# Guide to Smart FM Revision Log

<table>
<thead>
<tr>
<th>S/N</th>
<th>Brief description of changes</th>
<th>Revision date</th>
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<tbody>
<tr>
<td>01</td>
<td>First issue</td>
<td>1 Oct 2019</td>
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Preface

As part of the Real Estate Industry Transformation Map (ITM) launched on 8 February 2018 by Mr Desmond Lee, Minister for Social and Family Development and Second Minister for National Development, the Building and Construction Authority (BCA) was tasked to coordinate the development of the Facilities Management (FM) sector. A tripartite Facilities Management Implementation Committee (FMIC) was formed in April 2018. The FMIC brings together major stakeholders, comprising both public and private building owners, FM service and solution providers, trade associations and chambers (TACs), and unions, to develop detailed action plans to implement the strategies identified in the Real Estate ITM.

A key strategy in the Real Estates ITM is the reduction of reliance on manpower by leveraging on data analytics, predictive maintenance and smart technology solutions. A Smart FM Taskforce, was subsequently formed to develop a framework for implementation and formulate strategies for adoption of smart FM by industry. This Guide to Smart FM is an output of the Taskforce. It aims to provide Building Owners and their FM Managers with an easy-to-use reference to guide them on the key steps to take in their smart FM journey.

The adoption of smart FM is complementary to the industry’s ongoing efforts towards Integrated Digital Delivery (IDD). Building Owners and their FM Managers can use the Guide to identify and implement smart technology solutions that meet their business objectives in the area of IDD. It includes solutions that streamline work processes and allow for real-time monitoring of assets and operations which can help Building Owners enhance their asset values and improve FM service quality.

For the preparation of this Guide, extensive consultations were held with various public agencies, building owners, FM service and solution providers to understand their challenges and plans, and to draw lessons learnt from their experience in implementing smart FM.
Acknowledgement

This *Guide to Smart FM* was developed with inputs from the Smart FM Taskforce. Special thanks is given to all Taskforce members for their significant contribution and support.

**Smart FM Taskforce Members**

**Co-Chairs:**

Mr Ang Kian Seng  
Group Director, Environmental Sustainability Group  
Building and Construction Authority

Ms Samantha Su  
Director (Built Environment Cluster)  
Info-communications Media Development Authority

Mr Mark Koh  
Group Director, Facilities and Estate Management  
JTC Corporation

**Members:**

Er Alfred Lim  
Vice President,  
CapitaLand Singapore Ltd

Mr Tony Choo  
Head, Engineering Support Services  
CapitaLand Singapore Ltd

Mr Lim Tow Fok  
General Manager  
Keppel Land International Ltd

Mr Franklin Tang  
Chief Executive Officer  
Habitap Pte Ltd

Mr Ho Chee Kit  
Senior Director  
Cushman & Wakefield Services Singapore

Mr Daniel Ong  
Deputy Managing Director  
Jardine Engineering Corporation (Singapore)

Mr Dominic Khor  
General Manager, SMM-Digital FM  
Surbana Jurong Pte Ltd

Mr Tan Boon Kuan  
Group General Manager  
Carrier Singapore Pte Ltd

Mr Jason Foo  
Director, Facilities Planning & Advisory Division  
JTC Corporation

Mr Derrick Ong  
Acting Director, Facilities & Estates Management (Central Division)  
JTC Corporation

Mr Toh Eng Shyan  
Director, Environmental Sustainability Group  
Building and Construction Authority

Appreciation is also extended to the following individuals for their valuable contribution to the use cases documented in the Guide:

Mr Dennis Aw, Director, Infrastructure, Safety & Security Office, Yale-NUS College

Mr Jake Chia, Assistant Director, Facilities Planning & Advisory Division, JTC
Executive Summary

Smart FM refers to the integration of systems, processes, technologies and personnel to enhance the management of a building’s facilities. It is about *doing better with technology*, using it as a means to an end.

The *Guide to Smart FM* aims to help Building Owners and their FM managers articulate and realise their smart FM goals, through SMART. It is a five-step process to facilitate the implementation process, improve communication and serve as a framework to continually review the smart FM goals. Building Owners, FM Managers, FMCs and Service/ Solution Providers can use this Guide and the 5-Step SMART process as follows:

<table>
<thead>
<tr>
<th>Steps</th>
<th>Building Owners &amp; FM Managers</th>
<th>FMCs and Service/ Solution Providers</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td><strong>Set business objectives and outcomes</strong></td>
<td>Understand Building Owners’ smart FM goals</td>
</tr>
<tr>
<td>2</td>
<td><strong>Map out smart FM solutions as enablers</strong></td>
<td>Position technology solutions to meet Building Owners’ smart FM goals</td>
</tr>
<tr>
<td>3</td>
<td><strong>Adopt suitable implementation model</strong></td>
<td>Propose suitable implementation models</td>
</tr>
<tr>
<td>4</td>
<td><strong>Review procurement contract</strong></td>
<td>Offer longer-term, outcome-based contract</td>
</tr>
<tr>
<td>5</td>
<td><strong>Track outcomes and review for continuous improvement</strong></td>
<td>Review effectiveness of adopted solution(s) with Building Owners and their FM Managers</td>
</tr>
</tbody>
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This Guide is designed to be applicable to various building types and FM operating models, while being mindful that most buildings have a diverse range of systems.
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Chapter 1. Introduction

Smart FM refers to the integration of systems, processes, technologies and personnel to enhance the management of a building’s facilities. It is a means to an end and ironically, should not begin with technology in mind. It is important to consider the process and people aspect in order to harness the full potential of smart FM and achieve a holistic solution that can support data-driven decisions, create change and improve outcomes (see Figure 1).

![Figure 1. Transformational change through smart FM requires more than just technology](attachment:image.png)

In recent years, there is a significant interest from Building Owners to develop smart buildings or estates that cater to varied customers’ experiences.

It is not just purely about automating business processes but being able to create a smart environment for Building Owners and FM managers through a holistic approach that allows higher level of smart facilities management in areas such as command-and-control for security and resource deployment, on-demand energy management, and use of digital twins for simulation and modelling.

Creating a connected and interactive smart living space for tenants and visitors to the building is equally important. As the economy shifts from traditional industry silos to integrated digital ecosystems, businesses that place their customers’ experience first, have the ability to continuously create new value, and that build on digital economies of scale, will thrive. Solutions can include booking of facilities, seamless building access, incident reporting, and payment transactions through a single app, thus creating a seamless and end-to-end user experience.
With the rise of emerging technologies such as Artificial Intelligence (AI), Internet of Things (IoT) devices, Immersive Media (AR/VR), and cloud-based technologies, the FM industry is now able to leverage on such technologies to help Building Owners achieve the abovementioned, transform their business model to allow scalability, and be able to gain a competitive edge in the market. Having said so, the organisation’s business requirements and processes must also be taken into consideration prior to the adoption of smart FM solutions.

When embarking on smart FM, it should start with a deliberate review of the facility’s processes and performance to ensure alignment with business requirements and operational outcomes. Smart FM solution can be deployed, where appropriate, to optimise, automate and transform the delivery of a FM operation or process. The adoption of technological innovations can affect both the core business and the employees of the organisation. Building Owners should plan for regular training or upskilling of the FM Managers as this is an essential step for more effective application of the smart FM solutions.

Building Owners and FM Managers can easily evaluate outcome and/or contracting efficiency by collating occupants’ feedback, reporting energy savings or usage, tracking the time to resolve incidents, etc. This in turn allows the Building Owners and FM Managers to determine how well the smart FM solutions have been implemented, used and managed, thereby streamlining and transforming the way existing FM processes and practices are carried out.

When smart FM is well executed, businesses can experience a reduction in life cycle cost, with better process efficiency. “Beyond efficiency gains, smart FM can also create an environment where tenants and employees are comfortable, energised, and able to do their best works”¹.

¹ IFMA-JLL white paper, Welcome to the Internet of Things (IoT) era, Findings and insight from IFMA and JLL’s IoT research
5-Step SMART Process to Smart FM

A 5-step SMART process, shown in Figure 2 below, is recommended to aid the Building Owners and FM Managers in their smart FM journey. The detailed steps will be further explained in Chapter 2. The 5-step SMART Process.

Figure 2. 5-Step SMART process to Smart FM
Chapter 2. The 5-step SMART Process

Step 1: Set Business Objectives and Outcomes

![Diagram showing Business Objectives and Corporate Pillars]

Technological innovation can shape and impact FM practices, but there is a need to evaluate and align its business objectives with its fundamental principles of integrating people, place, process and technology.

