FACILITY INFORMATION & TECHNOLOGY MANAGEMENT

IFMA's Facility Information Management and Technology Management Course

Student Guide

IFMA™

Acknowledgments

IFMA's professional development courses – including our world-class credential programs, the FMP®, SFP® and CFM® – are the cornerstone of our industry-leading offerings for career advancement. The contribution of IFMA volunteer members is critical to the relevance and value of our educational programs. The result of their global input is learning for facility managers, by facility managers. We would like to acknowledge the cumulative hours and expertise our members have contributed to educational content development and review, from design through delivery, with special acknowledgement to Geoff Williams as a lead contributor, ensuring that IFMA's Facility Information Management and Technology Management Course accurately reflects the body of knowledge and skills required of FMs in today's global business environment.

IFMA would like to give special thanks for being able to incorporate several elements from The Facility Manager's Guide to Information Technology: Second Edition, Version 2.1, edited by Geoff Williams and Michael May.

Geoff Williams, CFM, FMP, SFP, IFMA Fellow
Brian Dean, CFM
Jyothi Paul, CFM, FMP
David Reynolds, CFM, FMP
Hemant Sharma, CFM
Edward Williams, CFM, FMP

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Intellectual Property and Copyright Notice

Edition 2022, Version V2017PAIT_1.0

Printed on 100% post-consumer waste recycled paper

Table of Contents

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

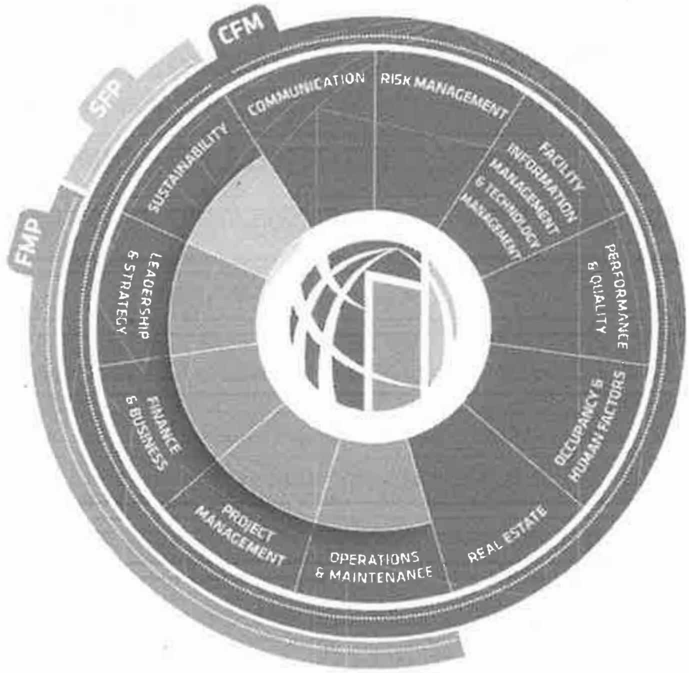
Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

IFMA Credentials

About IFMA Credentials

After analyzing the work performed by facility managers, we have defined 11 competency areas. Our three world class FM credentials, — Facility Management Professional™ (FMP®), Sustainability Facility Professional® (SFP®), and Certified Facility Manager® (CFM®) — are based on these competencies.



1. The FMP® is the foundational credential for FM professionals and industry suppliers looking to increase their depth-of-knowledge on the core FM topics deemed critical by employers.
2. The SFP® is the leading credential for all FM and like-minded professionals with an interest in the development of sustainable FM strategies.
3. The CFM® is the premier certification for experienced FM professionals. A comprehensive exam assesses knowledge, skills, and proficiency across all FM competency areas.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

IFMA's Core Competency Courses

IFMA's 11 core competency courses, developed from IFMA's Global Job Analysis (GJTA), comprise the body of knowledge for facility managers. IFMA continuously refreshes the courses to align with global industry standards for FM knowledge, skills, and tasks. The courses provide practical knowledge and examples to help you improve your performance.

IFMA's Core Competency Courses include the following:

Communication: develop the skills you need to be an effective liaison between external and internal stakeholders.

Participants will be able to:

- Create and deliver the right message for the intended result.
- Develop an FM communication plan.
- Identify and share relevant information to the appropriate audience.

Risk Management: address the role of the facility manager in supporting or leading risk management planning; emergency preparedness, response and recovery; facility resilience and business continuity.

Participants will understand how to:

- Respond appropriately to emergencies affecting the facility.
- Meet the organization's business continuity goals.

Facility Information Management and Technology Management: understand how to leverage modern tools and techniques for today's workplaces and occupants.

Participants will be able to:

- Understand secure, efficient data collection supports decision-making processes to meet core business objectives.
- Conduct technology needs assessments and anticipate the impact of new technologies.
- Understand decisions are made to keep, update, augment, or replace technology.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Occupancy and Human Factors: grow your ability to support organizational and individual occupant performance, while leading the FM team to develop and implement practices necessary to achieve success.

Participants will be able to:

- Create an environment where motivation, productivity, and retention are the norm.
- Blend safety and security with innovation.
- Negotiate service level agreements.

Real Estate: understand real estate principles and practices and how they contribute to achieving the core business strategy.

Participants will be able to:

- Develop and implement a real estate strategy to support the core business including assessing, acquiring, and disposing of real estate, and space management.
- Understand project management principles for managing new construction and other major projects.

Performance and Quality: define and make relevant what it means to capture fitness for the intended purpose, embrace a continuous improvement mindset, and satisfy stakeholders' needs.

Participants will be able to:

- Determine the needs and expectations of stakeholders for the facility and related service requirements.
- Understand and describe what comprises a comprehensive quality management system for FM.
- Measure the FM organization's performance to make continual improvements.

Sustainability: define the basics of five areas of sustainability and make relevant what it means to embrace sustainability.

Participants will be able to:

- Understand the management basics of:
  - Energy
  - Water
  - Materials and Consumables
  - Waste
  - Workplace and Site

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Welcome

Course Introduction

Welcome to IFMA's Facility Information Management and Technology Management Course!

Participant Introductions

- → Your name
- → Company name and/or job responsibilities
- → Reason(s) for taking this course — expected outcome(s)
- → Your experience in FM — years and work responsibilities over your career

Expectations

Learner responsibilities:

- → Be prepared – complete class pre-work
- → Take part in class discussions and activities
- → Follow the rules of common courtesy
- → Provide feedback to the instructor and IFMA

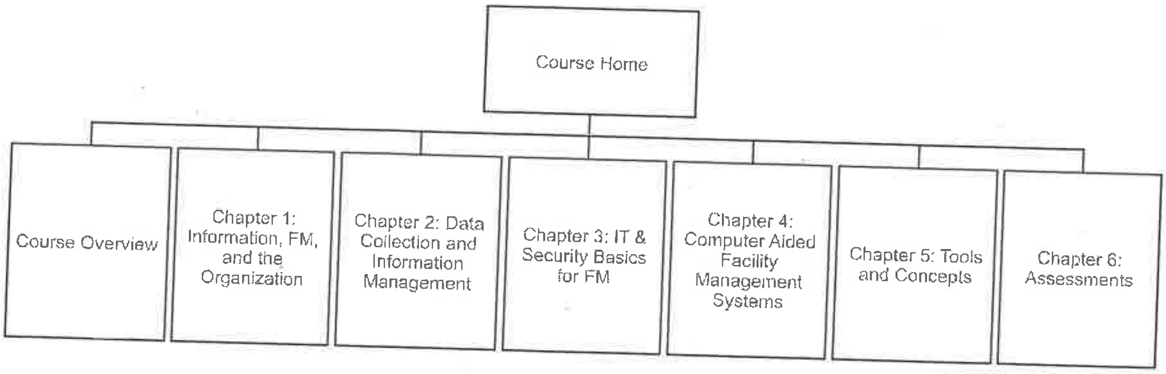
Course Audience

Welcome to IFMA's Facility Information Management and Technology Management Course! This course is designed for persons interested in developing knowledge and skills in IFMA's FM Core Competencies and who wish to gain practical knowledge to enhance FM industry professional development.

Course Chapters

There are six chapters in the Facility Information Management and Technology core course.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper



Course Goals

The goals for this course are as follows:

- Understand secure, efficient data collection supports decision-making processes to meet core business objectives
- Conduct technology needs assessments and anticipate the impact of new technologies.
- Understand decisions are made to keep, update, augment, or replace technology.

Course Overview

Information and Technology management is the inclusive overseeing of a business's Information Technology structure from a facility manager's standpoint. As explained by Aleks Shenkman, Director of Engineering, SpaceIQ:

> *"Where an IT specialist ensures the operability of networked systems, an IT facilities manager ensures facilities support those functions. In simpler terms, the IT professional wires the server rack while the IT facility manger ensures the room it is in has the proper ventilation, temperature controls and air handling."*

The FM role is one of general facility management which includes a range of IT requirements and demands which among others include:

- Working with the IT Department to support installations and assets
- Ensure that workplaces and IT assets co-exist by placing assets at their most beneficial points
- Manage the physical environment for the IT infrastructure for example:
  - Is the power source correct?
  - Is the climate correctly controlled?
  - Is the air quality monitored?

