts regarding lifecycle thinking towards both physical assets and information.

**Practical implications** – This study provides direction for future developments in the facilities sector, suggesting the pursuit to address systemic issues as being both worthwhile and feasible.

**Originality/value** – The novelty of this study is the ranking and synthesis of practitioner priorities with regard to high-level information management issues which is lacking in the literature, with a focus to-date on case-specific technical integration.

**Keywords** Facilities, Facility management, Information management, Practitioner interview, Exploratory research, Thematic synthesis, Systemic, Drivers, Challenges, Opportunities

**Paper type** Research paper

## 1. Introduction

Facilities managers (FMs) play a key role in reducing the negative impacts of real estate (RE) on the environment, being responsible during their operational lifetime which is the most resource-intensive stage (Wang *et al.*, 2014). Teicholz (2018) discusses the productivity deficit in the FM domain, a result of manual retrieval, searching for information and collecting existing or missing asset data. To address these issues, many studies have demonstrated information management (IM) strategies for the operational phase of the asset lifecycle such as through the use of commercial FM systems, as well as downstream use of data, such as building information models (BIM), generated during development phases. But in spite of many integration demonstrations and the emergence of related international standards governing data management for FMs (ISO 19650, ISO 41000 etc.), a suitable approach has yet to be widely agreed. Furthermore, a key study suggests that while other disciplines are advancing in digitalisation efforts, FMs may be experiencing reduced access to information (Quinn *et al.*, 2020), likely because of the difficulty of keeping pace with technological change (Pärn and Edwards, 2017).

Both Ashworth (2020) and Shaw *et al.* (2021) describe the emergent and under-defined nature of the FM domain. It is in this complex domain that considering the priorities of practitioners in planning development initiatives is particularly important due to its bottom-up and industry-led nature (McArthur and Bortoluzzi, 2018). So, with the main aim of defining appropriate research endeavours which consider the priorities of practitioners, and in developing a comprehensive understanding of IM for the FM domain, this paper systematically examines the sentiments of experienced facilities practitioners using a thematic synthesis methodology. It results in the development of two hypotheses around which the interviews are discussed and recommendations for future research are proposed.

The remainder of this paper consists of five sections. Section 2 discusses the gap in FM research, Section 3 describes the thematic synthesis methodology, Section 4 presents the results of interview analysis and synthesis, Section 5 discusses how the findings relate to the wider literature and finally, conclusions are drawn in Section 6.

## 2. Background

### *2.1 Information management in the facilities domain*

FMs are responsible for facility performance which is directly linked to the quality of data available (NIBS, 2011). The steady increase of digitalisation within the built environment means that buildings and the systems they contain, are generating increasing quantities of such data (Jia *et al.*, 2019), reflecting a wider global trend of data availability (Siegele, 2020).

So, given the importance of quality data for improving asset performance and reducing resource use, a concerning observation by Liu and Issa (2014) finds that 85% of FMs consider the information they receive from earlier lifecycle phases inappropriate for use during operation and maintenance (O&M). A number of authors suggest technical as well as systemic explanations for this. Some of the technical challenges are discussed by Pärn and Edwards (2017) who explain that available data delivery methods are providing excessive information, ill-suited to the downstream FM needs, including unnecessary geometric detail. Other studies discuss systemic challenges existing in the profession which can result in poor access to quality data, such as delayed involvement in projects and the resulting inability to influence the design with maintenance considerations (Tucker and Anang Masuri, 2016; Ashworth, 2020), and the broad scope of FM activities and resulting responsibility ambiguity (Pärn *et al.*, 2017). So, while the wider architectural, engineering, construction and operations (AECO) industry is seeing increased digitalisation (Bolpagni *et al.*, 2021), the FM domain is facing both technical and systemic challenges, impeding access to information.

Where FM professionals have access to data, a range of commercial information technology (IT) systems are available to assist with their specific O&M needs, described in detail by Maslesa and Jensen (2020). We can broadly refer to them as computer-aided facilities management (CAFM) systems. However, both Chen *et al.* (2018) and Gouda Mohamed *et al.* (2020) explain that the tools are typically expensive, siloed and continue to rely on basic, unintegrated functionality. To address the issue of incompatible data, a significant number of works in the research community focus on BIM–CAFM integration, the works of Pärn and Edwards (2017), Farghaly *et al.* (2018) and Gao and Pishdad-Bozorgi (2019) together providing comprehensive reference material on the contributions of the numerous examples. Though there is broad agreement on the potential opportunity of BIM–CAFM integration (Rogage and Greenwood, 2020), not one proposal has yet been widely adopted. In response, the research community also agree on the need for greater domain standardisation and work in this direction is evidenced by efforts such as the buildingSMART FM Handover (East *et al.*, 2021), mechanical/electrical systems semantics alignment by Luo *et al.* (2021) and research towards more "loosely coupled systems and open standards" by Farghaly *et al.* (2018) and others in the linked open data community.

### *2.2 Considering practitioner priorities in facilities management research*

Because of the organisational specificity of FM developments (Gao and Pishdad-Bozorgi, 2019), stakeholder engagement is considered "key to realising the value of BIM in operations" (McArthur and Bortoluzzi, 2018). There are two literary sources which provide collated FM practitioner viewpoints, academic studies and industry reports. With the latter lacking the scientific rigour of peer review, we focus on the academic sources alone in this work.

A number of studies to date use qualitative methods to investigate FM practitioner sentiments. Both Becerik-Gerber *et al.* (2012) and Liu and Issa (2013) conduct semi-structured interviews regarding BIM adoption and experience with data quality amongst FM practitioners, whereas Dixit *et al.* (2019) use both interviews and surveys. Bosch *et al.* (2015) conduct a similar study using a thematic encoding approach but specific to Dutch asset managers, while more recently, Durdyev *et al.* (2022) examine the FM context in New Zealand, ranking practitioner priorities, again, with regard to BIM adoption. Farghaly *et al.* (2018) use a related qualitative approach, conducting focus groups to collect information requirements for asset management functions to support BIM data exchange, and finally, recent work by Ashworth (2020), again, uses thematic encoding of practitioner interviews to

establish critical success factors for specifying FM data requirements. These works provide evidence of the effectiveness of the qualitative method in collecting the views of FM practitioners, but as we can see, they are focused mainly on BIM-related processes and adoption.