The principles shown in Figure 3 serve as the underlying foundation to an organisation’s business objectives, reinforced by the following corporate pillars in the implementation of smart FM:

- Delivering efficient FM operations
- Ensuring satisfaction of the occupants (e.g. employees, tenants, etc.)
- Enhancing building assets through upgrading works or proper maintenance

Building Owners and FM Managers can refer to these principles to identify their key business objectives. As it may vary by building or estate, smart FM is best planned for in the early stages of design as it can be critical to its successful implementation.
Setting Business Objectives, Desired FM Outcomes and Corresponding Key Performance Indicators (KPIs)

The adoption of smart FM technologies should primarily be driven by an organisation’s business objectives. Building Owners and FM Managers are recommended to first identify their top 3 business objectives with the Smart FM fundamentals in mind.

### Identify top 3 business objectives:
- Cost
- Manpower (internal or external)
- Customer satisfaction
- Productivity
- System reliability
- Security requirements
- Etc.

### Set desired FM outcomes and corresponding KPIs to evaluate/monitor performance.
For example:
- To reduce 10% of operating cost by 2022
- Increase user satisfaction on general area cleanliness
- Improve internal FM staff productivity due to headcount freeze and ageing workforce

### Prioritise which FM services to focus efforts on based on business objectives and desired FM outcomes:

<table>
<thead>
<tr>
<th>Soft FM</th>
<th>Hard FM</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM Management</td>
<td>BMS</td>
</tr>
<tr>
<td>Landscape</td>
<td>Chiller plant</td>
</tr>
<tr>
<td>Refuse</td>
<td>Lifts</td>
</tr>
<tr>
<td>Cleaning</td>
<td>M&amp;E equipment</td>
</tr>
<tr>
<td>Façade</td>
<td>Carpark</td>
</tr>
<tr>
<td>Pest Control</td>
<td>Building Information Modelling (BIM)</td>
</tr>
<tr>
<td>Security</td>
<td>Office renovation/ architecture works</td>
</tr>
<tr>
<td>Etc.</td>
<td>Etc.</td>
</tr>
</tbody>
</table>

Based on ISO 41001:2018 Facility Management System:
- **Soft FM** covers the people and organisation, and is related to work psychology and occupational physiology.
- **Hard FM** refers to the physical built environment with focus on (work-) space and (building-) infrastructure.

*Figure 4. Flowchart on Step 1 of the 5-Step SMART process*
The desired FM outcomes can be established based on these identified business objectives and pertinent operational issues that need to be addressed. It is recommended for Building Owners and FM Managers to determine corresponding KPIs to evaluate and monitor the performance of each desired FM outcome.

Lastly, Building Owners and FM Managers are to decide which FM services to focus on. The FM services should be prioritised based on their impact in realising the desired FM outcomes and KPIs. The template in Table 1 can help to facilitate this process.

<table>
<thead>
<tr>
<th>Top 3 Business Objectives</th>
<th>Check Point</th>
<th>Desired FM Outcomes and Corresponding KPIs</th>
<th>High-Priority FM Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.g. Cost</td>
<td>E.g. What is my annual FM expenditure and cost breakdown? What area can be improved/reduced?</td>
<td>E.g. To reduce energy cost by 10% by 2022</td>
<td>E.g. Chiller plant maintenance</td>
</tr>
<tr>
<td>E.g. Customer satisfaction</td>
<td>E.g. What is my customer satisfaction level for each services?</td>
<td>E.g. Increase user satisfaction on general area cleanliness and reduce complaints by 20%</td>
<td>E.g. Cleaning of toilets (high volume of user feedback)</td>
</tr>
<tr>
<td>E.g. Productivity</td>
<td>E.g. Does the task or project required high amount of manual processes or paperwork? What area can be improved further?</td>
<td>E.g. Increase internal FM staff productivity due to headcount freeze and ageing workforce Increase productivity by 15%</td>
<td>E.g. FM management processes (manpower intensive)</td>
</tr>
</tbody>
</table>

Table 1. Template to rank business objectives, set desired FM outcomes, and determine high-priority FM services to focus on
What Should Building Owners and FM Managers Consider in Step 1:

- What are my top 3 business objectives?
- What do I want to achieve and set as my desired FM outcomes, based on my business objectives and issues faced?
- What corresponding KPIs can I set to monitor the progress of my desired FM outcomes?
- Which FM services should I prioritise to address the desired FM outcomes?
- Can I streamline my current FM processes and procurement framework to meet the identified business objectives and desired FM outcomes?

**Tool to use**

Table 1: Template to rank business objectives, set desired FM outcomes, and determine high-priority FM services to focus on
Step 2: Map Out Smart FM Solutions as Enablers

The next step is for Building Owners and FM Managers to determine suitable technology solutions for the high-priority FM services identified in Step 1. At this stage, it is important for Building Owners and FM Managers to concurrently review and streamline current FM processes and explore how smart FM technologies can be integrated.

Building Owners and FM Managers can refer to Appendix A: List of Smart FM Point Solutions for solutions that addresses specific FM pain points related to infrastructure and common services.

The Singapore International Facility Management Association (SIFMA) has also collaborated with the Agency for Science, Technology and Research (A*STAR) to develop a Consortium Operation and Technology Roadmap (COTR) for the FM sector (see Appendix B: Facilities Management Consortium Operation and Technology Roadmap (COTR)). The COTR aims to outline the general trends (e.g. push and pull drivers towards smart FM) and direction of the FM sector, and maps out smart FM solutions that are deemed relevant for the sector from short to long term.

Establish a Smart FM Framework

Building Owners and FM Managers can take reference to the abovementioned to identify technology solutions they can map into the Smart FM Framework as shown in Table 2. The Framework serves to facilitate dialogues between Building Owners and Service/ Solution Providers. Proposals can be reviewed alongside the Framework to see how the technology solutions offered can help to achieve the desired FM outcomes.

The Framework also classifies smart FM solutions into three types of “smartness” where Building Owners and FM Managers can assess the scope and type of solutions each FM service requires. It is important to note that the three types of “smartness” are not in any order of merit or maturity of technologies. The choice of solutions should be determined by a cost-benefit analysis in achieving the desired smart FM outcomes.
Other than looking into adoption of solutions to enhance business operations and productivities, Building Owners and FM managers should also consider how data can be collected, managed and analysed for innovation. For example, data collected from people-traffic information could help business owners identify the right timing to push out attractive store promotion via the mall’s customer app or being able to allocate the right amount of manpower required for cleaning services during peak and non-peak season so as to ensure that the public or workspaces are well maintained. Such approaches can bring greater value-add not only for Building Owners but also for the tenants and employees.

**Explore Aggregation Opportunities**

Building Owners and FM Managers can explore areas where economies of scale can be achieved through aggregation at all 3 types of “smartness” (i.e. Type 1, 2 and/or 3). For Building Owners with a portfolio of buildings, the aggregation may be done at their end (i.e. demand side). For example, a technology solution can be deployed, or certain FM functions like security and cleaning can be aggregated, across the portfolio of buildings, for a better overview and management of resources.

Building Owners with a single development may explore aggregation at the supply side, through FMCs and Service/ Solution Providers. When more Building Owners move from traditional prescriptive-based contracting to outcome-based, FMCs and
Services/ Solution Providers can better manage their resources to meet services demands. Greater benefits can be reaped through aggregation for buildings in a vicinity or district that adopt outcome-based contracting. This will be covered and explained further in Step 4.

What Should Building Owners and FM Managers Consider in Step 2:

- What type of “smartness” (Type 1, Type 2, or Type 3) is each high-priority FM service currently at?
- What type of “smartness” do I want to achieve for each high-priority FM service? Is it aligned with my business objectives and desired FM outcomes?
- What are my pain points and gain points for each high-priority FM service?
- Do the technology solutions proposed by the FMCs and Service/ Solution Providers fit the requirements to achieve my desired FM outcomes?
- How would I like to engage the building occupants and visitors?
- Are there FM services that could be integrated to provide multi-functional and enhanced outcomes, e.g. connected lighting systems?
- Are there areas where aggregation can be done to achieve economies of scale – at demand and/or supply side?
- Is it advantageous to aggregate demand across a portfolio of buildings?

Tool to use
Table 2: Smart FM Framework

References

- Appendix A: List of Smart FM Point Solutions
- Appendix B: Facilities Management Consortium Operation & Technology Roadmap (COTR)
Step 3: **Adopt Suitable Implementation Model**

Upon deciding which smart FM solutions to adopt under Step 2, it is important for Building Owners and FM Managers to determine how these solutions can be implemented.

Where relevant, Building Owners and FM Managers can consider incorporating the concept of Services 4.0\(^2\), which envision services to be end-to-end, frictionless, empathic, and being able to anticipate customer needs using emerging technologies. In Services 4.0, businesses will need to meet changing customer needs quickly, innovate, scale and be able to create new value in order to differentiate themselves from competitors.

**Model A: Integrated Smart FM Solution**

The following implementation model (*see Figure 5 below*) is one in which the smart solutions feed data into an integrated software suite, either provided by the appointed FMC or acquired by the Building Owner to operate and manage its FM operations.