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Facility technology solutions are evolving at a rapid pace. Facility managers must analyze vast quantities of facility data and act quickly on the information to support the demand organization's core business objectives. Many of the essential tools for effective FM are digital, requiring facility managers to develop new knowledge and skillsets to be effective in their roles.

IFMA's Facility Information Management and Technology Management Course provides a starting point for facility mangers who want to start a dialogue the organization's IT function and other stakeholders and understand how to leverage modern tools and techniques for today's workplaces and occupants.

Information and Technology Competencies in FM

Outlined below are the competencies and the performance standards that a facility manager should know regarding information and technology management, data collection, protection and cyber-security, technology needs, assessments and implementation and the maintenance and upgrade of technology systems.

Given the need to collect and manage information with the use of information technology, a competent facility manager conducts data collection and information management in a manner that:

- Data is collected consistently and in a manner that results in valid, reliable data collection.
- Data has utility in decision-making processes.
- Data is collected in an efficient manner, minimizing the risks of data corruption.
- Information is maintained in a secure manner with proper safeguards in place to prohibit unauthorized access or unintended modifications.

Given the risks and threats associated with the use of information technology, a competent facility manager manages the protection of information and secures technology systems in a manner that:

- Safeguards are developed in collaboration with Security and the Information Technology functions and other stakeholders as appropriate.
- Protocols are established that specify levels of authority and rights of access to facilities information, equipment, and systems.
- Safeguards are used to control access to facilities, equipment and systems.
- Where appropriate, redundant systems are used to assure continued operations in case of a system failure.
- Where appropriate, redundant, or replacement services are immediately accessible to assure continued functioning of the technology systems.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Given that a facility and its occupants have technology needs, a competent facility manger conducts a technology assessment in a manner that:

- Advances that may reduce energy consumption, improve safety, security and business operations are identified and considered in future planning.
- Cost analyses can be done to weigh the advantages of procuring new technologies.
- The impact of new technologies on structures, utilities, interiors, exteriors, grounds, and the environment can be anticipated and planned for.
- The impact of new technologies on staffing, operations, and maintenance can be anticipated and planned for.
- Future plans can be made for how and when to best commit to technology to meet those needs.
- Changing requirements are identified.
- The impact of changing needs on current systems can be determined.
- Cost analyses can be done to weigh the tradeoffs of keeping, upgrading, replacing, adding and disposing of technology.
- The demand organization can take advantage of cost savings through current licensing and service agreements instead of entering into multiple agreements for software that performs a similar purpose.
- IT does not have to support different systems designed to perform similar activities.
- The interface and communication with other departments is automatic and that it does not require additional steps or software to retrieve, read, edit, and respond to communications.
- Implementation is conducted properly to avoid unexpected costs and financial impact.

Given the usage of technology systems, a competent facility manager maintains technology systems in a manner that:

- Business decisions in favor of keeping, upgrading, replacing, or augmenting the current technology can be made based on valid data.
- The contributions of the technology to the effectiveness of the organization can be determined.
- The reasons technology is not used, or not used appropriately, can be identified and corrective action planned.

Information and technology management is a core FM competency. This course is based on the following competencies:

- data collection and information management
- protection and cyber security

- assessments and implementations
- upgrade of technology systems

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 1: Information Technology, FM, and the Organization

Lessons

- Objectives
- Lesson 1: Using Technology to Support Organizational Strategy
- Lesson 2: Organizational Trends and Technology
- Lesson 3: Technology and Stakeholder Needs
- Lesson 4: IT and the Impact on Facility Management
- Lesson 5: IT & FM: What is the Relationship?

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Objectives

Chapter 1: Objectives

On completion of this chapter, you will be able to:

- Describe the facility manager's role in using technology to support the organization's strategic and operational goals.
- Explain how workplace trends and emerging technology affect the utilization of FM technology in the organization.
- Outline the unique technological needs of stakeholders.
- Identify recent technological trends and their impact on the FM and stakeholders.
- Determine the appropriate strategies to work with IT, as a partner and customer, to achieve organizational goals.

The facility's use of technology must be seen in the context with the organization's strategic and facility management plans. Technology is a tool that can perform certain tasks, but it should also be used as a means for aligning facility management plans to help the organization and FM achieve long-range strategic goals and objectives.

Lesson 1: Using Technology to Support Organizational Strategy

Lesson 1: Introduction

On completion of this lesson, you will be able to:

- Describe the facility manager's role in using technology to support the organization's strategic and operational goals.

Technology's Role in Meeting 21st Century Workplace and Organizational Needs

Figure 1 illustrates how emerging technology, the evolving workplace, and expectations of the FM are inter-related. Technology is critical to the facility manager's ability to meet the needs and expectations of the evolving 21st Century workplace.

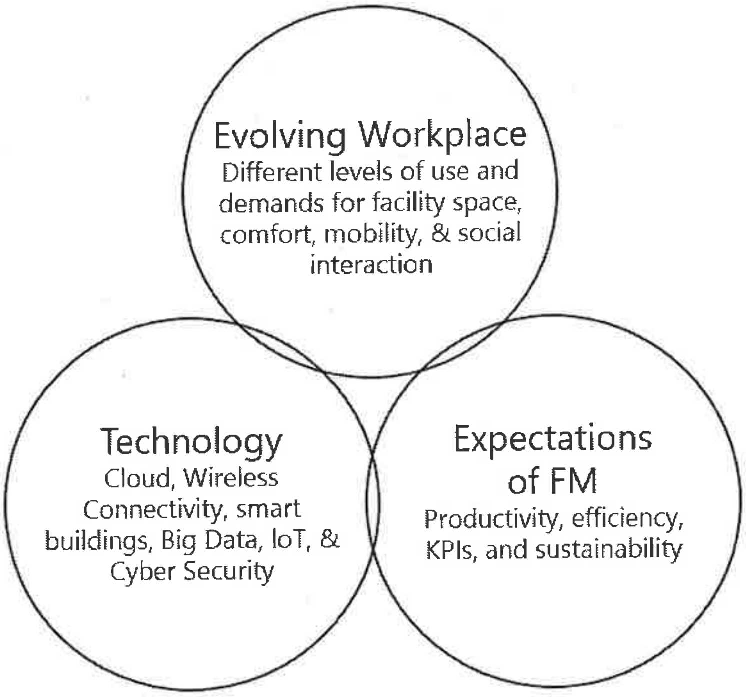


Figure 1 Emerging Technology, the Workplace, and the FM

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Expectations of FM and Technology Trends

Today's facility manager works in an era driven by big data, social media, mobility, web platforms, and smart technologies. These same technologies allow management to instantly see how organizations perform in terms of efficiency, productivity, and sustainability. For example, a technology that supports high levels of sustainable operations leads to reductions in operating cost, energy use, and the facility's impact on the environment.

Web 2.0, the Cloud, network protocols, and standardization, and connectivity have enhanced integrated workflow management and automated building control. These platforms allow the facility manager to monitor every aspect of building performance and to provide relevant data to management. The facility manager utilizes this same data to optimize facility performance and safety, decrease operating costs, improve cash flow, and develop relevant Key Performance Indicators (KPIs).

Workplace Shifts and Technology Trends

Mobility, collaborative technology and other social changes have redefined what constitutes "the workplace," and occupants expect the same flexibility and customization, whether at work or home. For example, in April 2020, COVID-19 forced an estimated 51% of U.S. employees to work remotely (Gallup, 2020). Facility managers must ensure facility technology plans includes the infrastructure to support employees regardless of whether they work in the building or remotely. In addition, the changing paradigm of work and mobility forces facility managers to re-evaluate and optimize space management.