In an effort to better understand the challenges in BIM adoption, several authors propose abstracted classifications or groupings. Becerik-Gerber *et al.* (2012) divide the challenges in BIM adoption for FMs into the following categories; "process related, organisational and technological". Similarly, Rogage and Greenwood (2020) suggest a division of challenges *in effective information management during handover* into; "communication related, technological, and the lack of awareness of required information". Abstraction to such classifications is part of the hypotheses-building process and can facilitate prioritisation of research efforts. For example, the latter study asserts that two of the three groupings are "beyond the immediate control of researchers", suggesting that academia instead focus on the technical issues which may be more easily tested under laboratory conditions. In this way, the value of a particular research direction can be empirically supported.

These previous works establish precedence for those methods used in this study; however, the available literature lacks investigation into the broader issues around IM in the domain, Matarneh *et al.* (2019) concluding in their seminal domain review that:

> "Current research tends to focus on BIM-based technologies integration to enhance FM practice, rather than resolving the issues regarding facilities information management, which is considered as the backbone for successful FM practice."

Furthermore, a prioritisation of those more organisational/cultural, or what we will refer to as *systemic* issues, is similarly missing and may be helpful to guide research direction.

## 3. Research methods

This is an exploratory study as described by Saunders *et al.* (2016), designed to contribute to a comprehensive understanding of the FM domain. Experiences relating to IM from the point of view of FM practitioners may provide insight as to which developments are to be prioritised to support the lifecycle approach of their function across an organisation. For this reason, this study analyses the experience of practitioners around the following high-level subjects as they relate to IM within their business function:

- *drivers*: those aspects which motivate a business function towards a certain strategy;
- *challenges*: those aspects which hinder a business function from achieving a certain strategy; and
- *opportunities*: positive aspects which either result from, or contribute to, a certain strategy.

A thematic synthesis methodology (Figure 1), described in detail by Thomas and Harden (2008), is used to analyse and interpret a series of practitioner interviews. Emergent themes are assigned a weight of significance and used to provide a ranking of participant priorities for further synthesis and analysis. It should be noted that the topics relating to IM, as perceived by an individual, may differ from overarching organisational goals (such as the financial driver in a profit-driven organisation) which are not the focus of this

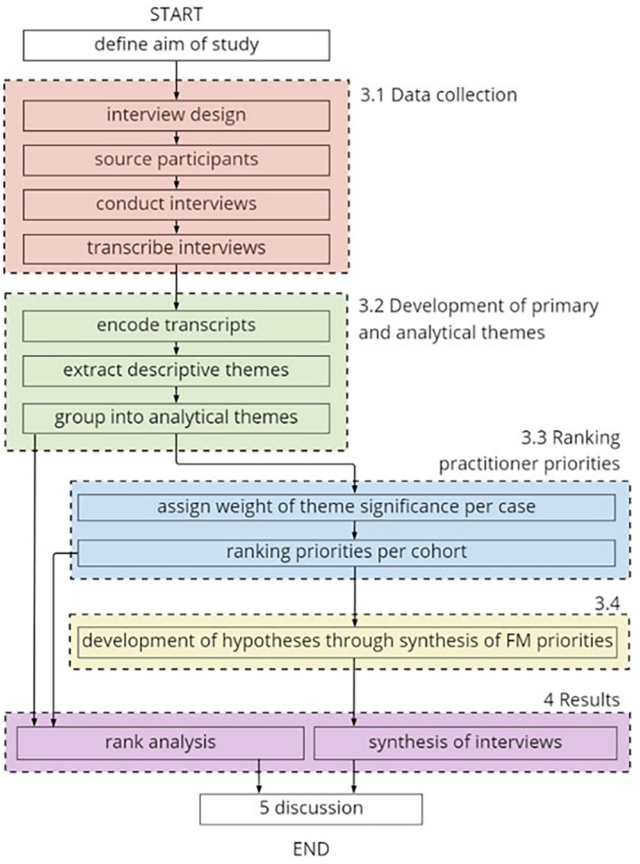


**Figure 1.** The five steps of this exploratory study describe a method for developing, conducting and analysing practitioner interviews, and are detailed in the following sections

study. The validity of these methods to address the aim of this study is based on precedence from other similar qualitative studies within the FM domain, as discussed in Section 2.2.

*3.1 Data collection*

The primary data for this study are the interview transcripts. Secondary data in the form of available related literature was also examined and is referred to throughout.

*3.1.1 Participant selection.* As this research relies heavily on the input of practitioners, and in line with studies of similar scale in the AECO sector, quality of respondents was prioritised over quantity (Tabatabaee *et al.*, 2021; Durdyev *et al.*, 2022). Prominent organisations across a wide segment of RE sectors were identified throughout Ireland, The Netherlands and Sweden and interview participants were selected based on their experience and role. To ensure data saturation a range of viewpoints were sought (Fusch and Ness, 2015) and given the IM focus, the interview cohort included six FMs and three data managers (DMs) and both male and female (23%) participants. Interview cohort information is provided in Appendix 1.

*3.1.2 Interview design.* Nine semi-structured interviews were conducted by two interviewers. An interview structure (summarised in Appendix 2) and consent form were provided to participants in advance of the meeting which lasted between 1 and 1.5 hours. The interview began with a presentation of the wider research topic and aims of the study as being "to understand the drivers, challenges and opportunities around IM". Meetings were audio recorded with the consent of the participant and used to transcribe the interview for later analysis. The structure of the interview was not followed rigidly, but rather acted as a guide for a discussion around the main topics. Leading questions were avoided, allowing themes to emerge organically. The interviews are summarised in Appendix 3.

### *3.2 Development of primary and analytical themes*

Thomas and Harden (2008) explain that:

> Thematic synthesis has three stages: the coding of text "line-by-line"; the development of "descriptive themes"; and the generation of "analytical themes". While the development of descriptive themes remains "close" to the primary studies, the analytical themes represent a stage of interpretation whereby the reviewers "go beyond" the primary studies and generate new interpretive constructs, explanations or hypotheses.

The following sub-sections describe how these stages are used in this study in detail. At each stage, consensus was sought between two researchers.

*3.2.1 Extracting descriptive themes through transcript encoding.* Nvivo 1.6 software is used for transcript encoding whereby sections of text are organised into emergent descriptive themes relating to *drivers, challenges and opportunities* in IM (Figure 2). For example, the sentence "we provide a wider variety of services than most organisations" (case 3) is encoded under the subject *Challenges* as the descriptive theme *Organisation complexity*. Through the process of encoding subsequent interviews, a bank of descriptive themes is compiled, resulting in a total of 44. A complete set of verbatim encoding examples is provided in Appendix 4.