The first approach is resource-lite and allows the Building Owner and FM Manager to have a reasonably comprehensive management dashboard. While the latter requires considerable scale and resource commitment to develop a reasonably comprehensive system and management dashboard, it allows customisation based on the organisation needs and is beneficial for Building Owners with a big portfolio of buildings. Regardless of which approach, both should provide the Building Owner the autonomy of its operation.

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\(^2\) Services 4.0 is Singapore’s response to the Services and Digital Economy (SDE) Technology Roadmap, envisioning Singapore delivering next-generation services that are end-to-end, frictionless, empathic, and anticipatory to customer needs. (Reference: [https://www2.imda.gov.sg/infocomm-media-landscape/services-40](https://www2.imda.gov.sg/infocomm-media-landscape/services-40))
The use cases of this model include JTC Corporation’s J-Ops (Refer to Chapter 4: Use Cases) and the CapitaLand Integrated Building Platform (IBP).
Model B: Single Smart FM Solution

This second implementation model is one in which Building Owners procure specific smart FM services and solutions individually and manage them with the software tools provided by each individual Service/ Solution Provider.

![Solution by multiple FM providers](image)

Figure 6. Single Smart FM Solution

It has become more common for specialised FM suppliers to develop smart solutions to complement their products and services for remote monitoring, fault detection, diagnostics and optimisation. For example, major chiller suppliers have deep expertise and extensive performance data of their equipment. The leading suppliers have developed smart IoT solutions (connected services) for remote chiller plant monitoring and predictive maintenance.

While this approach can leverage on the specialised expertise and data of the Service/ Solution Providers, Building Owners and FM managers should keep in mind that if integration of multiple systems or solutions is within the future pipeline, the adopted or developed solutions should have open Application Programming Interfaces (APIs) to allow integration with a horizontal platform for central command-and-control and data exchange.
Additional Considerations

It should be emphasised that none of the implementation models are superior to another. The decision on the type of model to adopt must be based on the Building Owner’s business objectives, operational priorities and desired FM outcomes.

A phased adoption, variation or hybrid of the implementation models is entirely possible. For instance, a Building Owner with a large portfolio of buildings may start with a centralised FM operations centre (i.e. Model A) and have been reaping the benefits and cost savings from rectifying poorly commissioned equipment and sensors that have “drifted” in accuracy (low-hanging fruits). To attain the next leap of optimisation, the Building Owner may see it advantageous to subscribe to a chiller vendor’s remote monitoring service (i.e. Model B). This is with consideration that the chiller vendor has proprietary knowledge of its chillers and the possibility to leverage on its collective insights obtained from monitoring its global installed base.

As Building Owners and FM managers start to enjoy the benefits that can be gained from leveraging large data sets, such as optimising business processes or accelerating the development of artificial intelligence (AI), there are also concerns over trust and security thereby hindering the mass sharing of this information. Data sharing is a multi-disciplinary process which involves not only enabling technology, but also business and legal considerations. In June 2019, the Info-communications Media Development Authority (IMDA) and Personal Data Protection Commission (PDPC) have announced the first comprehensive Trusted Data Sharing Framework\(^3\) with the aim to guide organisations through the data sharing journey. Building Owners may refer to it for key considerations to take into account when planning data partnerships.

System and Technical Requirements

The implementation model selected in this Step determines the working arrangement with the FMCs and Service/ Solution Providers. This will impact the Building Owner

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and FM Manager’s ownership (e.g. cloud-hosted or on-premise) and the degree of freedom and access to the integrated FM system and/or individual FM sub-systems.

System and technical requirements in relation to these should be specified in the procurement contracts. The specification should include the data and format to be fed to the iFMS of the building, as well as the “north-bound” data interface to which the FM sub-systems can lodge incidents with the iFMS, for the purpose of logging, dispatch and management. More information on this can be found in Appendix C: Integrated FM System (iFMS).

Besides data fields like data and time of incident and resolution, severity and classification, other information required to enable outcome-based KPIs to be objectively computed or measured should be detailed as well. For example, number of incidents per week, mean time to failure, energy efficiency index, energy savings, financial savings, turnaround time or time to resolution.

Specifications within the procurement contracts are important to ensure that the smart FM solutions and systems are properly put in place to support and contribute to the smart FM platform. This would reduce operational disruptions and any cost implications to redesign the smart FM infrastructure within the building.
<table>
<thead>
<tr>
<th>What Should Building Owners and FM Managers Consider in Step 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What is my current working model for existing FM processes and services?</td>
</tr>
<tr>
<td>• How would I like to work with my FMCs or Service/ Solution Providers?</td>
</tr>
<tr>
<td>• Which implementation model is more viable at this point to incorporate the various technology solutions identified in Step 2? Or would phased adoption or a variation or hybrid of the implementation models be more applicable?</td>
</tr>
<tr>
<td>• Does the selected implementation model meet my business objectives, operational priorities and desired FM outcomes?</td>
</tr>
<tr>
<td>• How to ensure that I own all the data, regardless of the type of implementation models selected?</td>
</tr>
<tr>
<td>• Are the system and/or technical requirements specified within my procurement contracts adequate?</td>
</tr>
</tbody>
</table>

References

- IMDA and PDPC’s Trusted Data Sharing Framework  
- **Appendix C: Integrated FM System (iFMS)**
Step 4: Review Procurement Contract

After the Building Owners and FM Managers have identified the appropriate implementation models and related system and technical requirements in Step 3, they can proceed to work out the procurement contracts with the FMCs and Service/Solution Providers.

With the increasing number of data-driven smart technology solutions in the market, there is a shift from traditional headcount-based to outcome-based procurement methods. This shift has allowed innovative solutions that are less-resource intensive to enter the market. At the same time, this has encouraged FMCs and Service/Solution Providers to improve their operations to meet the Building Owners’ expectations.

Longer Contract Terms

When outcome-based measurements become the primary focus of the procurement contracts, both Building Owners and the FMCs or Service/Solution Providers can achieve more value as working partners, sharing a common interest towards a successful business and performance relationship. With the assurance of a longer contracting period, service and solution providers may be more willing to leverage on technology as enablers to supplement and complement its workforce to achieve better and more insightful outcomes over existing procurement methods, resulting in a win-win for all parties.

Employees of FMCs and Service and Solution Providers can be given the opportunity to upskill and benefit from job redesign to take up more complex roles resulting in greater productivity as well as increase in wages.

It is recommended that Building Owners and FM Managers should specify a contract duration of at least three years, with another three years extension. In some public

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4 Ministry of Home Affairs, Guide on outcome-based security contracts
5 National Environment Agency, Guide on specification for outcome-based cleaning contracts
6 Interlect’s Outcome-Based Agreement Group, A guide to outcome-based agreements – a better way to do business
agencies that have successfully adopted smart FM, their contract duration ranges between five to ten years.

A longer contract term can incentivise the FMCs or Service/ Solution Providers to invest in technology solutions, and upgrade the supporting infrastructure of the buildings to be ready for smart FM. Key considerations for such infrastructure can be found in *Chapter 3: Building Up Infrastructure for Smart FM*.

**Define Outcome-based Measurements**

Each class of stakeholder will have different expectations, requirements and desired outcomes.

When Building Owners and FM Managers work out the procurement contracts with the FMCs and Service/ Solution Providers, it is also important to identify and understand the requirements of various stakeholders. The technical specifications within the contract will need to take these into consideration:

a) **Financial stakeholders** will desire information on how the smart FM implementation will impact the company’s financial metrics and bottom line, as well as the interfacing to its accounting system.

b) **Operational stakeholders** that keep the building functioning on a day-to-day basis will be concerned with occupant satisfaction, ease of operation, access to critical systems’ information, and productivity of the maintenance staff. They will also want access to all the building’s systems to have better situational awareness, and address issues in real time, where required.

c) **Sustainability stakeholders** will be concerned with energy and water efficiency, utility optimisation, and how to reduce carbon emissions and save resources.

d) **Productivity stakeholders** will be concerned with occupant and user comfort, and will want to know about utilisation of the building’s spaces and how systems
integration can improve the productivity of workflow processes and user experience.

e) **Security stakeholders** may look beyond surveillance and want the building’s intelligence to maintain a proper access control system, help disseminate messages and locate people during an emergency.

f) **Public communications stakeholders** will want to include performance data in lobby displays to promote various initiatives deployed within the building (e.g. sustainability efforts) and help visitors with registration and wayfinding.

All the parties mentioned above will be interested in obtaining detailed data in their specific areas so that they can analyse the data gathered and optimise relevant building systems according to best practices. Defining metrics and outcome-based KPIs for tracking, i.e. outcome-based measurements, will help to clarify the data flow, technical requirements and reporting or data visualisation to fulfil their respective work scope.

Building Owners and FM Managers can refer to guides listed in [2], [3] and [4] of **References** that will provide details on specifying operational requirements aligned with an outcome-based procurement approach for energy performance contracting, security and cleaning services.