Facility Management and Strategic Goals

The FM Strategic Planning Model (Figure 2) describes the process a well-managed organization uses to set its strategic objectives.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

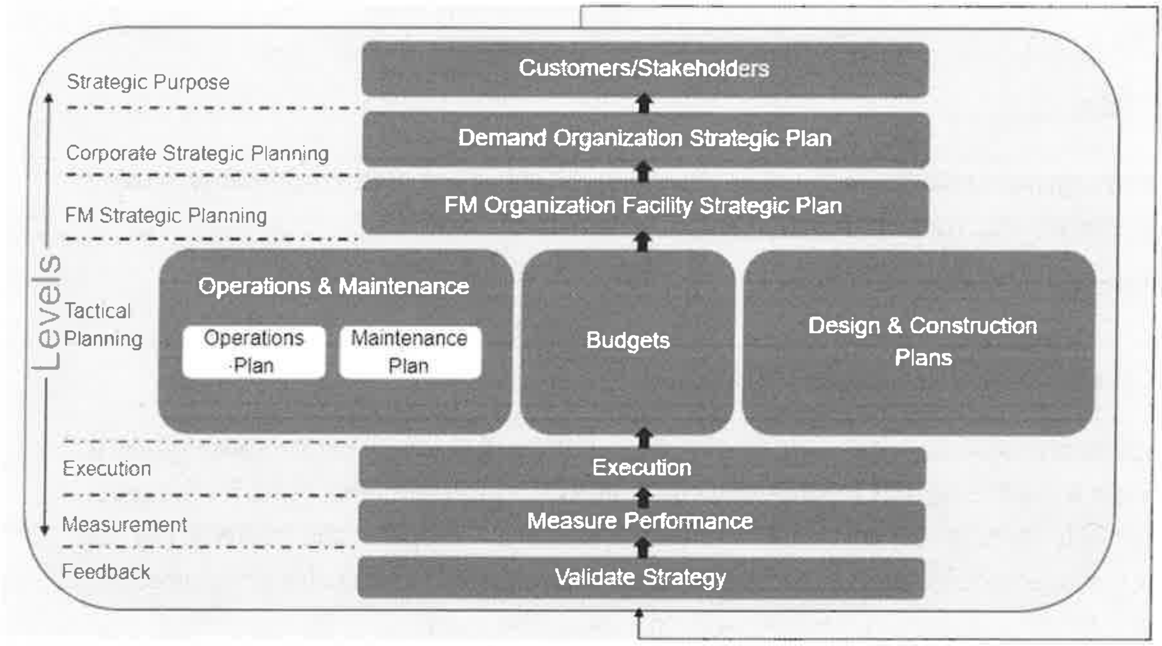


Figure 2 FM Strategic Planning Model

The model underscores the relationship between the organization's strategic plan and the facility strategic plan. Strategic plans have a direct impact on how a facility manager integrates and implements technology within a facility. The organization seeks first to understand its customers' needs and then plans a strategy to fill those needs in a way that fits the organization's mission, values and culture. Business division and departments are called upon to create their own strategic plans to support the organization's strategic objectives. Each department, including FM, must decide how it will use its resources to support and advance the organization's overall goals. Critical questions for each department include:

- Will it need to shift resources from previous areas of focus to new objectives?
- Will it need to increase productivity? How will it do this?
- Will new kinds of skilled employees be needed?
- Will current employees need new skills?
- Will new tools be needed?
- Will the department need to reorganize?

The answer to these questions helps to develop the strategic facility plan, which is composed of numerous tactical plans. Tactical plans include budgeting and staffing, operations and maintenance, capital projects and technology plans. Included are examples of how organizational strategy and technology are related and affect the FM.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Shifts in Organizational Strategy and Technology

A shift in organizational strategy creates the need for enhanced use of technology within a facility and requires coordination by FM.

Consider the following examples:

Property Management

A property management company decides that to reach its financial performance goals, it will target a specific type of tenant—organizations willing to pay higher rents for features that can help them attract and retain knowledge workers. To support this strategy, FM asks senior management to invest in technology improvements and sustainable programs for new and existing properties, possibly seeking sustainable building certification when feasible. FM will need to acquire building automation technology to optimize energy use. An integrated workplace management system (IWMS) could be used to generate reports to support certification applications. The FM organization will need to ensure that its staff is trained in using the new technology.

Healthcare Company

A healthcare company that includes a hospital and several office buildings must become more efficient. Management sees an opportunity for growth in this market and would like to increase overall revenues by 10 percent. At the same time, budgets are being cut because of aggressive negotiations by government payers and insurers. Facility management has been told to decrease facility space. Facility management considers this strategic direction and proposes more aggressive space management and the use of an analytic tool that will help facility management measure the use of facility space in terms of productivity. The goal is to redefine space to support revenue-producing activities and, if possible, to decrease the organization's physical footprint. One opportunity is to reduce use for record-keeping and repurpose it by using newer technologies that allow offsite storage and more rapid, global access.

Manufacturing

A manufacturer focuses on contracts with a few, large customers. While this provides stable revenue and lower administrative and selling costs, it means that the company has a low tolerance for risks that can threaten contracted commitments to deliver products in specific

Edition 2022, Version V2017PAIT_1.0

quantities at set times. FM considers this situation and proposes using a building automation system (BAS) that can provide early warnings of core building system failures, such as loss of air conditioning, which might inhibit occupant activity. An integrated maintenance workflow system can be used to implement a more systematic approach to maintaining building systems.

Private University

A private university recognized that the arrival of Big Data signaled an opportunity to utilize a computerized maintenance management system (CMMS) to analyze and improve its work order, repair, and maintenance services. The university's FM department analyzed extensive data available in the CMMS on technician's responses to work orders for inspection, repair, and maintenance tasks to offer a glimpse into the challenges they faced in ensuring improved campus operations, services and conditions. Analysis of the data led to the implementation of a mobile application that allowed technicians to comprehensively manage assigned work orders, reduce paperwork, and increase awareness of the importance of facility data to improve planning and operational efficiency.

Lesson 2: Organizational Trends and Technology

Lesson 2: Introduction

On completion of this lesson, you will be able to:

- Explain how workplace trends and emerging technology affect the utilization of FM technology in the organization.

Organizational Trends

Competent facility managers learn to accept and master change, whether it is occurring in their facility or with the tools they utilize. One of the first steps to mastering change is to maintain a general awareness of trends and innovations in technologies, organizations, and workplaces. Facility managers can increase their understanding of facility technology trends and innovations by participating in professional associations, attending meetings and networking with their peers.

Technology is an integral part of organizational change. Organizational trends relevant to today's FM include:

- Globalization
- Economic competition
- Knowledge workers
- Sustainable facilities
- Demographics
- Virtual/Remote workplace
- Security and safety

Figure 3: illustrates how trends in the organization and workplace relate to and influence facility management.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Figure 3 Organizational Trends & Facility Management

Trends in Detail

Globalization

The world is moving from an age of industrialization and monopoly to what the U.S. journalist, Thomas Friedman, calls a "Flat World" — a global economy in which the playing field is leveled by technology. Changes in transportation, communication, and information technology allows countries with emerging economies to effectively compete with established European and North American economies.

Globalization has given rise to the development of business organizations that are not just international - doing business across borders, or multinational - headquartered in one country, but transnational - entities with production and other facilities dispersed across many continents. The lifeblood of a transnational organization is communication and information technologies. Communication and work proceed 24 hours a day, seven days a week, as these organizations leverage technologies to improve business and sales operations, collaboration, and communication.

Economic Competition

New supply chain practices, outsourcing, offshoring and eCommerce have helped businesses lower costs and prices, but profit margins remain narrow. Trends in strategic business management focus on lean and agile operations, higher productivity, reliability and quality. Consequently, facilities are becoming more compact and scalable, and interruptions due to poor management or misuse reduce market share and profitability. For example, facility managers who do not leverage technologies such as Building Information Modeling (BIM), Radio-Frequency Identification (RFID), or Internet of Things (IoT) to optimize space management risk inefficient and underutilized square footage and reduced profitability.

Knowledge Workers

Globalization, the Internet, and the proliferation of information has intensified competition for knowledge workers whose primary job involves handling or using information and data. These workers take time to recruit and onboard, work remotely, and often require specialized training and tools. Organizations invest a great deal of time and money, creating facilities that support the unique space and technology needs of knowledge workers.

Green Technology & Sustainable Facilities

Competition for finite resources is increasing and climate change represents a significant challenge worldwide. Governments are imposing carbon taxes to compel organizations to make changes in energy use and to invest in processes that mitigate the effects of climate change. A sustainable organization is committed to practices that support rather than deplete finite resources and manages its materials and energy effectively and responsibly.

The Triple Bottom Line, shown in Figure 4, illustrates sustainable facilities as an intersection of social, environmental, and economic forces that call for bearable, equitable, and viable solutions. IFMA's Sustainable Facility Professional (SFP) credential prepares facility managers to make data-driven decisions and understand sustainable best practices and the strategic issues surrounding sustainable facility management.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Figure 4 The Triple Bottom Line

Changing Demographics

The worldwide workforce is aging, becoming more diverse, and better educated. Baby boomers (born 1946-1964) are retiring and represent 25% of the workforce. Generation X (1965-1980) and Millennials (born 1981-2000) represent nearly 70% of the workforce in 2020. Generation Z (born 2001-2020) is the newest entrant to the workforce and represents approximately 5% of the modern workforce.

Generation Z are digital and mobile natives, born and raised entirely in a fast-paced, social media, and Internet-centric world. They expect the modern workplace to be teeming with interactive, social, and collaborative tools. They are motivated by diversity, personalization, individuality, and pragmatic approaches to decision-making and work. Generation Z characteristics and work ethic require FM to adjust common office practices, space planning, and support remote work.

Virtual/Remote Workplace

Prior to COVID-19, 33% of employees in the U.S. worked from home at least some of the time, and immediately after the virus emerged, that number increased to 74%. Even before Covid, the rapid pace of innovation in IT and communications technology, and the increased adoption of collaborative software like Skype, Slack and Zoom, made remote work more feasible and cost-effective.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Cost savings is the number one reason most organizations adopt remote work. For example, in 2013, Aetna saved 2.9 million square feet in office space through flexible and remote work and realized a savings of $78 million.