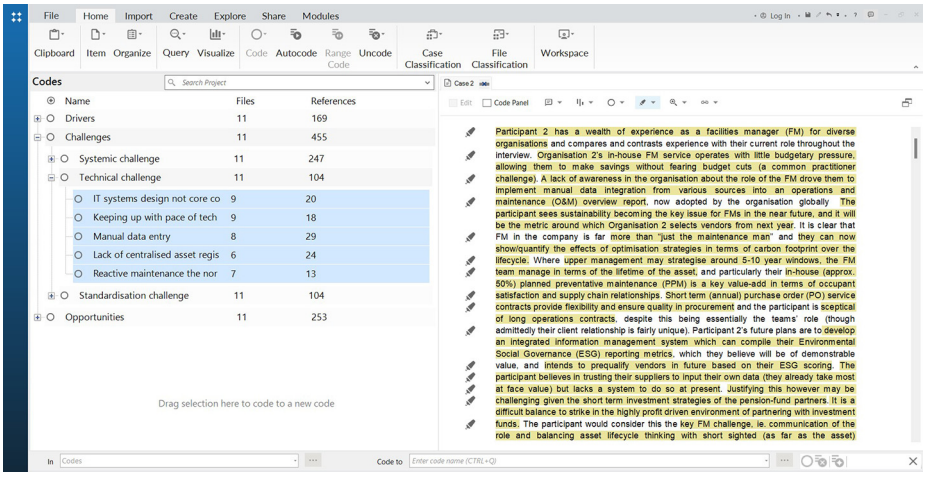


**Figure 2.**
Nvivo 1.6 software is used for line-by-line thematic coding, organising interview transcripts into a taxonomic hierarchy of subjects, analytical themes and descriptive themes

*3.2.2 Grouping into analytical themes.* The next stage of the thematic synthesis method is to group descriptive themes into logical categories. These abstracted *analytical themes* enable synthesis of several descriptive themes together around a common topic, with precedence in the works of Becerik-Gerber *et al.* (2012) and Rogage and Greenwood (2020). An example of this step can be seen in Figure 2 where several descriptive themes are grouped together as *technical challenges*, the overall groupings are provided in Figure 3.

*3.3 Ranking practitioner priorities*

This step results in a ranking of descriptive IM themes based on practitioner sentiments which may help to prioritise future developments. For example, using a related method, Durdyev *et al.* (2022) interpret practitioner sentiments from interviews according to a scale of importance, providing a ranking of topics relating to BIM adoption by FMs.

*3.3.1 Assigning a weight of theme significance per case.* Following transcript encoding each descriptive theme is assigned a weight based on its significance during each interview. These were either –1 ("low significance"), 0 ("some significance") or +1 ("high significance"), with 0/null assigned to cases where the theme did not emerge. The weightings were discussed by two interviewers during meetings until consensus was reached in each case. Figure 4 provides the weighting of descriptive themes.

*3.3.2 Ranking priorities per cohort.* To compare the priorities of the two cohort groups, the analysis is broken into:

- FM interviews (cases 1–6); and
- DM interviews (cases 7–9).

The average weight for each descriptive theme is calculated according to the above cohort groupings (Figure 3) and the results are ranked in terms of priority in Figure 4, *Group code* referring to the related analytical theme.

*3.4 Development of hypotheses through synthesis of facilities manager priorities*

A characteristic of exploratory research is the ability to adapt the study direction as a result of new data revelations and new insight emerging throughout (Saunders *et al.*, 2016). So, given the broad result of FM cohort priorities (Figure 4) and due to FM being the domain of focus for this study, a further step of synthesis is carried out which results in two hypotheses. This step, according to Thomas and Harden (2008) "is the most difficult to describe and is, potentially, the most controversial, since it is dependent on the judgement and insights of the reviewers". In this final step, descriptive themes prioritised by the FM cohort are interpreted into research hypotheses, Figure 5 demonstrates their inter-related nature.

## 4. Results

This section describes the results of the study, including both interpretation of the ranking of practitioner priorities as well as synthesis of the interviews around emergent hypotheses. To enrich the findings for the reader, individual case summaries and sample verbatim quotes are provided in Appendixes 3 and 4, respectively.

| Topic | Analytical Grouping | Group Code | Descriptive Themes | Cases: Facility Management 1 | 2 | 3 | 4 | 5 | 6 | Cases: Data Management 7 | 8 | 9 | FM average | DM average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drivers | Sustainable Operations | Op | Carbon footprint reduction | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0.50 | 0.67 |
| | | Op | Up-time for operations | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0.50 | 0.33 |
| | | Op | Internal (top down) | 0 | -1 | -1 | 1 | 1 | 1 | 0 | 0 | 0 | 0.17 | 0.00 |
| | | Op | Internal (key individual/s) | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0.50 | 0.33 |
| | | Op | External driver | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 1 | 0 | -0.17 | 0.33 |
| | | Op | Financial driver | 0 | -1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0.00 | 0.67 |
| | Sustainable Information | Info | Single source of truth for data | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0.50 | 1.00 |
| | | Info | Cross-departmental data integration | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0.50 | 0.67 |
| | | Info | IT scalability | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0.50 | 0.67 |
| | | Info | IT Independence | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.17 | 0.33 |
| Challenges | Systemic Challenge | Sys | Internal buy-in (organisation mindset) | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | -1 | 0.50 | -0.33 |
| | | Sys | Lack of understanding of FM role | 0 | 1 | 1 | -1 | 1 | 1 | 0 | 0 | 0 | 0.50 | 0.00 |
| | | Sys | Lack of Lifecycle thinking in organisation | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0.33 | 0.00 |
| | | Sys | Lack of information sharing | 1 | 0 | 1 | -1 | 0 | 0 | 0 | 1 | 0 | 0.17 | 0.33 |
| | | Sys | Complexity of organisation | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.17 | 0.00 |
| | | Sys | Under-resourced FM department | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.17 | 0.00 |
| | | Sys | External buy-in (stakeholder mindset) | 1 | 0 | 0 | -1 | 1 | 0 | 0 | 0 | -1 | 0.17 | -0.33 |
| | | Sys | Risk adversity | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0.00 | 0.33 |
| | | Sys | Delayed Involvement | -1 | 0 | 1 | -1 | 1 | -1 | 1 | 0 | 0 | -0.17 | 0.33 |
| | | Sys | Budgetary disincentive to improve performance | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -0.17 | -0.33 |
| | | Sys | Lack of FM voice at board level | 0 | 1 | 1 | -1 | 1 | -1 | 0 | 0 | -1 | -0.17 | -0.33 |
| | Technical Challenge | Tech | Manual data entry | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0.17 | 0.67 |
| | | Tech | Keeping up with pace of technological change | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.17 | 0.00 |
| | | Tech | IT systems design not core competency | -1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | -1 | 0.17 | -0.33 |
| | | Tech | Lack of centralised asset registry | -1 | -1 | 1 | 0 | 1 | -1 | 1 | 0 | 0 | -0.17 | 0.33 |
| | | Tech | Reactive maintenance the norm | -1 | -1 | 1 | -1 | 1 | 0 | 0 | 0 | 0 | -0.50 | 0.00 |
| | Standardisation Challenge | Sta | Unstructured data | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0.50 | 0.67 |
| | | Sta | Lack of standardised practices | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0.17 | 0.67 |
| | | Sta | Proprietary systems + data / vendor lock-in | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0.17 | 0.33 |
| Opportunities | Systemic Opportunities | Sys | Total cost of ownership budgeting | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0.33 | 0.33 |
| | | Sys | Redistribution of skills | 0 | -1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0.17 | 0.33 |
| | | Sys | Independent validation | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0.33 | 0.33 |
| | | Sys | Integrated contracting | 1 | -1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0.17 | 0.33 |
| | | Sys | Right people in the right place | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.17 | 0.00 |
| | | Sys | Further outsourcing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 | 0.00 |
| | Soft-FM Opportunities | Soft | Building relationships with suppliers | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0.50 | 0.00 |
| | | Soft | User feedback | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0.17 | 0.67 |
| | Technical Opportunities | Tech | Open standards | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0.50 | 1.00 |
| | | Tech | Effective planned preventative maintenance | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0.50 | 1.00 |
| | | Tech | Cross-department data querying | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.17 | 0.67 |
| | | Tech | Remote diagnostics | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0.33 | 0.33 |
| | | Tech | Commercial IWPM systems | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0.17 | 0.33 |
| | | Tech | Optmise systems scheduling | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.33 | 0.33 |
| | | Tech | Open source developments | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.00 | 0.33 |