**Integrated Facilities Management (IFM) Contract**

Building Owners and FM Managers can explore areas where greater economies of scale can be achieved by aggregating their demand within a building and/or across a portfolio of buildings through an Integrated FM (IFM) contract. IFM, together with a longer outcome-based contract term, will allow FMCs and Service/ Solution Providers greater payback certainty and flexibility to explore innovative smart FM solutions (e.g. IoT, integrated command centre, digital twin modelling, multi-functional FM robots) that enable on-demand and more optimal deployment of resources to meet the desired outcomes. Such integration of manpower, technology and processes enables FM service delivery to be optimised, leading to better service, at lower costs in the longer term.
What Should Building Owners and FM Managers Consider in Step 4:

- What are the outcome-based measurement, incentives and penalty for each FMC or Service/ Solution Provider?
- Can I work together with the FMCs or Service/ Solution Providers to adopt a longer contract term?
- Can the FMCs or Service/ Solution Providers optimise delivery of their services and solutions if I aggregate demand across my portfolio of buildings?
- What system or technical requirements should I take note of and incorporate within the procurement contract?
- Have my technical specifications for the smart FM solutions taken into consideration the various stakeholders’ requirements?
- Can I aggregate demand within a building and/or across my portfolio of buildings through an Integrated FM contract?
Step 5: Track Outcomes and Review for Continuous Improvement

After the procurement and implementation of the smart FM solutions, it is essential for the Building Owners and FM Managers to monitor and review the smart FM solutions adopted for continual improvement. It is also recommended that they re-examine Steps 1 to 4 to explore areas for further improvement.

Review Adopted Solutions

This last step will help Building Owners and FM Managers to evaluate if the adopted solutions are able to address the business objectives and smart FM outcomes identified earlier. It may also surface areas for improvement that can be taken into consideration when adopting other smart FM solutions in the future.

Table 5 below shows how Building Owners and FM Managers can tabulate their findings to ascertain if the adopted smart FM solutions have met their business objectives and desired FM outcomes.

<table>
<thead>
<tr>
<th>Top 3 Business Objectives</th>
<th>Check Point</th>
<th>Desired FM Outcomes and Corresponding KPIs</th>
<th>Evaluate Adopted Solutions</th>
<th>Recommended Areas for Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>E.g. Desired Outcomes and KPIs Achieved?</td>
<td>E.g. To reduce energy cost by 10% by 2022</td>
<td>E.g. Increase user satisfaction on general area cleanliness and reduce complaints by 20%</td>
<td></td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>Are the smart FM solutions adopted effective?</td>
<td>E.g. Increase internal FM staff productivity due to headcount freeze and ageing workforce Increase productivity by 15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productivity</td>
<td>Which area can be improved?</td>
<td>E.g. Increase productivity by 15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>How can it be improved?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Sample table to review if the adopted solutions have addressed desired FM outcomes

Explore Further Opportunities

After the review, Building Owners and FM Managers can continue to explore further opportunities. This can be done by re-visiting:
• Step 1 – To verify if business objectives, desired FM outcomes and FM service priorities have changed;
• Step 2 – To check if new and emerging smart FM technology solutions in the market can help provide better service; and
• Step 3 – To evaluate if a different implementation model(s) should be adopted; and whether the system and technical requirements to be specified in the procurement contracts needs to be enhanced.
• Step 4 – To review and better define the outcome-based measurements that can help improve the service quality of the FMCs or Service/ Solution Providers.

What Should Building Owners and FM Managers Consider in Step 5:

• Has the adopted smart FM technology solution been well implemented and integrated within my existing FM processes and systems?
• Has it addressed the business objectives and desired FM outcomes earlier identified in Step 1?
• What are the tangible benefits and issues of each adopted solution?
• Are there areas for improvement that can be taken into consideration when adopting other smart FM solutions in the future?
• Have the business objectives, desired FM outcomes and high-priority FM services changed?
• Are there new technology solutions in the market that can span across various FM services and better meet my needs?
• Do the high-priority FM services need to be changed to other types of “smartness”?
• Do I need to review and change the outcome-based measurements to better meet the needs/ requirements of various stakeholders?
Chapter 3. Building Up Infrastructure for Smart FM

The cost of Smart FM can be significantly reduced if the necessary supporting infrastructure was designed to be “smart ready” from day one.

A smart FM infrastructure can include data interfaces and encompass features like energy metering points on all pieces of equipment including, but not limited to, electrical switchgear and distribution, primary water distribution, HVAC systems, vertical transport, and irrigation systems. To develop these infrastructures in existing buildings may be more challenging, but it is still possible to progressively build up such infrastructure for smart FM. It could be incorporated in tandem with building system replacements and retrofits.

Key considerations that Building Owners and FM Managers may take into account when building up their Smart FM infrastructure include:

a) Adoption of BACnet or Modbus protocol for the network backbone of the Building Management System (BMS), so that standard compliant controllers and equipment can be easily added to the building network.

b) Adherence to corporate IT governance and adoption of vendors’ best practices to manage network security.

c) Adoption of a common and consistent naming convention for BMS data points (technically known as ‘data normalisation’). The BMS should be able to provide automated and scheduled export of a set of any chosen data points to commonly used file formats, e.g. CSV or XLS. This will enable the exchange of data between systems, e.g. to allow such data to be crunched by analytics or optimisation software.
   • A useful reference is Project Haystack, an open source data tagging methodology adopted by the building automation industry.

d) Use of Power-over-Ethernet and wireless technology to facilitate sensor deployment for the collection of data on temperature, humidity, occupancy, ambient light, CO₂, etc. These devices communicate with a gateway that streams data into a backend server.
e) Installation of sub-meters for various energy loads and areas to facilitate energy audits and identify maintenance needs and targets to reduce energy use.

f) Provision of adequate documentation comprising of the following to ensure operational continuity from design to maintenance:

- Written description of all the systems’ operation and control actions to meet the functional requirements of the system, including control strategy and logic diagrams,
- Integration test results of air and hydronic systems,
- Networking schematic of the BMS network, showing device locations and network addresses,
- Description of BMS point list including user adjustable points, hard and derived points, and their respective controller and register addresses, and
- Instruction manuals and training guides.

Some of these has already been incorporated into the “Smart Building Operation” section of the Green Mark Criteria for New Non-residential Buildings 2015 (GM NRB:2015) and the Green Mark Criteria for Existing Non-residential Buildings (GM ENRB:2017) – see [1] of References.

The Info-communications Media Development Authority (IMDA) had also developed and released the Internet of Things (IoT) Cyber Security Guide for public consultation on 25 January 2019. It is expected to be launched by end of 2019 and with the aim to provide guidance to users and enterprises when procuring, deploying and operating IoT devices/systems, while enabling FMCs and Service/ Solution Providers to verify the security posture of their solutions. It provides practical guidelines that include baseline recommendations, foundational concepts and checklists. Building Owners, FM Managers, FMCs and Service/ Solution Providers can take reference to it to implement and operate IoT devices/systems securely.

Besides having the right infrastructure for Smart FM to be deployed successfully, Building Owner and FM managers should also look at the possibilities and
opportunities that other emerging technologies such as 5G, robotics, edge computing, cloud technologies, and digital platform\textsuperscript{7} can bring for the organisation.

Take digital platforms as an example. There has been recognition that digital platforms and the ecosystems surrounding them will become the foundation for the next major stage of technology and economic disruption. With data flows and digital platforms, the digital economy opens up tremendous opportunities for new growth areas. Businesses can increasingly dictate how products and services are designed and delivered around their needs, resulting in the formation of new business ecosystems and market intermediaries. Building owners are strongly encouraged to innovate and evolve their business models in order to achieve scalability and staying competitive in the global marketplace.

Another example would be 5G\textsuperscript{8} technology, which is globally acknowledged to be the next big leap in mobile and wireless communications. It is widely touted to enable the development of new business models and advanced applications, fostering business innovation and spurring economic growth. Communities, businesses and industries are expected to benefit from the transformative impact that 5G enables.

Apart from the above, Building Owners are recommended to plan for the training and/or skills upgrading of their internal FM Team, especially in the areas of technologies e.g. IoT, immersive media, data analytics etc. The proper operation of the technology devices and systems installed, as well as management of the data collected, will allow the FM Team to make timely and informed decisions thereby enhancing their service quality.

\textsuperscript{7} Digital platforms create value by facilitating exchanges between two or more interdependent groups. Typically, such platforms aggregate ecosystems of end-users and producers (demand and supply) to transact with each other through technology. (Reference: https://www2.imda.gov.sg/programme-listing/digital-platforms)

\textsuperscript{8} 5G Innovation - https://www2.imda.gov.sg/programme-listing/5G-Innovation
Chapter 4. Use Cases

4.1 J-Ops Command Centre, JTC Corporation (JTC)

Overview

JTC is the lead agency to spearhead the planning and development of industrial infrastructure in Singapore. Over the years, JTC has developed over 7,000 hectares of industrial and 4 million m² of ready-built facilities. With a growing portfolio of properties, JTC embarked on developing the J-Ops Command Centre to address changes in the FM landscape and to seek sustainable and effective solutions for better manpower and resource deployment.