Safety and Security

A facility's overall safety and security is a collaborative effort between the FM, executive management, security managers, human resources, information technology, and employees. The facility manager's main priority is securing and protecting people/occupants, followed by securing the building and its assets.

Safety and security in the workplace changed shortly after the turn of the century. Tragic events like 9/11 forced facility managers to focus on threats both inside and outside of the workplace. Cloud technologies and Web applications provided the opportunity to focus on protecting occupants and the facility by utilizing internal and external remote surveillance and access control. Emergency response and evacuation plans have been enhanced by mobile applications and other smart appliances and technologies. Emerging technology like IoT (Internet of Things), AI (Artificial Intelligent), and Big Data has the potential to further improve the safety and security of the workplace.

Benefits of Technology to the Organization

Facility management is integral to the continuous improvement and efficiency of the corporation's organizational and financial goals. Facility managers must be prepared to present the benefits of adopting and implementing emerging technology to stakeholders, as well as evaluate investments in technology in strategic terms — both financial and non-financial.

The benefits of current and emerging FM technologies include:

- **Cost savings from:**
  - Improved operating efficiency
  - Increased equipment service life from improved maintenance practices
  - Optimized use of facility space
  - Efficient vendor relations and project management
- **Alignment with organizational values, such as:**
  - Commitment to sustainable practices
  - Improved work/life balance and equipping employees with quality tools

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

- Improved organizational governance
- Greater control over organizational assets and greater transparency in the results of operating and purchasing decisions
- Enhanced workplace quality and services that can also increase facility customer satisfaction

- **Documenting compliance with laws, regulations and contracts**
  - Helps to document, organize and monitor compliance to regulations
- **Enhanced knowledge management**
  - A continual challenge for organizations is to capture and access their employees' collective wisdom, even as members exit the organization. Facility technology provides the means to gather information about the facility's systems and practices.
- **Enhanced occupant productivity interaction and workplace experience**
  - Optimize service efficiency, workspace optimization, and predictive maintenance (Databases, RFID, and IoT)
  - Increased access to information, improved communications and business processes (Big Data, Mobile, AI, & Machine Learning)
- **Increased Safety and Security**
  - Intrusion, CCTV, access control including biometric
  - Fire alarm systems

Strategic Alignment and Technology Projects

Facility managers need to consider strategic alignment goals when they propose a new technology project to management. Alignment is strengthened when a plan calls for new technology to be integrated with an organization's existing platforms. A well-developed technology plan will:

- Describe the technology and the benefits to the organization and limit details to the audience's interest and level of understanding.
- Be based on a needs assessment.
- Be created in collaboration with the organization's IT department to ensure compliance with internal standards, facilitate adoption and installation, and avoid the risk of software and other system conflicts.
- Articulate the impact of the plan on people (both occupants and staff) and business processes.
- Includes metrics that define how to measure the success of the plan.

- Be benchmarked against best practices in comparable organizations or facilities.
- Includes a business case that demonstrates the project's economic and non-economic advantages, such as return on investment (ROI), life-cycle cost analysis (LCCA) or total cost of ownership (TCO).
- Considers the rate of technological change in context with the project timetable and reduces the risk that a technology will become obsolete before it is implemented.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 3: Technology and Stakeholder Needs

Lesson 3: Introduction

On completion of this lesson, you will be able to:

- Outline the unique technological needs of stakeholders.

Stakeholders and Technology

A facility manager who identifies the needs of diverse stakeholders, both inside and outside the organization, and uses technology to address those needs in a cost-effective manner, is a valuable member of the organization's strategic planning team. To leverage technology, facility managers must find a way to become involved early in the strategic planning process. Opportunities to improve efficiency and building performance may be limited or eliminated by decisions made during a project's initial planning and design phase or may simply become obsolete if not immediately acted on by decision-makers.

One way to earn a place in these early strategy discussions is for the facility manager to use his or her technology competence and awareness of stakeholder needs to build networks of influence to help develop solutions that benefit the facility management function and the entire organization. Stakeholders have different goals, and these goals define their needs and expectations. The tabs below show examples of internal and external stakeholder needs and technological solutions facility managers can deploy to meet those needs. The lists are not exhaustive and may not work for every stakeholder or organization.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Internal Stakeholder Needs

Stakeholder and Needs	Discussion
Senior management • Economic performance • Risk management • Compliance • Transparency	Senior management (or the C-suite level) is ultimately responsible for the organization's ability to meet its strategic objectives, including its financial performance goals. They welcome any increases in asset value, decreases in operating expenses, and cost-effective actions that protect the organization from foreseeable loss. They need FM technology to show how the organization is performing in terms of KPIs and the "bottom line," as well as accurate and timely data.
Boards of directors • Governance • Public image • Sustainability	Boards of directors are responsible for an organization's governance — ensuring that the organization's policies are followed and that management is directing the organization toward agreed goals. They are concerned about maintaining the organization's positive public image and fulfilling its responsibilities to its stakeholders. Increasingly, those responsibilities include sustainable organizational policies and processes.
Line management • Fulfillment of function objectives • Ability to attract talent • Lower costs (in cost allocation systems)	Line managers of individual departments are concerned with productivity because this is how their performance will be judged by senior management. Facility management has a close relationship with Finance and human resources; however, it's relationship is especially and mutually important. It merits a close coordination and cooperation.
Occupants • Safety and security • Health, cleanliness and comfort • Pride in association • Amenities that provide convenience and	Occupants want a safe, secure, healthful, clean and comfortable place to work. They want the tools necessary to succeed and want to be proud of their workplace and organization. Part of that pride stems from the quality of services the facility provides

Stakeholder and Needs	Discussion
quality service	and the care the organization takes to respond to their work-related and non-work-related needs.
Facility management staff • Safety • Convenience • Job skill growth and opportunities for advancement or mobility	Like other occupants, facility management staff wants a safe and healthful workplace, tools and resources necessary to perform work, and supportive co-workers and managers. They expect technology to make their jobs easier and want to be trained before utilizing tools and technology.

Table 1 Internal Stakeholder Needs

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

External Stakeholder Needs

Stakeholder Needs	Discussion
Investors or shareholders • Financial performance • Security • Transparency	Investors or shareholders want the value of their investment to increase and to be as risk-free as possible. Their needs are met by using facility technology that increases efficiency and productivity, identifies and manages risks to the facility's operation, and provides information about factors affecting the organization's value and performance.
Customers and visitors • Safe, secure and healthful facility • Uninterrupted service • Responsiveness	Facility visitors, including contractors, expect the same facility conditions as any other occupant. Customers also expect reliable and economical access to the product or service they are purchasing. Their needs are met when technology ensures the quality of the built environment and reduces the risk of interruption of facility services.
Suppliers • Communication	Suppliers want to make their own processes easier and more reliable, and this usually depends on more effective sharing of information and communication. Facility technology that provides simple and secure access to facility information will benefit both the organization and the supplier.
Regulatory agencies • Reporting of required information in an accurate and timely manner	Regulators simply want to do their job and get current and accurate data and reports in a timely manner. Facility technology that automates this process benefits both regulators and facility management.

Edition 2022, Version V2017PAIT_1.0

Printed on 100% post-consumer waste recycled paper

Stakeholder Needs	Discussion
Local neighbors and communities • Safe, secure and healthful environment • Timely communication in emergencies	Communities want quality of life and open and transparent communication. Their needs are met when facility technology helps to decrease environmental risks and hazards and ensures timely communication during emergencies.

Table 2 External Stakeholder Needs

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 4: IT and the Impact on Facility Management

Lesson 4: Introduction

On completion of this lesson, you will be able to:

- Identify recent technological trends and their impact on the FM and stakeholders.

Timeline of Facility Management Technology

1960's

Intel co-founder Howard Moore noted that the number of components in an integrated circuit had doubled every year since 1958 and would probably continue to grow exponentially until 1975.

1965

The first CMMS systems were used to remind maintenance technicians to perform simple recurring tasks using punch cards.

1970's

Introduction of building automated systems (BAS) and automated controls (pneumatic controls). Every day, work orders were printed out on paper and distributed to the maintenance team manually. When the technicians completed the job, they filled out the work order forms and returned them to data-entry clerks, who then would type the information directly into the mainframe computer.

1980's

Facility management started to emerge as a formal discipline, and mainframe computer technology led to FM being introduced to IT. Direct digital controls provided closed-loop control of HVAC and other systems, such as lighting, were introduced. Early versions of computer-aided facility management (CAFM) systems like ARCHIBUS began emerging to support facility management functions by integrating CAD drawings and relational databases. MS-DOS was released in 1981, Windows first versions were released in 1985.

1983

IBM rolled out its first personal computer (PC) and the utilization of CAD (Computer-Aided Design) in architectural design moved the construction industry from using hand-drawn, paper-based drawings, to plans generated by programs like AutoCAD. Automation in

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

manufacturing and the need to use technology to automatically monitor and control facility systems and processes lead to advances in facility monitoring and control.