1 high significance 0 some significance 0 theme did not emerge -1 low significance

**Figure 3.**
Forty-four emergent themes are scored for importance on a scale of –1 to +1 across the nine interviews

**Note:** The themes are grouped into eight logical categories for further analysis

### *4.1 Analysis of thematic ranking*

The following is an analysis of the ranking presented in Figure 4, interpreting the comparison of FM and DM cohorts, and is mainly focused on the abstracted analytical groupings.

| Topic | Facilities Management (cases 1-6) Group Code | Descriptive Themes | Rank | Data Management (cases 7-9) Group Code | Descriptive Themes | Rank |
|---|---|---|---|---|---|---|
| Drivers | **Op** | **Carbon footprint reduction** | 1 | **Info** | **Single source of truth for data** | 1 |
| | **Op** | **Up-time for operations** | | Op | Carbon footprint reduction | 2 |
| | **Op** | **Internal (key individual/s)** | | Op | Financial driver | |
| | **Info** | **Single source of truth for data** | | Info | Cross-departmental data integration | |
| | **Info** | **Cross-departmental data integration** | | Info | IT scalability | |
| | **Info** | **IT scalability** | | Op | Up-time for operations | 3 |
| | Op | Internal (top down) | 2 | Op | Internal (key individual/s) | |
| | Info | IT Independence | | Op | External driver | |
| | Op | Financial driver | 3 | Info | IT Independence | |
| | Op | External driver | 4 | Op | Internal (top down) | 4 |
| Challenges | **Sys** | **Internal buy-in (organisation mindset)** | 1 | **Tech** | **Manual data entry** | 1 |
| | **Sys** | **Lack of understanding of FM role** | | **Sta** | **Unstructured data** | |
| | **Sta** | **Unstructured data** | | **Sta** | **Lack of standardised practices** | |
| | Sys | Lack of Lifecycle thinking in organisation | 2 | Sys | Lack of information sharing | 2 |
| | Sys | Lack of information sharing | 3 | Sys | Risk adversity | |
| | Sys | Complexity of organisation | | Sys | Delayed Involvement | |
| | Sys | Under-resourced FM department | | Tech | Lack of centralised asset registry | |
| | Sys | External buy-in (stakeholder mindset) | | Sta | Proprietary systems + data / vendor lock-in | |
| | Tech | Manual data entry | | Sys | Lack of understanding of FM role | 3 |
| | Tech | Keeping up with pace of technological change | | Sys | Lack of Lifecycle thinking in organisation | |
| | Tech | IT systems design not core competency | | Sys | Complexity of organisation | |
| | Sta | Lack of standardised practices | | Sys | Under-resourced FM department | |
| | Sta | Proprietary systems + data / vendor lock-in | | Tech | Keeping up with pace of technological change | |
| | Sys | Risk adversity | 4 | Tech | Reactive maintenance the norm | |
| | Sys | Delayed Involvement | 5 | Sys | Internal buy-in (organisation mindset) | 4 |
| | Sys | Budgetary disincentive to improve performance | | Sys | External buy-in (stakeholder mindset) | |
| | Sys | Lack of FM voice at board level | | Sys | Budgetary disincentive to improve performance | |
| | Tech | Lack of centralised asset registry | | Sys | Lack of FM voice at board level | |
| | Tech | Reactive maintenance the norm | 6 | Tech | IT systems design not core competency | |
| Opportunities | **Soft** | **Building relationships with suppliers** | 1 | **Tech** | **Open standards** | 1 |
| | **Tech** | **Open standards** | | **Tech** | **Effective planned preventative maintenance** | |
| | **Tech** | **Effective planned preventative maintenance** | | Soft | User feedback | 2 |
| | Sys | Total cost of ownership budgeting | 2 | Tech | Cross-department data querying | |
| | Sys | Independent validation | | Sys | Total cost of ownership budgeting | |
| | Tech | Remote diagnostics | | Sys | Redistribution of skills | |
| | Tech | Optmise systems scheduling | | Sys | Independent validation | |
| | Sys | Redistribution of skills | 3 | Sys | Integrated contracting | 3 |
| | Sys | Integrated contracting | | Tech | Remote diagnostics | |
| | Sys | Right people in the right place | | Tech | Commercial IWPM systems | |
| | Soft | User feedback | | Tech | Optmise systems scheduling | |
| | Tech | Cross-department data querying | | Tech | Open source developments | |
| | Tech | Commercial IWPM systems | | Sys | Right people in the right place | |
| | Sys | Further outsourcing | 4 | Sys | Further outsourcing | 4 |
| | Tech | Open source developments | | Soft | Building relationships with suppliers | |

**Note:** The observation that the top priorities of the FM cohort reflect the broad domain scope results in a further step of thematic synthesis

**Figure 4.**
Ranking of descriptive themes in order of significance for each cohort

Where the top *driver* is resoundingly a "single source of truth" for the DM cohort, a result of the nature of their IM role, the FM cohort shares this priority equally with a number of other diverse issues. It reflects the broad scope of the FM function, one participant explains that "everything crosses the FM's desk" (case 3).