JTC’s J-Ops Command Centre is one of the first integrated building and estate operations command centres in Singapore. It houses multiple smart FM systems with functions such as workflow automation (Type 1), building optimisation (Type 2) and estate monitoring (Type 2). These systems allow JTC to remotely monitor and manage FM operations for most of its developments and estates across the island.

With the J-Ops Command Centre, FM Managers from JTC are able to pull data from more than 180,000 data-points connected to 39 of its buildings, to analyse and achieve improvements in tenant comfort, reduction in energy leakages, and efficiencies in resource deployment. Buildings under the J-Ops Command Centre are expected to generate 15% improvement in productivity and energy savings.

JTC’s FM transformation journey is summarised below based on the 5-step SMART process:

Step 1: Set Business Objectives and Outcomes

The management of JTC’s growing portfolio of facilities at such an extensive scale has given JTC the oversight to identify and pinpoint the following key challenges that needs to be addressed at the higher level:

i. Growing and ageing pool of buildings and infrastructure
ii. Rising operating and energy costs  
iii. Manpower constraints  
iv. Laborious vendor management across large number of contracts and services  
v. Increasing customer expectations on level of service delivery  
vi. Need for better access to data and communication between different building management systems (BMS)

To address these challenges, JTC identified and set the following business objectives, FM outcomes and high-priority FM services to focus on:

**Step 2: Map Out Smart FM Solutions as Enablers**

The J-Ops Command Centre was conceptualised with these challenges and business objectives in mind. Further to selecting the high-priority FM services, JTC proceeded to identify smart solutions for each FM services that can meet the business objectives and desired FM outcomes.

*Table 5* below maps out the smart solutions identified by JTC under the Smart FM Framework. These smart solutions were subsequently implemented under the J-Ops Command Centre.
Table 4. JTC’s Smart FM Framework

Facilities & Estate Management System (FEMS) (Type 1)

JTC adopted the FEMS, an automated workflow system, that digitised all FM-related work orders. This helped the FM Managers automate their existing work processes and enhance the efficiency of their service delivery.

Feedback provided by customers and tenants on facility faults and issues are first documented and tracked in the system, before being routed to the respective FM Managers and/or technicians to resolve.

Estate Monitoring System (Type 1)

The J-Ops Command Centre houses an Integrated Estate Monitoring System that pulls video feeds from closed circuit televisions (CCTVs) deployed at more than half of JTC’s estates and developments.

The system has integrated customised video analytics to bring potential security occurrences to the attention of the Security Team. Required response and checks on the ground can then be activated quickly.

Lift Monitoring System (Type 1)

The J-Ops Command Centre includes a Lift Monitoring System that uses non-intrusive sensors on existing lifts to monitor real-time and historical utilisation data as well as abnormal behaviors, and track maintenance activities.
**Smart Bins (Type 1)**

JTC also deployed over 40 Smart Bins across its estates and developments. These smart bins are solar-powered, cloud-connected and self-compacting to eliminate bin overflows.

The system dashboard can be accessed from the J-Ops Command Centre to understand waste patterns, optimise collection routines and improve manpower productivity and deployment.

**Building Optimisation System (Type 2)**

Last but not least, the Building Optimisation System (BOS) is a cloud-based system that allows JTC to centrally and remotely monitor, analyse and optimise the performance of their portfolio of buildings.

The BOS collects real-time operating data, across 39 JTC buildings, from different equipment within building sub-systems such as Air Conditioning and Mechanical Ventilation, Electrical, Fire Protection, Lifts and Pumps systems. The system has analytical and diagnostic capabilities to help JTC’s FM Managers detect and rectify inefficiencies.

![Figure 8. J-Ops Command Centre’s Building Optimisation System](image)

**Step 3: Adopt Suitable Implementation Model**

After identifying the smart solutions, JTC moved on to select a suitable implementation model for each solution (see Figure 9). Based on JTC’s experience, some useful pointers to note when doing so include:
i. For solutions with larger scale and scope, implementation model A may be considered for economies of scale.

ii. For ad-hoc services, implementation model B may be considered for ease of implementation.

iii. If there is/are Managing Agent(s) involved, implementation model A may not be suitable as the implementation process may be hindered with too many parties involved.

It is important to reiterate that none of the implementation models are superior to another. The type of implementation model to adopt depends on the individual organisation or building’s mode of operation.

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**Implementation Model A – Integrated Smart FM Solution**

Acquired & Operated by Building Owner

Solution as a Service via FMC

Example:
1. Facilities & Estate Management System
2. Automated Workflow System
3. Building Optimisation System

Example:
1. Drone for FM operations
2. Work Dispatch System

**Implementation Model B – Single Smart FM Solution**

Example:
1. Smart Bins
2. Integrated Toilet Management Solution
3. Lift Monitoring System

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**Figure 9. Implementation models adopted by JTC for various smart FM solutions**

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**Step 4: Review Procurement Contract**

Almost all of JTC’s properties undertake the integrated FM contracting. Through the amalgamation of FM contracts, JTC reduced the number of service contracts by 42%. The increase in scale and value of the contract, as well as longer contract period, also

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made economic sense for JTC’s service partners to invest in manpower development and adopt suitable building technologies.

Figure 11 below summaries the considerations JTC had when reviewing their procurement contracts.

**Figure 10. JTC’s Considerations for Procurement Contracts**

**Step 5: Track Outcomes and Review for Continuous Improvement**

For continuous improvement, JTC tracked and reviewed each of the smart FM solutions implemented. The benefits of undergoing the FM transformation change in their operations include:

*Improved Effectiveness of FM Services with Centralised Monitoring and Management*

By consolidating the monitoring and management of their multiple FM operations, estates and developments at the J-Ops Command Centre, JTC is able to optimise their resources, improve their FM Team’s knowledge base and streamline various coordination and organisation processes. This increased the FM Team’s productivity by an estimated 15%.

The integration of multiple brands of BMS into an open and organised communication protocol, and with standardised naming conventions for the BMS data points, has also
reduced confusion and eased the overall monitoring of building performance across JTC’s portfolio of buildings.

*Ease of Access to Comprehensive Database to Carry Out Data Analytics*

Data from connected buildings across the island are stored and organised in a cloud storage. With a comprehensive database that is easily accessible, JTC can carry out data analysis on different areas to provide better insights for improvements in current FM operations and the design of future buildings.

*Enhanced Service Delivery with Pre-emptive Maintenance and Improved Response Time*

The intelligent fault detection systems ensure problems are detected before they escalate, resulting in fewer equipment breakdowns. The Automated Workflow System has also improved process efficiency and shortened response and rectification time. This not only enhanced user experience and reduced feedback from them, it also allowed JTC to save up to 15% in energy cost with the buildings constantly performing at an optimal state.

*Key Lessons Learnt*

The following design specifications should be considered for future projects to facilitate the adoption of Smart FM:

*Standardised Naming Convention to Enable Monitoring and Management Across Portfolio of Buildings*

With many of their BMS using different naming conventions and some with closed communication protocols, JTC had to spend additional time and effort to standardise the naming convention and clean up the data points across all the buildings managed by the J-Ops Command Centre. Only then can these buildings be effectively linked back to the Building Optimisation System. A standardised naming convention will allow the FM Managers to better troubleshoot issues and increase productivity.

*Interoperability Between Systems to Facilitate Data Transfer and Systems Integration*
With multiple systems housed under the J-Ops Command Centre, JTC had to ensure that all the systems are designed with an open communication protocol and the data can be pushed and aggregated in a cloud storage. The systems should also allow for 3rd Party Application Programming Interface (API) connections. By doing so, data transfer between systems can be made possible and facilitate the future integration of different systems if there are synergistic gains.
4.2 MyInfra FM App, Yale-NUS College

Overview

 Constructed in 2015, Yale-NUS College is a 63,000 m² campus where students live in, and become active members of, three residential colleges during their four years of study. The campus facilities are managed by its Infrastructure, Safety & Security Office.

The Office oversees more than 30 term contractors ranging from hard FM services to soft FM and custodial services. On average, the Office receives 6,000 items of feedback a year from the Yale-NUS community, comprising students, faculty and staff. The feedback ranges from requests to provide event support to reports on technical issues such as choked toilets or fused lightbulbs.

To streamline and optimise their incident reporting and closure process, the Office developed the MyInfra App, a Type 1 FM workflow management mobile application that covers different FM services (see Table 6 below).
<table>
<thead>
<tr>
<th>Type</th>
<th>Scope</th>
<th>Description</th>
<th>FM Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Digitalised Workflow</td>
<td>When triggered, by human/ sensor, automatically initiates a process that track, log and close the incident</td>
<td>M&amp;E Functions</td>
</tr>
</tbody>
</table>

Table 5. Yale-NUS College’s Smart FM Framework

Yale-NUS is the first organisation in Singapore to attain the ISO 41001:2018 certification on Facility Management Systems.