1990's

The continued emergence of MS-DOS (Microsoft's Operating System) and the personal computer made technology ubiquitous in the workplace. FM became more and more responsible for supporting the electrical and data wiring from the cubicle to the data center.

1995

Microsoft Windows 3.1/95 operating system led to innovations in personal computer productivity and database applications. Novell NetWare, Banyan VINES, and other networking solutions that allowed the networking of PCs in the early days. Windows NT (32-bit) was the first Microsoft product that allowed for the networking of PCs effectively.

1999

CAFM (Computer-Aided Facility Management) utilization in FM is directly related to the integration of MS-DOS and the emergence of distributed networks and Web browsers.

2000's

In the 2000's the emergence of the Internet and World Wide Web (graphical internet was 1993 with NCSA Mosaic and later Netscape Navigator) increases the demand for FM and IT support. Information technology staff and budgets increased substantially, and IT becomes as operationally and strategically important to the organization as human resources, finance, and sales. Distributed data and the demand to support IT gave FM the opportunity to quantify its operational and strategic value to the organization. BAS (Building Automated Systems) evolved to integrate the Web browser and network architecture. Information technology staff and budgets increased substantially.

2010

Advances in computer processing power, distributed systems, connectivity, mobile tech, and Wi-Fi led to a rapid convergence of FM technologies and software. BIM (Building Information Modeling), RFID (Radio Frequency Identification), and SOA (Service-Oriented Technologies) emerged.

2020

The Internet of Things (IoT), a network of connected sensors and automated technologies coupled with Big Data, allows FM to better track and measure facility performance.

Technological Trends and Facility Management

Technological Trends & FM

Numerous technological trends are influencing the way technology is used in the workplace and by facility management. Technological trends relevant to FM are shown in Figure 5 and discussed below.

Greater and more distributed intelligence

The rapid increase in microprocessor speed and capacity makes possible:

- Smarter sensor networks in buildings, sensor nodes that can store data, send messages and receive instructions — sometimes wirelessly.
- Automated actions that can save time and money. One facility management consultant noted that simply automating the entry of occupant responses to a facility audit reduced the costs of that activity by 75 percent.
- Systems that can display multiple layers of information about a given object and relate separate objects (IoT).
- Business analytics software can collect data from multiple systems in real-time and analyze the data to support decision-making.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

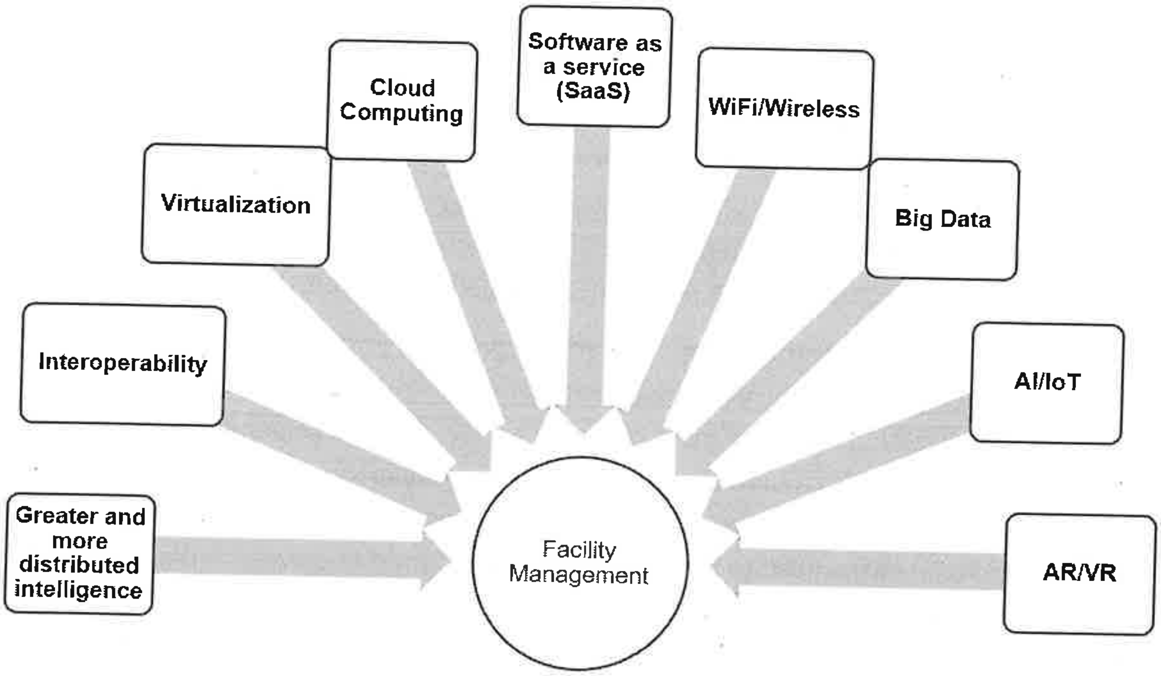


Figure 5 Technological Trends in FM

Interoperability

One of the greatest obstacles in implementing facility management systems is achieving interoperability among the different special-purpose systems that a facility has acquired over time. System providers tend to use proprietary technology that limits networking and interoperability with facility management tools, making management more difficult and preventing facility managers from realizing a return on technology investments.

BACnet™ (for Building Automation and Control Networks), was one of the first open communication protocol to support interoperability among different automated devices. It became an ASHRAE/ANSI standard in 1995 and an ISO standard in 2003. A similar but proprietary product, LonWorks® (originally LonTalk), was released in 1999 and has been recognized by ISO/IEC. An increasing number of building control products build in these common protocols. ISO 16484-5:2017 defines data communication services and protocols for computer equipment used for monitoring and control of HVAC&R and other building systems and to define object-oriented representation of information communicated between systems and facilitating the application and use of digital control technology in buildings.

Another approach to interoperability is to utilize Internet Protocol (IP), as a protocol and a server that acts as a gateway and translator to support data communication among building control components and VoIP (Voice over Internet Protocol).

Virtualization

Virtualization refers to the act of creating a virtual version of something, including virtual computer hardware platforms, storage devices, servers, and other computer network resources. In a computing context, virtualization obscures the physical aspects of the relationship between a user and a computer system or network and allows the user to perform the desired tasks across multiple platforms and operating systems

Virtualization is used within individual computers and networks to improve performance and increase reliability. It is used to create host/guest server environments (virtual server), and this form of virtualization holds the most potential for FM; a virtual server can run multiple operating systems with multiple configurations. A virtual machine server (VMS) can have up to 50 different environments on one device or one "u" slot in a data center rack. Virtualization reduces the need to have the "one-to-one" ratio of servers to platforms, applications and operating systems (Figure 6). Virtual machines allow IT and the FM to manage multiple computerized facility applications on one machine rather than multiple racks in the data center. This relieves and reduces operating costs and facility footprint.

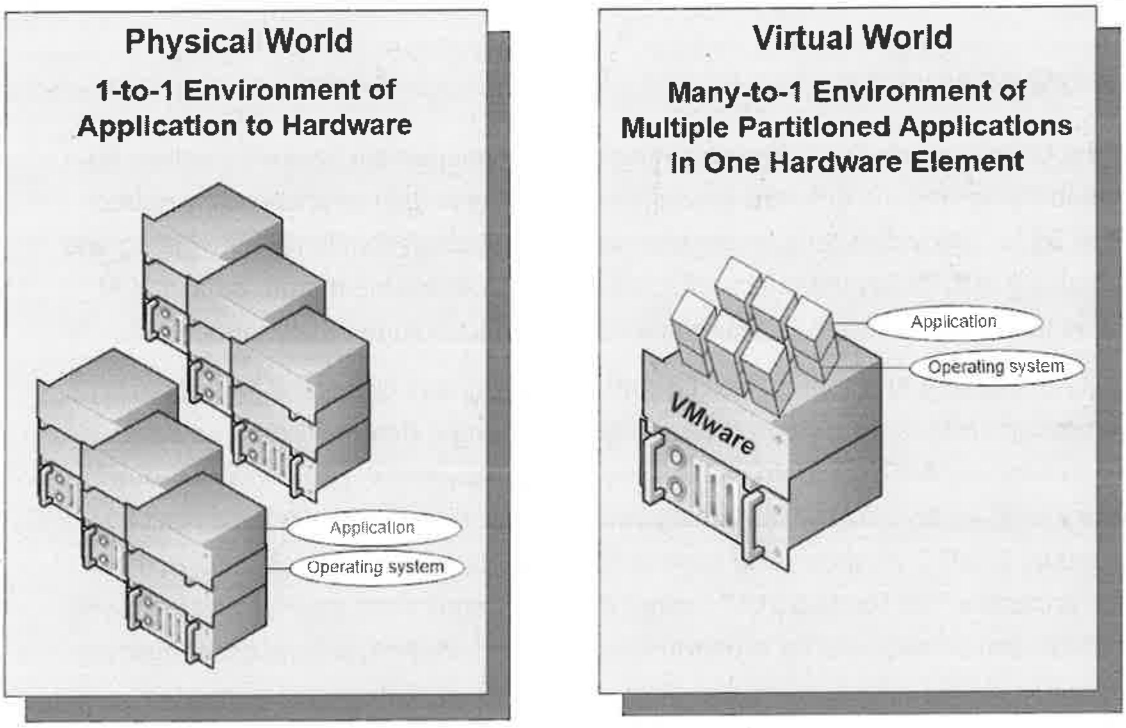


Figure 6 Virtual Machines

Cloud Computing

In cloud computing, users store, access and process data that is stored on the Internet Cloud. The major advantages of cloud computing are scalability and lower up-front costs. Organizations can purchase storage in the Cloud and avoid the expense of purchasing hardware and software, as well as operating costs to house the equipment and IT resources. Cloud computing offers greater redundancy in systems and fewer interruptions of service.