Reflecting on the *challenges*, we observe a clearer distinction between the priorities of FMs and DMs. Whereas the DM priorities mainly relate to technical and standardisation challenges, FM priorities focus around systemic issues such as "organisational mindset" and "understanding of the FM role", which, as discussed in Section 2.2, may be more difficult to

address (Rogage and Greenwood, 2020). An example of the challenge around organisational culture is conveyed by one participant explaining that:

> [. . .] a lot of my colleagues do not know what I do on a day-to-day basis, they just think I'm the maintenance man [. . .] they don't know all the aspects of what the FM does. (case 2)

Finally, the key *opportunities* as perceived by the cohort are relatively consistent, only differing in the inclusion of "building relationships with suppliers" added to the FM priorities. This reflects the growing trend towards outsourcing (Adhikari *et al.*, 2019) and its importance in the domain. It is notable that "effective planned preventative maintenance" is perceived by the DMs as a top priority, a fundamentally FM-centred topic and a departure from earlier results for DMs which focus heavily on their data-handling role. This perhaps reflects their appreciation of the priorities of the FM discipline they support and confirmation that they too view IM as being instrumental in maintaining buildings over their lifetime.

In summary, the DM cohort prioritises technical issues, reflective of their business function, whereas the FMs focus on a more broad set of themes, particularly systemic ones. However, despite this divergence, the overall priorities of the two groups appear relatively consistent. This suggests alignment in mindset and a shared awareness of the importance of effective IM for longevity of the RE assets under their administration.

### *4.2 Interview synthesis*

In the following sub-sections, the interviews are synthesised around two emergent hypotheses as described in Section 3.4 and conveyed visually in Figure 5.

*4.2.1 Information management is being driven by key individuals using innovative methods.* In almost all cases, it appears that fundamental IM change is being driven, not top-down by an informed organisation, but by forward-thinking individuals. One participant even described an attempt at top-down IM as having been "traumatising" where an integrated system was imposed but which did not consider the day-to-day needs of users" and "resulted in push-back" (case 6). They felt that "facility managers are under pressure to accept and in some cases manage systems that are not suited to do the job,

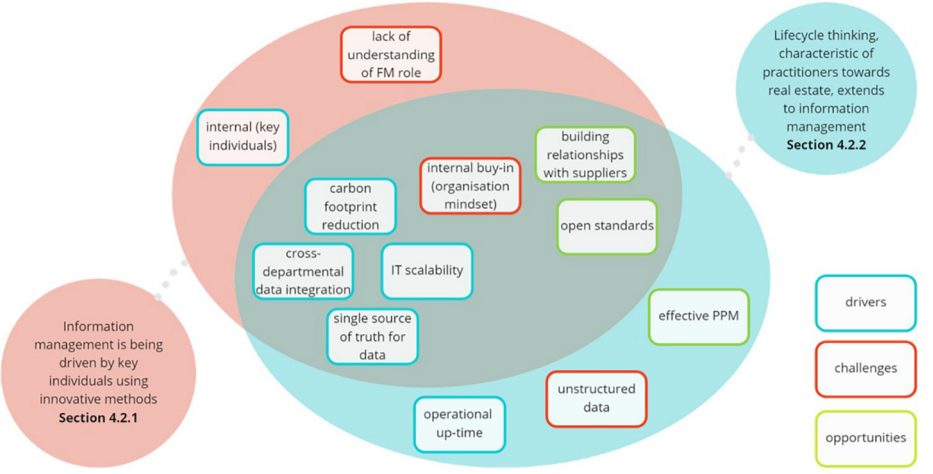


**Figure 5.**
Conceptual overlap between the broad FM cohort priorities results in a further step of synthesis providing two hypotheses of the study

To address such misalignment, a number of participants described a user-centric approach to IM implementation, including key contractors in designing the systems (cases 1, 2, 5 and 8), one participant explaining that "we see our specialist contractors as an extension of our team" (case 5), a sentiment echoed across the cohort. In spite of such grassroots efforts, top-level buy-in will typically be required to invest in effective IM and various participants described ongoing negotiations with upper management around a suitable system. "We've just been given the green light, in principle" (case 8) suggesting evidence of successful negotiations.

Perhaps most interestingly, several participants describe their own innovative communication techniques which are garnering buy-in from the wider organisation and stakeholders. The participant in case 2 describes cross-domain data federation to convey the carbon reduction effects of FM interventions, justifying their innovative approach by explaining that "I needed to be able to regularly report, to the wider organisation, the carbon reduction metrics, across what are now siloed systems." In case 1, inter-departmental IM meetings "are building trust" and having a gradual but positive effect on organisational culture. Finally, in cases 1, 6 and 8, total-cost-of-ownership financial forecasting for capital investment decisions is highlighting the often-ignored cost of maintenance, a result in both cases of collaboration between IT and FM departments. And so, the interviews demonstrate that key individuals appear to be driving both IM practice, and in some cases wider culture change within their organisation, towards an FM lifecycle mentality for both RE and the information used to manage it.

*4.2.2 Lifecycle thinking, characteristic of practitioners towards real estate, extends to information management.* The maintenance of systems over their usable life falls into the typical FM scope. Given that operational expenditure (OPEX) typically far outweighs capital expenditure (CAPEX), accounting for around 75% of lifecycle cost (Grzyl *et al.*, 2017), considering the lifecycle view (or *total-cost-of-ownership* as discussed above) in decision-making is an important function of the FM role. Another important and related function is the outsourcing of specialist services. Economically speaking, from a suppliers' point of view, it is in their best interests to make themselves indispensable to the client (Shawosh and Nicholas, 2019), and this risk of vendor lock-in emerged as a theme during the interviews. With respect to physical systems, one well informed FM team (case 4) conveyed an acute awareness of the risks with closed protocols for mechanical systems, being careful to avoid them during procurement. The question arises as to whether this precaution can be extended into IM strategy.

Throughout the interviews, the FM characteristic of lifecycle thinking towards built assets is similarly evident with regard to IT systems. One participant, recognising the risk of vendor lock-in when procuring a commercial integrated FM system, reported "looking at the direction the service provider is leaning to make sure it aligns with our future facilities needs" (case 5), whereas another expressed a feeling of a lack of available options in the market, expressing with resignation "it's the [major vendor] way or the highway" (case 6). Another related sentiment was that the required knowledge to oversee such IT migration is not a typical competency of FM teams (cases 2, 3, 4, 5, 8) and that, because of the underdefined role, this responsibility was, in some cases, inadvertently landing with the facilities department. Whether it is developing a unique system (case 1) or procuring a commercial integrated workplace management system (cases 2, 3, 5, 6 and 8) required due diligence to secure a sustainable solution which will fit the organisations' future needs, is "complex and not a core-competency" (case 3). A number of participants report looking to larger existing customers of the prospective vendor for reassurance of suitability (cases

5, 6 and 8) and considered the service, or *integration period*, as being crucial to an effective implementation.