**Challenges Faced**

With an average of 6,000 items of feedback received a year, and more than 30 term contractors to manage, the Office faced several challenges in administering their FM workflow and service delivery:

**Difficulties in Incident Tracking with Multiple User Touchpoints**

The Yale-NUS community used various communication channels, such as emails and phone calls, to contact the Officers-In-Charge (OICs) to request for assistance and/or report issues.

The OICs then took action on the cases by getting their term contractors to assist with and/or rectify the issues. Close monitoring of incidents was challenging as there was no central management of incidents and progress. It was also difficult for the FM Team to follow up when the OICs went on leave.

**Long Turnaround Time with Inefficient Workflow Processes**

In order to manage and oversee the various term contractors, communication and information flow relied heavily on time-consuming sequential workflow processes that required extensive manual data entry. This resulted in long turnaround times to resolve issues and close incidents.

Up till June 2016, the average turnaround time to resolve a feedback on technical issue was 17 days and the median time taken to close cases was 13.5 days.
Technology Solution Undertaken

With a sizeable database of feedback collated over time and an FM Team which had developed a better understanding on the needs of the college community, the Office saw that it was an opportune time to embrace Smart FM technologies.

The Office decided on a Type 1 solution on workflow automation to meet its business objectives and desired outcomes. The Office opted for a customised system instead of an off-the-shelf solution as it needed ownership of the system. This led to the creation of the “MyInfra” snap-and-send FM mobile application.

One of the key features of the MyInfra FM App is its ability to direct feedback automatically to the respective OICs through a single point operator. Through analysing existing records, frequently reported issues were streamlined into common categories such as “Plumbing” and “Lighting”. These categories are displayed as shortcuts in the mobile app (as shown in Figure 11 below) for users to readily tap and send their feedback or report an issue to the respective OICs directly.

![Figure 11. Yale-NUS College’s MyInfra FM App](image-url)
The App allows users to take photos of the reported issue and input the location and other details to aid the OICs and term contractors in taking action (see Figure 11 above). The OICs are able to communicate with the users through the App to book appointments to gain access to their apartments if required. The respective OICs will then assign the term contractor to address the issue.

The App also allows users to track the progress of their feedback. Once the issue is resolved, the contractor will update the status and take a photo evidence of the completed work. All communication between the OICs and users are made through the App. As all the conversations are time stamped, when a feedback is not followed up within a stipulated duration, the Office’s FM Manager is notified automatically and can intervene if necessary.

**Benefits of Smart FM Deployment**

*Reduced Turnaround Time with Streamlined Workflow Process*

*Figure 12* below illustrates the Office’s streamlined workflow process following the deployment of Smart FM technologies. By eliminating ineffective layers and duplicated efforts in the work processes and adopting of the MyInfra FM App, the FM Team and its contractors’ average turnaround time and median time taken to close cases improved from 17 days to less than one day.

*Figure 12. Streamlined FM work process adopted by Yale-NUS College’s Infrastructure, Safety & Security Office*
Ease of Incident Reporting and Tracking with Single Point Operator

With the MyInfra FM App functioning as an automated single point operator, incident reporting and tracking can be done easily.

The App serves as a common platform for all stakeholders to have access and provide real time updates, ensuring that information is accurate and up to date. With all reported cases being logged and tracked systematically, including the record of objective evidence on completion of works, the App provides transparency and accountability to all stakeholders.

The Office and its FM Team can also have greater visibility of the overall incident management process and progress for each case. Outstanding cases can be flagged and dealt with quickly.

Improved User Engagement and Satisfaction

Besides reducing the turnaround time, the MyInfra FM App serves as an easy to use feedback platform which allows the users to monitor the status of their feedback and receive progressive updates until the case is closed. This improves the engagement with users and brings about a better overall experience and user satisfaction.

Key Lessons Learnt

The following learning points are highlighted by the Office and its FM Team for consideration when embarking on similar smart FM technology solutions in the future:

Review and Streamline Workflow Processes Before Development of App to Optimise Its Use and Benefits

While the App could be designed to fit their existing work processes, the Office and its FM Team recognised that it was important to review and streamline their workflow processes before developing the app. This allows the full benefits of the App to be realised.
After embarking on a deliberate review of their FM workflow processes to increase efficiency, the average turnaround time to resolve a feedback on technical issue per month and the median time taken to close cases was 14 days and four days respectively. The App then reduced both further, to less than one day.

**Use of Customised System In View of Specific Needs and Data Ownership**

Having re-engineered their work processes, the Office and its FM Team selected a customised system for the MyInfra FM App to better suit their needs. With ownership of the system, minor modifications can be made to the App when necessary. It also ensures that the Office owns the data collected through the App, which can be readily extracted for analysis to aid the Office and its FM Team in further optimising their FM processes and operations.

**Implement Trial Deployment Period to Solicit User Feedback and Fine-Tune System Prior to Full Implementation**

One of the challenges the Office faced was developing an interface that fits all mobile devices, screen sizes, and the different iOS and Android versions.

To mitigate this, the Office released a beta version in 2018 for a select group of students to seek their feedback. The system was fine-tuned accordingly to resolve any compatibility and teething issues. The MyInfra FM App was subsequently launched to the Yale-NUS community in January 2019, and was well-received by students.
Chapter 5. Conclusion

This Guide to Smart FM aims to help Building Owners and FM Managers articulate and realise their desired Smart FM outcomes. It has shared on core principles of the Smart FM Framework and provided a 5-Step SMART Process to help the Building Owners and FM Managers in identifying their business objectives, smart FM outcomes and prioritising key FM services for the adoption of suitable technology solutions.

In view of our aging workforce and manpower constraints, the current ways of managing building facilities have to change. Planning and adoption of smart FM solutions will help Building Owners and FM Managers to meet these challenges and future-proof their assets. Going forward, smart FM will play a key role in the drive towards Integrated Digital Delivery, especially in the area of digital asset delivery and management. With relevant training and skills upgrading, the existing FM Team can value-add to their existing job scope and be ready for this digital wave.

The table below summarises the key questions Building Owners and FM Managers should ask and consider when going through each of the 5-step SMART Process.

Appendix D: Decision Template for 5-Step SMART Process has also been designed to guide Building Owners and FM Managers through this process as they embark upon their smart FM transformation journey.

<table>
<thead>
<tr>
<th>5-step SMART Process</th>
<th>What Should Building Owners and FM Managers Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>• What are my top 3 business objectives?</td>
</tr>
<tr>
<td>Set business objectives and outcomes</td>
<td>• What do I want to achieve and set as my desired FM outcomes, based on my business objectives and issues faced?</td>
</tr>
<tr>
<td></td>
<td>• What corresponding KPIs can I set to monitor the progress of my desired FM outcomes?</td>
</tr>
<tr>
<td></td>
<td>• Which FM services should I prioritise to address the desired FM outcomes?</td>
</tr>
</tbody>
</table>
## 5-step SMART Process

<table>
<thead>
<tr>
<th>What Should Building Owners and FM Managers Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Can I streamline my current FM processes and procurement framework to meet the identified business objectives and desired FM outcomes?</td>
</tr>
</tbody>
</table>

**Tool to use**

Table 1: Template to rank business objectives, set desired FM outcomes, and determine high-priority FM services to focus on

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### Step 2

**Map out smart FM Solutions as enablers**

<table>
<thead>
<tr>
<th>What Should Building Owners and FM Managers Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>- What type of “smartness” (Type 1, Type 2, or Type 3) is each high-priority FM service currently at?</td>
</tr>
<tr>
<td>- What type of “smartness” do I want to achieve for each high-priority FM service? Is it aligned with my business objectives and desired FM outcomes?</td>
</tr>
<tr>
<td>- What are my pain points and gain points for each high-priority FM service?</td>
</tr>
<tr>
<td>- Do the technology solutions proposed by the FMCs and Service/ Solution Providers fit the requirements to achieve my desired FM outcomes?</td>
</tr>
<tr>
<td>- How would I like to engage the building occupants and visitors?</td>
</tr>
<tr>
<td>- Are there FM services that could be integrated to provide multi-functional and enhanced outcomes, e.g. connected lighting systems?</td>
</tr>
<tr>
<td>- Are there areas where aggregation can be done to achieve economies of scale – at demand and/or supply side?</td>
</tr>
<tr>
<td>- Is it advantageous to aggregate demand across a portfolio of buildings?</td>
</tr>
</tbody>
</table>