Cloud computing services can be public - over the Internet, community-based - clients with similar needs for security or compliance, or private - dedicated to a single organization and operated by the organization itself or by a third party.

Figure 7 shows how users interact with Cloud-based services and infrastructure. Remote servers return data and provide access to cloud-based applications.

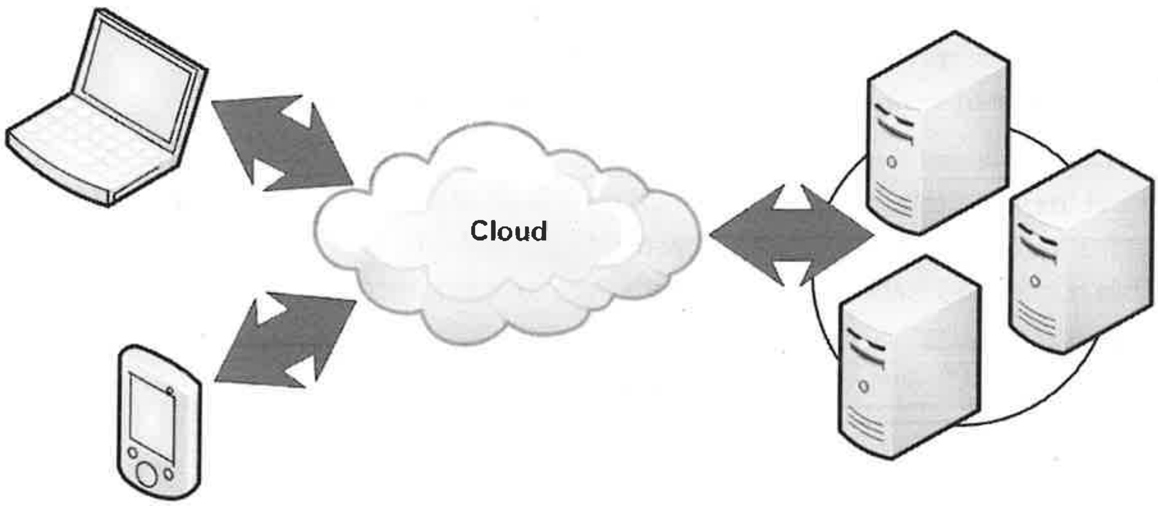


Figure 7 Cloud Computing

Software as a service

In software as a service (SaaS), the user does not own the application being used; the application resides at a remote location, rather than on the user's system, and the user accesses it through a cloud platform, usually for a fee. SaaS saves an organization the expense of managing multiple software licenses and maintaining the application through periodic updates and upgrades. It frees up IT time, processing and storage space on the organization's information system. Many facility management systems are available as SaaS.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Wireless Communications

The increase in access and control is due primarily to the growth of wireless communication and small, portable, but powerful devices, such as smartphones or tablet computers.

In an intelligent building, remote sensors or motes can send data to wireless hubs, then sent on to controllers. Instructions based on this input is returned wirelessly to switches and actuators. This system saves the expense of wiring by expanding the use of wireless sensor networks in a building control environment. Another advantage of wireless systems is that it reduces a building's fire load or combustible components.

The most obvious use of wireless sensor networks is managing a facility's climate and energy consumption, but there are other applications. For example, wireless security networks can make it easier to capture images from closed-circuit TVs located throughout the facility, detect intrusions through an array of sensors, and control access at various facility entry points. Wireless sensor networks could be integrated into a facility management tool to show in real-time where parking spaces are available.

Access is also increased through mobile devices. Facility management staff have access to systems at the worksite or remotely. With each generation of wireless service, the amount of data that can be transmitted and the speed of transmission increases. New generations of mobile connectivity standards have appeared approximately every 10 years.

Year	Connectivity Standard	Transmission Speed
1981	1G	2 Kbps
1992	2G	64 Kbps
2001	3G	2 Mbps
2011	4G	1 Gbps

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Year	Connectivity Standard	Transmission Speed
2020	5G	1-5 Gbps

Table 3 Mobile Connectivity and Transmission Speed

Cyber Security

Today's workplace is equipped with numerous devices and building systems that are connected to the Internet. Each of these systems presents a potential vulnerability and can serve as a back door for hackers to exploit. In 2019, a Harvard Business Review (HBR) study determined that 60 percent of all cybersecurity breaches were launched using three building control devices as points of entry — VoIP telephones, video recorders, and office machines.

Facility managers are not cybersecurity experts but must actively secure their facility and develop a plan to respond to cyber threats. Facility managers must take the lead in the hardening of building control systems, and work with IT to assess the vulnerability of networked systems. Mitigating cyber-attacks starts with assessing risk during the technology selection process, as well as working closely with IT and executive management to develop an effective security plan. Cybersecurity is covered in chapter two (IT & Security Basics for the FM).

Big Data

The term "big data" first appeared in a 1997 paper in which NASA scientists used the term to describe a problem they had with the visualization of large data sets. Wikipedia defines Big Data as an all-encompassing term for any collection of data sets so large and complex that it becomes difficult to process using current data management tools or applications. An example of Big Data's application in facility management is accessing remote sensors to tabulate reliability and efficiency data.

Artificial Intelligence (AI)

Artificial intelligence (AI) refers to the simulation of human intelligence in computer and other technologies or any technology that exhibits traits associated with learning and problem-solving. Google has been using AI since 2018 to manage server cooling in its data centers. The data center AI system acts independently, and every five minutes takes a snapshot of cooling system parameters and determines actions required to maintain temperature and minimize energy consumption.

Internet of Things (IoT)

The Internet of Things (IoT) is an emerging term for connected devices and smart appliances that communicate with one another via the Internet, embedded sensors, and/or Wi-Fi. IoT utilizes device-to-device communication like RFID and includes other sensor and wireless technologies. IoT's significance is that devices expose themselves digitally which in turn allows the FM to better monitor and quantify macro-level facility data and performance.

Augmented Reality (AR) & Virtual Reality (VR)

Augmented reality (AR) and virtual reality (VR) are technologies that offer a multitude of benefits to a wide range of industries and will change the way organizations communicate, plan and operate. Augmented reality digitally projects elements such as images and documents, into the real-world environment via a smartphone camera or tablet. Virtual reality places the user in the center of the virtual environment. The application of AR and VR to facility management is unlimited. AR/VR can train employees, increase worker safety, enhance space management, and help FM to determine how to retrofit and upgrade new facilities and equipment into existing systems and processes.

Implications of Technology Trends on the Facility Manager

How do facility managers stay up to date on technology trends?

- A facility manager must include technology proficiency in their professional development plans, and continuously look for opportunities to increase knowledge about emerging technology. Look for formal training through IFMA, local chapters, and subscribe to journals and blogs.
- A facility manager must develop a close partnership with IT. This necessary relationship is discussed more fully later in this chapter.

Facility managers must be aware of how technology affects the organization, stakeholders' perspectives and needs, and creatively match their needs with emerging facility technology.

- Facility and occupant surveys should include questions about facility technology, including its adequacy for occupant needs and reliability.

- Facility managers must also learn to use business analytics — identify what measures are appropriate for their organization's objectives, ensure that the right data is being collected, draw valid and constructive conclusions from that data and present results effectively to management.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 5: IT & FM: What is the Relationship?

Lesson 5: Introduction

On completion of this lesson, you will be able to:

- Determine the appropriate strategies to work with IT, as a partner and customer, to achieve organizational goals.

Building a strong IT/FM relationship

The relationship between IT and FM has evolved as their individual roles and needs within the workplace have become more complex. Distributed technologies and web applications have led to an increased integration of the functions between IT and FM. Facility managers must view IT as both a stakeholder and a partner in meeting an organization's strategic goals. Building a productive and collaborative relationship between IT and FM starts with conversations about the other's strategic goals and requirements, shared interests, and common tasks and KPIs.