As was clear from the ranking of perceived opportunities (Figure 4), open standards emerged as being of great importance across the cohort groupings, a direction which can address concerns around proprietary systems and vendor lock-in. Discussing one such initiative (case 9), the motivation for developing their open-source asset management data model was "the realisation that the built environment is now where earlier software was, vertically integrated platforms" and "a hostage situation" where solutions are being "developed against a proprietary vendor rather than a standard". Their approach towards "portability of applications based on a common data model" is referred to by another participant as "IT independence", a state towards which they (case 1) are now migrating. These ideas, they explain, are "starting to pick up speed incredibly fast", even being adopted by some governments in structuring their public data (Folmer *et al.*, 2020). This view is also reflected by widespread interest within the research community, specifically in the work of the *World Wide Web Consortium Linked Building Data Community Group* and others.

As is well established, FMs view built assets over their lifetime. The key takeaway is that it appears that this characteristic extends similarly towards *information*, for which more sustainable solutions are needed in the long term.

## 5. Discussion

As described at the outset, the majority of FM research to date has focused on BIM–CAFM integration but has largely ignored more systemic IM topics, and where authors have classified IM challenges into abstracted categories, a focus on the technical rather than systemic issues is considered as being more within the grasp of researchers (Rogage and Greenwood, 2020). This study, however, demonstrates that systemic issues, which were perceived as the greatest *challenge* by the FM cohort, are being addressed by practitioners through innovative communication. Participants describe examples and, at least anecdotally, report tangible effects on organisational culture, particularly around the understanding of FM objectives. These objectives reflect a consideration of assets over their operational lifetime including not just the CAPEX but the OPEX, which is often ignored in short sighted decision-making (Ashworth, 2020). Evidence of such improvements in communication demonstrate that further investigating practical solutions to systemic FM issues may be both feasible and worthwhile as it would address the priorities of practitioners and the "backbone of successful FM practice" (Matarneh *et al.*, 2019). It also suggests that FMs may be well placed to drive wider organisational change, perhaps a result of their people-focused and interdisciplinary nature (Cotts *et al.*, 2014).

It is evident from the closely aligned view of the key *opportunities* that there exist parallels between the FM and DM mindset with regard to their tendency towards lifecycle thinking. Furthermore, evidence that collaboration between those departments (as in cases 6 and 8) resulted in whole-life costing, suggests that closer cooperation between these functions may be a beneficial strategy to support data-driven whole-life decision-making, this proposition supported by the work of Marcinkowski and Gawin (2020).

Across all subject areas, the prioritisation of issues stipulating a need for greater standardisation (driver: "IT scalability", challenge: "unstructured data" and opportunity: "open standards") reflects the resounding consensus within the research community of the potential benefits. This consensus is evidenced by the works of Balaji *et al.* (2016) and Luo *et al.* (2021), as well as ongoing efforts within standardisations bodies such as ISO (*Technical committee 267*) and ASHRAE (*Semantic Interoperability-Working Group*), towards open standards for building operators. This study supports continued effort, however

challenging, in this direction and we suggest that FM views be considered as a priority in standardisation efforts, being the custodians and operators of the built environment on behalf of asset owners and already exhibiting a well-formed concept of future information needs.

### *5.1 Limitations and future work*

Sector specific traits affect the drivers of IM. Within the study sample, public bodies feel the most external pressure towards carbon reporting, local authorities tend to have a more diverse set of assets to manage than a commercial FM, while ownership models versus tenancy models also affect the scope of IM needs. A wider study could include RE segments, such as data centres, retail, manufacturing and hospitality, to provide a more comprehensive range of views. Furthermore, this study focuses on the Northern European FM sector, so further interviews are required to establish the global generalisability of the findings.

Qualitative research methods have some subjectivity by nature and so, on the recommendation of Thomas and Harden (2008), we reduce this risk by communicating the methods as clearly as possible. Though effective for the exploratory context of this study, a more detailed weighting system as, for example, in the work of Durdyev *et al.* (2022), may provide more granular and discerning results.

The prioritisation of FM challenges in this study suggests a need for future work addressing systemic rather than technical issues, an area currently under-represented in the literature (Matarneh *et al.*, 2019). It was also demonstrated that addressing these issues may not in fact be insurmountable for researchers with demonstrations of, for example, culture change and cross-domain understanding reported in a number of interviews. And so, our future work will aim towards further interdisciplinary understanding, using information federation as a mode of communication of FM lifecycle thinking.

## 6. Conclusion

Effective IM can help RE operators improve asset performance during operation, reducing negative environmental impacts. However, a myriad of well-documented challenges restrict the efficacy of IM practice, for example, the significant disconnect between the construction and operational building phases. The volume of FM research to date which addresses technical issues around IM, such as interoperability between BIM and CAFM systems, would suggest these as the key domain challenges. In contrast, this exploratory study suggests that practitioners are more concerned with underlying systemic issues than technical ones, and though most have been identified in the FM literature, tackling these systemic challenges is considered to be beyond the remit of academic research.

Through a series of semi-structured interviews across a broad segment of RE sectors, sentiments are collected regarding IM in practice from a careful selection of experienced facilities practitioners. Using a thematic synthesis methodology, responses are classified and ranked for significance, establishing a list of priorities. The ranking suggests that practitioners are primarily concerned with systemic issues around IM and we find evidence of practical steps being taken to resolve them, challenging the assumption that such objectives are insurmountable to address. Furthermore, a synthesis of the interviews is provided around the cohort's key IM issues. Emerging hypotheses suggest potential benefits from closer alignment between FM and IT functions and recommend the inclusion of the FM voice in developing greatly needed interdisciplinary standards, the domain practitioners demonstrating a well-formed understanding of future information needs. Our future work will test these hypotheses, using cross-domain information federation as a means to advocate the FM lifecycle mindset, with the aim of addressing systemic domain issues.