**Tool to use**

Table 2: Smart FM Framework
<table>
<thead>
<tr>
<th>5-step SMART Process</th>
<th>What Should Building Owners and FM Managers Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>References</strong></td>
<td>• <em>Appendix A: List of Smart FM Point Solutions</em></td>
</tr>
<tr>
<td></td>
<td>• <em>Appendix B: Facilities Management Consortium</em></td>
</tr>
<tr>
<td></td>
<td><em>Operation &amp; Technology Roadmap (COTR)</em></td>
</tr>
</tbody>
</table>

| Step 3              | What is my current working model for existing FM processes and services? |
|                     | How would I like to work with my FMCs or Service/Solution Providers?   |
|                     | Which implementation model is more viable at this point to incorporate the various technology solutions identified in Step 2? Or would phased adoption or a variation or hybrid of the implementation models be more applicable? |
|                     | Does the selected implementation model meet my business objectives, operational priorities and desired FM outcomes? |
|                     | Do I own all the data, regardless of the type of implementation models selected? |
|                     | Are the system and/or technical requirements specified within my procurement contracts adequate? |

|                     | • *Appendix C: Integrated FM System (iFMS)*            |

<p>| Step 4              | What system or technical requirements should I take note of and incorporate within the procurement contract? |</p>
<table>
<thead>
<tr>
<th>5-step SMART Process</th>
<th>What Should Building Owners and FM Managers Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Have my technical specifications for the smart FM solutions taken into consideration the various stakeholders’ requirements?</td>
</tr>
<tr>
<td></td>
<td>• Does my organisation’s procurement framework enable an outcome-based contract?</td>
</tr>
<tr>
<td></td>
<td>• What are the outcome-based measurement, incentives and penalty for each FMC or Service/ Solution Provider?</td>
</tr>
<tr>
<td></td>
<td>• Can I work together with the FMCs or Service/ Solution Providers to adopt a longer contract term?</td>
</tr>
<tr>
<td></td>
<td>• Can the FMCs or Service/ Solution Providers optimise delivery of their services and solutions if I aggregate demand across my portfolio of buildings?</td>
</tr>
<tr>
<td></td>
<td>• Can I aggregate demand within a building and/or across my portfolio of buildings through an Integrated FM contract?</td>
</tr>
<tr>
<td>Step 5</td>
<td>Has the adopted smart FM technology solution been well implemented and integrated within my existing FM processes and systems?</td>
</tr>
<tr>
<td>Track outcomes and review for continuous improvement</td>
<td>• Has it addressed the business objectives and desired FM outcomes earlier identified in Step 1?</td>
</tr>
<tr>
<td></td>
<td>• What are the tangible benefits and issues of each adopted solution?</td>
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<tr>
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<td>• Are there areas for improvement that can be taken into consideration when adopting other smart FM solutions in the future?</td>
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<td>• Have the business objectives, desired FM outcomes and high-priority FM services changed?</td>
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<td>• Are there new technology solutions in the market that can span across various FM services and better meet my needs?</td>
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<td>5-step SMART Process</td>
<td>What Should Building Owners and FM Managers Consider</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>- Do the high-priority FM services need to be changed to other types of “smartness”?</td>
</tr>
<tr>
<td></td>
<td>- Do I need to review and change the outcome-based measurements to better meet the needs/requirements of various stakeholders?</td>
</tr>
</tbody>
</table>

Table 6. The 5-step SMART process – summary of what Building Owners and FM Managers should consider
References


[5] Welcome to the IoT era, Findings and insight from IFMA and JLL’s Internet of Things (IoT) research by IFMA and JLL

[6] A guide to outcome-based agreements – a better way to do business by Interllect’s Outcome-Based Agreement Group
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Table 6. The 5-step SMART process – summary of what Building Owners and FM Managers should consider
Appendix A: List of Smart FM Point Solutions

The market for smart FM technology solutions is maturing and the product range is comprehensive and ever-growing. Examples of smart FM solutions include IoT, data analytics and artificial intelligence, to pre-empt fault, optimise energy and manpower use, or enhance occupants’ experience and the FM Team’s ability to measure and meet desired outcomes.

To lower the technical hurdle and cost barrier, most FMCs or Service/ Solution Providers offer a cloud-hosted option on a subscription basis.

The cost of Smart FM can be significantly reduced if the necessary supporting infrastructure was designed for “smart” from day one within the base building systems. Nevertheless, it is still possible to progressively build up the supporting infrastructure for smart FM. Building Owners and FM Managers can explore various point solutions such as those listed below to address specific FM pain points related to infrastructure and common services.

The list is non-exhaustive; omitted are commercial systems such as retail signage, payment systems; and familiar technologies like the building automation system (BAS) and non-routine specialist activities like façade inspection.

M&E Services

1. Condition Monitoring of Chillers, Pumps, Lifts etc
2. Energy Performance Contract
3. Air-con as a Service
4. Fault Detection and Diagnostic

Security

5. Video Surveillance and Analytics
6. Visitor Management
7. Location Tracking
Environment Services

8. Smart Toilet System
9. Rodent Management System
10. Robotic Floor Cleaner

Converged Services

11. Multi-functional Robots
12. Connected Light System
13. Room and Space Management, Hot-desk
14. Emerging Services
15. Demand Response Program
16. Advanced Robot for Façade Cleaning
Appendix B: Facilities Management Consortium Operation & Technology Roadmap (COTR)

To build a future-ready FM sector as part of the Built Environment Cluster – Real Estate Industry Transformation Map (ITM), the Singapore International Facility Management Association (SIFMA) worked with the Agency for Science, Technology and Research (A*STAR), supported by the Building and Construction Authority (BCA) and Info-communications Media Development Authority (IMDA), to develop a Consortium Operation and Technology Roadmap (COTR) for the sector.

Aligned to the ITM, the COTR aims to outline the general trends and direction of the FM sector, map out technology solutions and prioritise them according to the needs of the sector from 2018 to 2027. The COTR serves as a useful reference to translate some of the identified areas, from short to long term, into actionable outcomes for the sector.

More than 100 people from 50 organisations across the industry, academia, and government agencies participated in the 3 facilitated workshops and mapped out over 50 technology solutions under the COTR.

The COTR report is expected to be released in October 2019, and more information can be found in the SIFMA website at [https://www.wgs1.net/ifma-sg/](https://www.wgs1.net/ifma-sg/).
Appendix C: Integrated FM System (iFMS)

The reality is that the vast stock of existing buildings has heterogeneous FM sub-systems, possibly including some of those point solution listed in Appendix A: List of Smart FM Point Solutions.

Even for a new building, the FM operational model is uncertain at the initial design and development phases. There is nonetheless a pressing business desire to:

- Exploit market capability and knowledge to innovate and value-add any FM service;
- Deliver and share coherent information to enable robust decision making and performance/contract management, and to facilitate aggregation of FM service demand or delivery; and
- Develop and apply common standards to enable benchmarking and consistency of data, so that the building can be manage more strategically as a business asset.

This may be regarded as a form of progression from disparate point solutions towards an integrated environment as shown in Figure 13 below:

This Guide proposes a distributed architecture that unify helpdesk, asset management and performance measurement with lightweight data interfaces from smart FM.
systems – Integrated FM System (iFMS) (see Figure 14 below). It is also called variedly as Integrated Helpdesk & Computer-Aided Facility Management (CAFM) System, or Computerised Maintenance Management System (CMMS). This Guide will use the term iFMS.

Figure 14. An iFMS, interoperating with other building systems and IT systems, and interacting with FM staff, occupants and FM service suppliers

Figure 14 above depicts a set of connected smart FM and IT sub-systems and stakeholders (FM staff, service providers, occupants) that are linked through accumulating, sharing, analysing, and acting upon the collective smart building data. Such an iFMS becomes a powerful tool, enabling optimal FM performance across all metrics of FM services e.g. safety, cleaning, security, energy efficiency, utility consumption and sustainability.
The core functions of the iFMS are to:

- Provide a common platform that aggregates, normalises, and coordinates the data from the disparate smart systems,
- Automate workflow by way of helpdesk, triggers from other FM systems, work order and document management, and
- Allow reporting and dashboards of the metrics important to each class of stakeholder.

It is open at the top (via a lightweight protocol like MQTT, REST for 3rd-party systems) and at the bottom (for interacting with FMCs or Service/ Solution Providers via mobile devices) so that the best-of-breed hardware, software, FMCs or Service/ Solution Providers can be integrated to provide the most innovative and suitable solutions.

The ownership of the collected data and transparent access to them should be vested with the Building Owners and their FM Managers. Beyond accessibility, data should also be semantically consistently to be useful. This can be facilitated by adopting a naming convention such as the Project Haystack (www.project-haystack.org).
Sample Requirements

This is a sample functional specification of the iFMS. Building Owners and FM Managers may reduce, expand and modify this specification to suit their needs.

Introduction

1. The purpose of the Integrated FM System is to allow the Buyer to monitor the provision of those services delivered by the FM Supplier and to facilitate asset, building and property data and management information to enable the Buyer to make informed decisions to support capital investment, estate strategy and cost/resource optimisation.