It's important to understand the ways IT and FM interact in terms of a customer-partner relationship. FM and IT interact and support one another, and the organization, in the following ways:

- **IT as a customer of FM**
- **FM as a customer of IT**
- **IT and FM as partners**

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

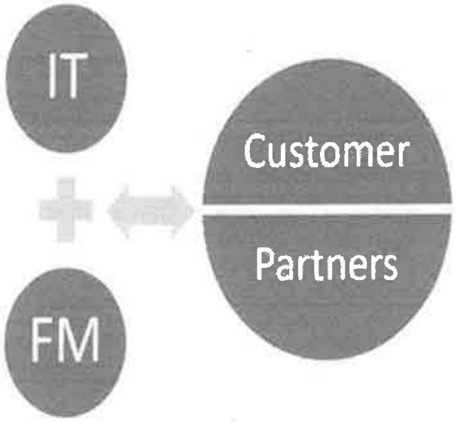


Figure 8 IT and FM interactions

IT as a Customer of FM

Information Technology plays a vital role in facility operations. IT's success depends on how well it coordinates the implementation of hardware, software, and infrastructure specifications and configuration with FM. As a customer of FM, IT expects:

- **High-Quality Support and Services:** Most IT functions cannot tolerate even brief disruptions or conditions that impair data and transmission quality. IT expects FM to support critical needs and initiatives, such as:
  - Space for equipment for example, servers, networks, data centers, environmental control for example, cooling, humidity control, air filtration, electrical wiring, and communication cabling installed in ceiling spaces or under raised floors. These spaces must be carefully located to manage risks to IT operations, decrease the possible of interference, and ensure efficient and effective network services.
  - Providing enough workspace for IT employees and equipment
  - Reliable access to power supply, as well as emergency backup
  - Fire protection
  - Back-up facilities, or sites, where IT can continue operations during facility disruptions or outages
  - Secured workspace and equipment, automated alerts and monitoring for example, locked rooms, video surveillance and climate control
  - Early notification for planned utility outages

- **Control Workload & Limit Integration Risks:** The IT function manages computer networks, hardware, and software and frequently provides support to other functions, such as serving as the "technical buyer" when the organization acquires new technologies or applications. IT is sensitive to any decisions that could increase its workload, become a drain on its limited resources, or risk interruptions to the enterprise. FM must involve IT early in the process of acquiring new building technology, particularly if there is a risk to functional processes and information systems.

FM as a customer of IT

Emerging technologies like Big Data, AI, and the IoT is changing the way facility managers do their job. The increased use of building technology requires IT assistance in selecting, implementing, and supporting these technologies. IT must understand FM's responsibility in terms of using technology to increase efficiency and service it provides to the organization in terms of:

- Operating the facility efficiently and effectively
- Supporting and providing senior management with relevant data on building performance
- Controlling building space needs and operational costs
- Supporting the organization's sustainability goals

IT & FM Applications

The Information Technology function plays a vital role in helping FM achieve its mission and goals, and its assistance is critical to selecting, deploying, and implementing all CAFM systems. The following CAFM applications are utilized by FM and may require support from IT:

Inventory/Asset Management

FM uses comprehensive and timely facility information and data provided by inventory management applications that include the following:

- Land
- Buildings
- Equipment
- Internal and external facility services

- Graphical data
- Facility process data
- Financial data
- Performance data
- Energy consumption data

Space Management

The space management applications allow the facility manager to optimize:

- Building construction to increase usable space
- Economic occupancy of space
- Ergonomic and functional design of workspaces and the built environment

Real Estate & Contract Management

FM manages a variety of real estate. CAFM must support the contract management process and provide the following essential data:

Contract Process	Contract Data
• Planning • Design • Negotiation • Implementation • Monitoring and control	• Performance requirements • Duration • Termination date and options • Parties' information • Property location • Responsibilities

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 1: Progress Check

1. What organizational trend is driven by new supply chain practices, outsourcing, and offshoring?
    a. Globalization
    b. Changing Demographics
    c. Economic Competition
    d. Knowledge Workers

2. What organizational trend was most impacted by COVID-19?
    a. Security and safety
    b. Virtual/Remote Workplace
    c. Changing Demographics
    d. Globalization

3. Which stakeholder is most concerned with economic performance?
    a. Senior management
    b. Line management
    c. Facility manager
    d. Suppliers

4. What technology provides staff **remote** and **secure** access to CAFM?
    a. Web Portal
    b. Cloud Computing
    c. Software as a Service (SaaS)
    d. Virtualization

5. What technology uses connected devices to provide large-scale monitoring of facility data and performance?
    a. Cloud Computing
    b. Augmented Reality
    c. Internet of Things (IoT)
    d. Big Data

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 2: Data Collection and Information Management

Lessons

- Objectives
- Lesson 1: Data Collection and FM
- Lesson 2: Data-Driven Facility Management
- Lesson 3: Minimizing the Risks of Data Corruption
- Lesson 4: Data Backup for Resilience

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Objectives

Chapter 2: Objectives

On completion of this chapter, you will be able to:

- Explain the data collection process and its implications on Facility Management
- Describe common classifications for data
- Utilize best practices in data collection and governance
- Describe the different standards for data aggregation and normalization
- Describe the types and benefits of data analytics
- Utilize the Analytics Capabilities Framework to optimize operational and strategic planning
- Understand the significance of data corruption and integrity to CAFM
- Develop a framework for CAFM user authorization and governance
- Summarize the significance of data backups and a plan for data resilience

Facilities generate a wealth of data, and it is essential for a facility manager to develop processes to capture, store and analyze data to help an organization achieve its goals. The explosion of information, distributed systems, and intelligent devices are giving new importance to data management. Data collection and storage have evolved from paper requisitions and Excel spreadsheets to a robust infrastructure supported by enterprise applications, such as Integrated Workplace Management Systems (IWMS). Regardless of the complexity of the system, an understanding of best practices and methods for data collection and information management is critical to the success of FM and the organization.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 1: Data Collection and FM

Lesson 1: Introduction

On completion of this lesson, you will be able to:

- Explain the data collection process and its implications on Facility Management
- Describe common classifications for data

Data and its Implications on Facility Management

Data is more than just numbers stored in a spreadsheet, information in a work order or maintenance log. Targeted data helps develop a "macro-scale" view of your facility, and develop a better understanding of trends and opportunities for improvement. Benchmarking data and trends start with utilizing platforms, such as a CAFM and/or IWMS, and forming a hypothesis about known efficiencies, inefficiencies, and opportunities for improvement.

Data Collection and Storage

Enterprise systems, databases, and network infrastructure enable the process of data aggregation. Data is useless unless it's collected, normalized, and formatted into a machine-readable format and then entered into a database or repository, such as an Excel spreadsheet.

What is Data?

In its raw form facility data can be classified as the following formats:

- **Alphanumeric (ASCII):** discrete data such as addresses, names, values, or attributes for example, data in text documents, contracts, structured lists, tables, and logs.
- **Graphic:** pixel data or graphic elements included in CAD/BIM, 2D, and 3D drawings or graphics.
- **Media/Multimedia**: data generated by security or other cameras, animations, or film.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Data Collection Best Practices

The following best practices will help you collect valid and reliable FM data:

Create a holistic view of the organization & FM

Develop a holistic view of the organization, and the FM operation, and identify and prioritize what information is required to efficiently run the business. This is where collaboration with stakeholders is important. Take time to share ideas and insights and determine priorities for moving forward with data collection and warehousing.

Take inventory of current facility data

Facility managers need to gain an understanding of the current state, where valid and relevant data resides, where and how data is being captured, and how it is tracked. It is important to identify where and how to capture both analog and digital data. In some cases, you can identify what and where data is being collected by walking through the facility.

For example, data stored in a CMMS, such as work orders, is a valuable data source. Data generated by the integration of IoT such as work order. Data within facilities has evolved from paper requisitions and clipboard inventory management to a robust infrastructure that often includes fully automated work order management systems and smart technologies.

The integration of IoT makes it possible to capture and store data generated by automated systems such as CCTV, fire alarms, access control systems, and security systems.

Ensure that the data is accurate and meaningful

The sheer volume of data provided by building systems, CAFM, and IWMS can be overwhelming. This can be a painful step that requires a frank assessment of the current state of the data for accuracy and whether it provides a complete picture of what is required to achieve optimum performance of the workplace and workforce. The key is to identify and have access to accurate and normalized data that you can trust. The reliability of data is not just dependent upon the technology and internal data warehouses, but the processes and procedures that are in place for collecting and maintaining accurate data.

Develop a roadmap for the future

The next step is to develop a roadmap for the future. The roadmap articulates a future that considers the effect of change in FM systems, the resources required to execute the plan, and the level of data governance within the organization (Figure 9). Consider the following questions:

How will the accessibility and accuracy of data change the way the business operates?

What types of skills are needed to manage data in the digital workplace of the 21st Century?

What changes, policies, or procedures need to be part of a broader plan for data governance?

Figure 9 Level of Data Governance

Common Examples of Facility Data

Table 4 provides common examples of facility data.

Work order response times	Work order response times and deferred work orders provide insight into the average amount of time it takes to find, report, and resolve a problem in a facility.
Planned versus unplanned maintenance	This data is simply a measure of scheduled maintenance compared to on-demand maintenance. Quantifying the percentage of planned versus unplanned maintenance will proactively meet the needs of the facility and its occupants.
Cost per repair	Tracking the average cost per repair, or per work order, will help you understand overall costs as it relates to the number of work orders in a given timespan.
Energy use and audits	It is common for equipment and other assets to increase energy use just before failure. Monitoring energy use will help you to proactively identify potential failures within a facility.