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## Appendix 1

**Table A1.** The interview cohort includes 6 facility/asset managers and 3 data managers, reflecting the IM for FM focus of the study

| Case reference | Experience | Role | Organisation type | Interviewers |
|---|---|---|---|---|
| 1 | 5–10 years | Asset manager | Infrastructure (airport) | 2 |
| 2 | 10–20 years | Facility manager | Residential (private) | 2 |
| 3 | 10–20 years | Facility manager | Local Authority (government) | 1 |
| 4 | 10–20 years | Energy systems manager | Higher education | 2 |
| 5 | 20+ years | Facility manager | Healthcare | 1 |
| 6 | 20+ years | Facility manager | Commercial | 1 |
| 7 | 20+ years | Data management consultant | RE data management consultancy | 2 |
| 8 | 10–20 years | IT manager | Residential (social) | 1 |
| 9 | 10–20 years | Software developer | RE data management solution provider | 2 |

## Appendix 2. Interview structure

(1) Part 1: drivers (approximately 1/3 of interview time)
- Organisation profile: information was collected about the organisation and its objectives.
- Participant profile: information was collected about the interviewee relating to their current and past roles and educational background.
- Stakeholder profile: information was collected about the supply chain and typical clients/stakeholders.

(2) Part 2: processes and information (approximately 2/3 of interview time)
- Process profile: investigated the activities and processes within the organisation.
- Lifecycle involvement: investigated the building lifecycle stages in which the organisation is involved such as design, construction, operation, etc.
- Information management: investigated current IM strategies within the organisation and with its stakeholders including their database, standards and write/access strategies.
- Scope for improvement: this section gave the participant space to express their greatest challenges with regard to IM, to suggest "low-hanging fruit" as well as more fundamental improvements to be made. They were also asked to describe an idealised situation for their organisation as well as the wider FM industry.

## Appendix 3. Interview summaries

*Case 1 – Asset manager for a major piece of transport infrastructure (airport)*

The participant described recent developments within the organisation to move towards IT independence and away from proprietary software environments. Met with significant internal and external resistance, it required innovative, cross-departmental collaboration, driven by key individuals, which is leading to a change in mindset by the organisation and its stakeholders.

*Case 2 – Facilities manager for pension-fund owned private residential rental company*
With little budgetary pressure, the team is able to focus on carbon-cutting measures, but a lack of awareness within the organisation about the role of the FM team led to implementing an innovative cross-domain federation of data to justify lifecycle decisions.

*Case 3 – Facilities manager for local authority (government body)*
With FM being a recently formalised role, the participant described a lack of top-down information management guidance or procedures. With financial and energy reduction pressure to improve asset performance, a first task will be to develop an asset registry to provide a view over the scope of responsibility, reactive maintenance being the norm and resources being scarce.

*Case 4 – Energy systems manager for a large university campus*
The participant described a technical team that was well informed regarding services they outsource and systems they purchase. Involved early in design projects they are able to encourage lifecycle thinking, though must still negotiate their position against other organisational pressures. Their centralised energy management system facilitates optimisation, though updates to the system are a significant undertaking and they lack any shared asset registry.

*Case 5 – Facilities manager for a large hospital*
Participant describes plans for merging several regional FM teams to support a new centralised hospital facility. They are undertaking a digital reorganisation including the procurement of a commercial integrated workplace management system. Acutely aware of the importance in unique identification and tracking capabilities throughout the asset registry, they are working with key specialist contractors to design the new system. Late involvement in the design has limited their ability to impact the maintainability of the new facility, though the specialist nature of the health sector has simplified negotiations somewhat.

*Case 6 – Facilities manager for commercial tenant*
Owning no property, the FM role is a complex set of responsibilities including project managing fit-outs and coordinating maintenance activities (100% of which are outsourced). A solid asset registry and strong financial analytical support enables lifecycle decision-making though a recent negative experience with a commercial integrated IT system imposed upon them has dissuaded the FM team as to further developing IM in the organisation.

*Case 7 – Real estate data management consultant*
The organisation mainly manages information at handover stage but is also involved at earlier and later stages of building projects. The participant describes an idealised OM situation, using unique identifiers and international standards, but regrets that currently the industry is still primarily paper and PDF based, a common repository being a reasonably advanced situation at present. Looking to legal requirements developing in other regions, the participant anticipates carbon declarations becoming integral to RE procurement in the near future. Delayed involvement is suggested as the greatest challenge for FMs, and a focus on strategies typically associated with manufacturing such as Lean principles are recommended, to improve quality in the RE sector.

*Case 8 – Information technology manager for social housing service provider*

Recent and projected growth is set to overload a currently heavily manual IT landscape. Having secured buy-in from management, the team is currently procuring a commercial integrated IT system, basing their selection of a provider on precedence from similar, but larger organisations. The participant sees the future role of the IT department as providing systems, training and high-level support, but suggests a need for analytical skills within the various business functions.

*Case 9 – Software developer for real estate information management solution provider*

The open source, community developed RE data model came about because of a number of leading RE companies wishing to get away from the current tightly integrated, vertical IT paradigm of the sector. The solution facilitates the integration (federation) and querying of heterogeneous building data. Though developed for the needs of property owners, the standard is in competition with other open data models which specialise primarily in other specialty areas such as building automation. The participant described such efforts as a step towards democratising the IT landscape, enabling smaller companies to participate in developing modular applications against an open standard, rather than a specific vendor.

## Appendix 4

| Topic | Analytical Grouping | Group Code | Descriptive Themes | Cases 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Coding example (verbatim quotations) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drivers | Sustainable Operations | Op | Carbon footprint reduction | | X | | | | | | | | *"I needed to be able to regularly report, to the wider organisation, the carbon reduction metrics, across what are now siloed systems."* |
| | | Op | Up-time for operations | | | | | X | | | | | *"...it will mean that some diagnosis can be done remotely, improving speed for addressing issues."* |
| | | Op | Internal (top down) | | | | | | X | | | | *"facility managers are under pressure to accept, and in some cases manage, systems that are not suited to do the job."* |
| | | Op | Internal (key individual/s) | | X | | | | | | | | *"I started pulling data from different sources, putting it together in one place, and circulating it to the management every month to show the reduction in carbon we were making."* |
| | | Op | External driver | X | | | | | | | | | *"If companies don't adopt, they will lose out to contractors who do."* |
| | | Op | Financial driver | | | | | | | | X | | *"...will be cheaper and more efficient. Just the manual effort currently of processing spreadsheets is outrageous. You've got humans doing machine work."* |
| | Sustainable Information | Info | Single source of truth for data | | | X | | | | | | | *"Currently there is a lot of duplication internally. It's due to a lack of trust and different departments' needs to structure directories differently."* |
| | | Info | Cross-departmental data integration | | | | | | | | X | | *"We've just been given the green light, in principle, to procure an 'integrated digital estate' system which will be flexible enough to integrate with the various existing business functions."* |
| | | Info | IT scalability | X | | | | | | | | | *"...it's about increased flexibility and speed of adaptation to an IT landscape that will continue to change."* |
| | | Info | IT Independence | | | | | | | | | X | *"...portability of solutions [...] realised that buildings are now where earlier software was at, one vendor, one hardware [...] a hostage situation"* |
| | | | | | | | | | | | | | |
| Challenges | Systemic Challenge | Sys | Internal buy-in (organisation mindset) | X | | | | | | | | | *"The challenge has been in convincing the organisation itself to change from traditional ways of thinking about information management"* |
| | | Sys | Lack of understanding of FM role | | X | | | | | | | | *"A lot of my colleagues do not know what i do on a day-to-day basis. They just think i'm the maintenance man. They think i'm the guy out there fixing the plumbing. They don't know all the aspects of what the facility manager does"* |
| | | Sys | Lack of Lifecycle thinking in organisation | | X | | | | | | | | *"Everything we do is over the lifetime of the asset, for management it's probably more like five to ten years [...] when it comes to investors it's difficult to see how to do long term planning when their strategy may be to hike the value and sell quick."* |
| | | Sys | Lack of information sharing | | | X | | | | | | | *"I only hear that tickets have been signed off after several days, unless I go asking for it from my inspectors."* |
| | | Sys | Complexity of organisation | | | | | | | | X | | *"The company started growing exponentially and the systems can't keep up with complexity of facets."* |
| | | Sys | Under-resourced FM department | | | X | | | | | | | *"I have two buildings on paper, but in reality it's a lot more [...] county hall, civic offices, housing, libraries, depots [...] I'm a one man band"* |