2. FM Suppliers will work collaboratively with the iFMS to provide the required information for the iFMS to support FM service delivery. These functions may include the following:

   a) FM Suppliers, along with other Service Users may raise a Service Request via the iFMS system for any work, some of which requires approval from the Buyer.
   b) Service Request becomes a Work Order (approved if required) and FM Suppliers receive Work Orders for various FM services such as cleaning, catering, security, waste management, faults, repairs and maintenance;
   c) FM Supplier must then update the status of any Work Order through to completion, along with site visits and any issues or concerns in the iFMS system, for monitoring by the Buyer or its representative;
   d) Updates on problems and the steps being taken to effect permanent solutions;
   e) Fix times for the different severity levels of problems;
   f) Progress of all on-going capital projects and minor works; and

3. The iFMS shall provide a web-based or mobile-based Helpdesk facility, which shall be the single point of contact for all Service Users in relation to all property and FM related Service Requests.
4. The iFMS shall have the capability to provide a comprehensive and flexible **Reporting** solution to cover the functional, operational and strategic aspects of FM e.g. performance and management information reporting for both the Buyer and FM Suppliers, as well as cost and sustainability management reporting.

5. The iFMS shall automate the collection of data and has the ability to track and maintain core facilities activities including
   a) Forward Maintenance Register;
   b) Maintenance management - demand (reactive), scheduled (preventive maintenance);

6. Sustainability – energy, water and waste performance, building certifications. The iFMS system has the capability for automated Work Order lifecycle monitoring, to ensure that Work Orders are progressed from one status to another within a defined timeframe, or else timely notifications are generated to the Buyer for intervention.

7. The iFMS shall be capable to allow FM Supplier and 3rd party Suppliers to supply input into it, either via web-based direct input or via the use of lightweight data interfaces such as MQTT and REST, see para 4.1.

8. When requested by the Buyer, the iFMS Supplier shall ensure that the iFMS system has an Application Programming Interface (API), that makes it possible for application programs to interact with each other and share data. E.g. Exchanging data with Buyer’s Enterprise Resource Planning (ERP) with Building Information Modelling (BIM).

9. The Buyer shall be provided with full access to the iFMS’s asset register information to achieve transparency of FM related information for on-going audit and information purposes. The Buyer shall retain all of the rights to this information both physically and intellectually.

10. The iFMS system provides cost control functionality which has the capability to
    a) Track costs through multi-level hierarchy of budgets, contracts and projects;
b) Provide transparency of FM expenditure for example, the breakdown of the costs of works carried out, distinguish between maintenance costs, for both labour and materials.

**Help Desk Integration**

1. The iFMS Helpdesk provides the following functionality:
   a) The capture, monitoring and escalation of active requests, via a web portal;
   b) Track maintenance activity, status updates and the provision of on-screen alerts by Supplier personnel;
   c) Provide automated email notifications of Work Orders;
   d) Ensure that all Service Requests are tracked, time stamped and traceable to the Supplier’s Personnel that dealt with the activity and amended or changed details at any time;
   e) Prioritise incidents, e.g. Business Critical requests, BMS (Building Management System) alarms and asbestos alerts;
   f) User surveys such as indoor environment quality, customers’ satisfaction.

**Building Asset Management and Tracking**

1. The iFMS Asset Management and Tracking functionality shall have the capability to:

   (a) Provide various forms of information relating to Assets including Location, Warranty; and Parts and maintenance records.

   (b) Provide the ability to record Planned and Reactive Maintenance activity information to enable full visibility to the Buyer of an Assets service history;

   (c) Ensure Planned and Reactive Maintenance activity requirements generate alerts at the appropriate time to ensure maintenance is carried within the timescales as specified by the Buyer;
(d) Automatically link Assets to create preventive and predictive maintenance (PPM) schedules. The Supplier shall ensure that all assets which are scheduled for maintenance or require attention due to malfunction are identified on Work Orders with respect to type and accurate location.

(e) Identify Critical Assets to ensure work is managed within the timescales specified by the Buyer;

(f) Provide logical grouping (by department, region or locations) of assets for easy storage, retrieval and viewing; and integrate with other facilities data to provide detailed financial and ownership details;

(g) Provide an export capability of asset data to third party applications in a variety of formats such as Excel and CSV;

(h) Monitor building lifecycle costs and energy efficiency; and record all consumption and expenditure levels for all utilities at a site by site metre level.

System Integration and Data Standards

1. The data integration of the FM Supplier’s hand held devices and those of their subcontractors must be routed through the iFMS to maintain accuracy and consistency of data. The iFMS Supplier shall propose a lightweight messaging data interface, such as MQTT and REST, to enable reliable and effective data exchange in real time between the iFMS system and the FM Supplier’s systems.

2. The data fields required shall adequately support FM service delivery and performance measurement, and shall thus include:

   a) Work type
   b) Building System
   e) Anticipated End Date, Time
   f) Time to Attend
c) Task ID

d) Task Open Date, Time

g) Time for Temporary Fix

h) Actual Completion Date, Time
Appendix D: Decision Template for 5-Step SMART Process

**SET BUSINESS OBJECTIVES & OUTCOMES**

*Choose 3 only*

<table>
<thead>
<tr>
<th>Business Objective</th>
<th>Desired FM Outcome and Corresponding KPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Cost</td>
<td>e.g. To reduce operating cost by 10% by 2021</td>
</tr>
<tr>
<td>☐ Manpower (Internal/External)</td>
<td></td>
</tr>
<tr>
<td>☐ System Reliability</td>
<td></td>
</tr>
<tr>
<td>☐ Productivity</td>
<td></td>
</tr>
<tr>
<td>☐ Customer satisfaction</td>
<td></td>
</tr>
<tr>
<td>☐ Security requirements</td>
<td></td>
</tr>
<tr>
<td>☐ Others, please specify:</td>
<td></td>
</tr>
</tbody>
</table>

**MAP OUT FM SOLUTIONS AS ENABLERS**

*Identify FM solutions (e.g. Company A Solution - video analytics) to meet business objective and outcome*

*Classify FM solutions into Category 1/2/3 (type not in order of merit)*

<table>
<thead>
<tr>
<th>FM Services</th>
<th>Implementation across cluster of buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. M&amp;E Functions</td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td>e.g. Security</td>
<td></td>
</tr>
<tr>
<td>e.g. Cleaning Services</td>
<td></td>
</tr>
<tr>
<td>Others, please specify:</td>
<td></td>
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</tbody>
</table>

**ADOPT SUITABLE IMPLEMENTATION MODEL**

*Classify FM solutions into Model A/B*

<table>
<thead>
<tr>
<th>Implementation Model to Adopt</th>
<th>FM Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model A: Integrated Smart FM Solutions (Each smart FM solution feeds data into one centralised system)</td>
<td>e.g. BCA Smart Chiller Portal, Company A Solution</td>
</tr>
<tr>
<td>☐ Solution as a Service via FMC</td>
<td></td>
</tr>
<tr>
<td>☐ Acquired &amp; Operated by Building Owner</td>
<td></td>
</tr>
<tr>
<td>Model B: Single Smart FM Solutions (Multiple smart FM solutions with multiple platforms to use)</td>
<td></td>
</tr>
</tbody>
</table>

**REVIEW PROCUREMENT CONTRACT**

Integrated FM contract for all chosen FM services:

☐ Yes ☐ No, please specify FM services excluded: ________

Adopt outcome/performance based contract (recommended)

☐ Yes ☐ No

FM Services Contract Term (recommended 5 to 10 years):

☐ 3+3 ☐ 5+5 ☐ 8 ☐ Others: ________

**TRACK OUTCOMES AND REVIEW FOR CONTINUAL IMPROVEMENT**

*Sample chart to track outcome KPI*

*Repeat this step for remaining business objectives and outcomes*

Electricity Consumption (kWh)

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumption (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 0</td>
<td>7,940,000</td>
</tr>
<tr>
<td>Year 1</td>
<td>7,428,040</td>
</tr>
<tr>
<td>Year 2</td>
<td>7,818,877</td>
</tr>
<tr>
<td>Year 3</td>
<td>7,243,416</td>
</tr>
</tbody>
</table>

Status: ☐ Behind ☐ On Track ☐ Ahead

Areas for further improvement/ Proposed recommendation: ________

Any new/emerging smart FM technology: ☐ Yes ☐ No

If yes, please specify: ________
# Cost-Benefit Analysis Table

<table>
<thead>
<tr>
<th>Business Objectives and Desired FM Outcomes</th>
<th>Smart FM Solutions Adopted</th>
<th>Upfront Developmental Costs (A)</th>
<th>Recurring or Yearly Maintenance Costs (B)</th>
<th>Total Cost of Ownership/Life Cycle Cost (A+B)</th>
<th>Annual Benefit</th>
<th>Total Benefit Over Entire Life Cycle</th>
<th>Feasibility Study Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1: e.g. To reduce electricity cost by 20%</td>
<td>e.g. Chiller plant optimisation</td>
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<tr>
<td></td>
<td>e.g. Smart lighting with occupancy sensors</td>
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<tr>
<td>#2: Please specify</td>
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