**Table A2.** Coding examples

(*continued*)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sys | External buy-in (stakeholder mindset) | | | | | X | | | | | *"...difficult to get the narrative understood, the risk of not doing something in a timely fashion, to make a clear PPM case."* |
| | | Sys | Risk adversity | X | | | | | | | | | *"If there is even a small chance it fails, operations just can't take the risk on a piece of critical infrastructure."* |
| | | Sys | Delayed Involvement | | | | | X | | | | | *"We were brought in late in the design with the result being a limitation to influence, from the early stages, maintainability of the project."* |
| | | Sys | Budgetary disincentive to improve performance | X | | | | | | | | | *"There is no incentive to improve efficiency when the contractor is being paid for processing data."* |
| | | Sys | Lack of FM voice at board level | | | | | X | | | | | *[A challenge for the domain is] "getting FM representation at copporate level, at the executive table. If not, there is a lack of direction."* |
| | Technical Challenge | Tech | Manual data entry | | | | | | | | X | | *"...will be cheaper and more efficient. Just the manual effort currently of processing spreadsheets is outrageous. You've got humans doing machine work."* |
| | | Tech | Keeping up with pace of technological change | | | | X | | | | | | *"Even updating the software is a massive undertaking at this scale."* |
| | | Tech | IT systems design not core competency | | | X | | | | | | | *"Understanding what you will need in future, and relating that to what is on the market is very difficult [...] conceptualising IT systems would not be a core competency."* |
| | | Tech | Lack of centralised asset registry | | | | X | | | | | | *"We're working at the moment with vast, unstructured data accross various portals."* |
| | | Tech | Reactive maintenance the norm | | | X | | | | | | | *"You're walking into work with your fingers crossed hoping that nothing decides to go belly-up for the day."* |
| | Standardisation Challenge | Sta | Unstructured data | | | | | | | X | | | *"contractors are inputting data [...] They gather the pdfs and drawings [...] As an industry we've gone from paper based to .pdf based, and this is not much of an improvement."* |
| | | Sta | Lack of standardised practices | | | | | | | | X | | *"Because the 'scheduled' and 'response' functions are not integrated, a boiler could be replaced twice."* |
| | | Sta | Proprietary systems + data / vendor lock-in | | | X | | | | | | | *"...the [mechanical] system required premature replacement due to the supplier ceasing operations."* |
| | | | | | | | | | | | | | |
| Opportunities | Systemic Opportunities | Sys | Total cost of ownership budgeting | | | X | | | | | | | *"the cost of operating the system, plus maintenance, far outweighs the initial capital investment."* |
| | | Sys | Redistribution of skills | | | | X | | | | | | *"We try to empower managers at a building level to solve issues. It reduces unnecessary visits."* |
| | | Sys | Independent validation | | | | | X | | | | | *"An important part of maintaining trust is carrying out external validation for mission-criticall items"* |
| | | Sys | Integrated contracting | X | | | | | | | | | *"[integrated contracting] isn't possible with traditional ways of thinking about risk and reward in projects."* |
| | | Sys | Right people in the right place | | | | | | | | X | | *"I see the role [of the IT department] in future as providing systems, training and high-level support, whereas querying and analytics skills will be needed within specific departments."* |

**Table A2.**

(*continued*)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sys | Further outsourcing | | | X | | | | | | | *"Direct labour is our biggest cost. You've got to pay pensions and salaries, and if someone's out sick we've got no cover. This way the obligation is on the contractor."* |
| Soft-FM Opportunities | Soft | Building relationships with suppliers | | | | | | X | | | | *"A good FM needs to know which contracts to retender for and which to stick with [...] mechanical contractor has been with us for 30 years. I would never switch. There is a great importance in institutional knowledge."* |
| | Soft | User feedback | | X | | | | | | | | *"Our in-house maintenance is a key value-add [...] we strive for continuity [...] for the residents to feel comfortable."* |
| Technical Opportunities | Tech | Open standards | | | | | | | | | X | *"allows developers to provide modular applications, developed against standards rather than vendors [...] opens up the market for smaller companies to participate."* |
| | Tech | Effective planned preventative maintenance | | | | | X | | | | | *"With a good planned preventative maintenance system there should be no unplanned downtime."* |
| | Tech | Cross-department data querying | X | | | | | | | | | *"The contractor currently provides the data, but the next level of trust would be for them to provide a SPARQL endpoint so that we can query the data directly."* |
| | Tech | Remote diagnostics | | | | | X | | | | | *"The next big thing for hard FM will be remote diagnostics [...] we're looking at vendors who can convince us that they're heading in that direction."* |
| | Tech | Commercial IWPM systems | | | | | | | | X | | *"Software development is not a core competency [...] will be cheaper and more efficient. Just the manual effort currently of processing spreadsheets is outrageous. You've got humans doing machine work."* |
| | Tech | Optmise systems scheduling | | X | | | | | | | | *"Low hanging fruit is just scheduling your systems properly. At [former employer] we reduced energy use by 26% by just turning the lights off at night."* |
| | Tech | Open source developments | | | | | | | | | X | *"...user improvements which are generalisable can be adopted into the data model in later releases."* |

**Table A2.**

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