Space utilization and occupancy	Space occupancy versus vacancy is essential to identifying effective space utilization within a given facility, this is even more important for corporate real estate providers, whom have a predicated need to maintain a high occupancy rate.

Table 4 Common Examples of Facility Data

Data Storage

Once aggregated and normalized, data is stored and accessible via enterprise computer facility management applications, such as:

- **Computerized Maintenance Management Systems (CMMS)** that house data on the physical condition of the facility, operating costs, and assets.
- **Building Control Systems** includes descriptive data about the facility and its assets.
- **Computer-Aided Facility Management (CAFM)** functions as an organizational database or repository and includes data, such as utilization of space, energy consumption, occupants, maintenance, real estate, contracts, equipment, and fire and safety information.
- **Building Information Models (BIM) and Computer-Aided Design (CAD)** provide graphical information applications that are used to create dashboards that display system data.
- **Facility databases & Enterprise Resource Planning (ERP) systems**, include data such as facility assets, facility performance, real estate, contract information, budgets and forecasts, and project planning and scheduling data.

Data Standardization

Aggregating, normalizing, and storing data is pointless unless it is converted to a common format, analyzed, and utilized to develop organizational metrics and analytics The facility's enterprise systems such, as IWMS or CAFM, adhere to common standards for the interoperability and exchange of FM data, and include Common Standards for Data Interoperability (Table 5).

ISO 16739-1:2018- Industry Foundation Classes (IFC)	Industry Foundation Classes (IFC) for data sharing are an open international standard for BIM data that are exchanged and shared

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

	among software applications used by the construction and facility management sector. The standard includes definitions that cover data required for buildings over their life cycle. This release, and upcoming releases, extend the scope to include data definitions for infrastructure assets over their life cycle as well.
Construction-Operations Building Information Exchange (COBie)	COBie is an international standard relating to managed asset information including space and equipment. It is strongly associated with Building Information Modeling (BIM) approaches to design, construction, and management of built assets.
OSCRE's Industry Data ModelTM (IDM)	OSCRE's Industry Data ModelTM (IDM) is a comprehensive real estate integrated data model that enables you to address real estate asset lifecycle management. It contains data definitions and use cases to develop a strategy for corporate real estate data and real estate investment data standards.
Project Haystack	Project Haystack is an open-source initiative to streamline working with data from the IoT.

Table 5 Common Standards for Data Interoperability

Lesson 2: Data-Driven Facility Management

Lesson 2: Introduction

On completion of this lesson, you will be able to:

- Utilize best practices in data collection and governance
- Describe the different standards for data aggregation and normalization
- Describe the types and benefits of data analytics

Introduction: Data-Driven Facility Management

Data-driven FM is the use of data and analytics to make informed operational decisions and planning. A data-driven approach provides an organization with the processes to utilize information in both a tactical and strategic context. Facts and figures are meaningless if you cannot gain valuable insights that lead to better informed actions. The success of data-driven facility management relies on FM identifying relevant metrics and benchmarks, collecting appropriate data, and then effectively analyzing the results. For example, data might be used in tactical planning to determine risks to maintaining service levels or develop metrics to measure progress towards a specific goal or benchmark, whereas the organization will utilize the same service level data to further develop metrics and KPIs. Data-driven FM starts by using platforms, such as CAFM or an IWMS to make sense of all the data.

Data Analytics

The sheer volume of data generated in most facilities is overwhelming. Facility automation and building management systems combined with emerging technology, such as the IoT, remote sensors, and mobile devices, allow you to collect a massive amount of information. The ability to capture, process, and refine data into actionable goals or benchmarks is the key differentiator between successful and unsuccessful organizations. Facility managers who get the most out of operational data utilize tools and platforms that not only capture information but also converts it into meaningful analytics. Most analytics indicate past

Printed on 100% post-consumer waste recycled paper

performance, while more sophisticated analytics developed through the use of AI and machine learning (ML), help anticipate trends and proactively implement interventions.

The best way to ensure a comprehensive picture of facility operations and to taking full advantage of the facility's data is to use descriptive, predictive, and prescriptive analytics. Table 6 describes each of these analytics and how they are related.

Analytic	Benefit	Example
Descriptive	Tells you what happened.	An HVAC system experiences ignition problems.
Diagnostic	Helps you understand why something happened past.	The ignition problem was due to a dirty pilot.
Predictive	Predicts what will happen in the future.	HVAC duct systems should be cleaned routinely and if not can lead to a dirty ignition pilot.
Prescriptive	Recommends what should happen.	Ducts and ignition pilots should be cleaned every two years, and filters should be cleaned twice a year.

Table 6 Types of Data Analytics

Analytics Capabilities Framework

Gartner describes an **Analytics Capabilities Framework** (ACF) that depicts the amount of human effort required to research and tabulate data analytics into decisions and actions that affect facility performance and management. Descriptive data involves extensive human input and effort to quantify and describe, whereas prescriptive data can be accomplished utilizing AI and ML. AI and ML algorithms describe the desired outcome, data is built into a prescriptive model that is utilized to implement operational decisions and actions — sometimes independent of human intervention, such as smart technology and IoT.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

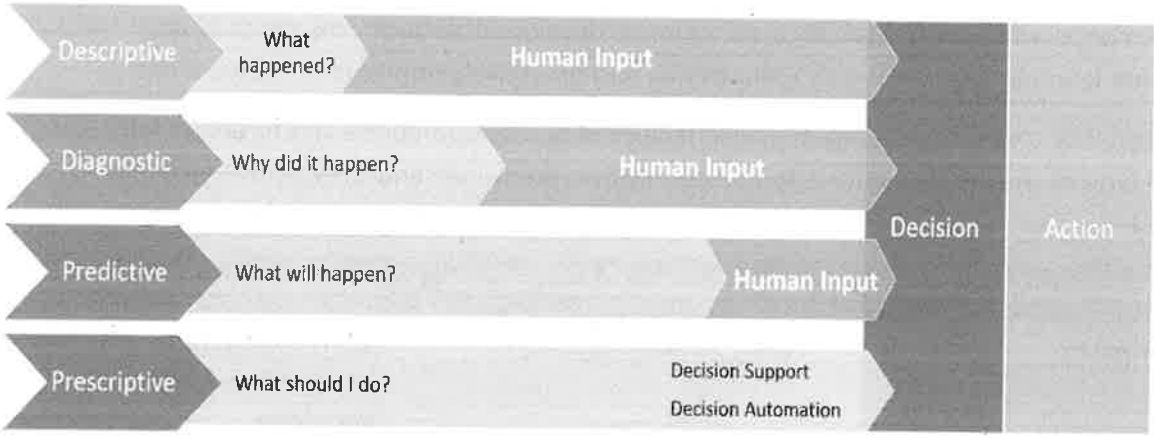


Figure 10 Analytics Capabilities Framework

Leveraging Analytics

Figure 11 Data Analytics

Descriptive Analytics

Descriptive analytics gives a holistic view of historical data by providing details on the current state of assets, resources, and repair and maintenance. Historical analytics is utilized to report actual performance or what happened in real-time, against predetermined metrics and benchmarks. Service level agreements are a good example of how descriptive analytics are used to monitor and measure metric performance over a defined timeframe.

Diagnostic Analytics

Diagnostic analytics are operational in nature and help identify what needs to be done right now. Whether it is cleaning common areas, maintaining HVAC systems, or prioritizing pressing tasks, diagnostic analytics help to develop real-time actionable goals, tasks, and recommendations.

Predictive Analytics

Predictive analytics helps develop strategies to help the facility function more efficiently in the future. Making analytical, data-driven predictions for the future leads to proactive decisions and a more efficient facility. Predictive analytics helps leverage warehoused data and develop critical metrics and measures, such as average time to failure, optimal utilization rates, and labor demands. Predictive maintenance requires the use of predictive analytics and smart technology. For example, retrofitting assets and equipment within the facility with sensors connected to the IoT, increases the access to relevant data and simplifies predictive maintenance.

Prescriptive Analytics

Prescriptive analytics rely on decision support systems, remote sensors, AI, and ML to make complex decisions required to proactively improve facility efficiency and performance. Leveraging prescriptive analytics is all about making complex decisions easier, more streamlined — improving efficiency.

Best Practice

Best practice for leveraging analytics:

1. Retrofit facility assets with remotes sensors, utilize cloud-based platforms, the IoT, and AI to collect data and quantify system performance.
2. Integrate systems and data through connected and mobile technologies.
3. Monitor performance and ensure data analytics help realize expected improvements, and don't be afraid to implement changes or interventions needed to improve performance.
4. Keeping the team and stakeholders informed by using an IWMS/CAFM.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 3: Minimizing the Risks of Data Corruption

Lesson 3: Introduction

On completion of this lesson, you will be able to:

- Utilize the Analytics Capabilities Framework to optimize operational and strategic planning
- Understand the significance of data corruption and integrity to CAFM
- Develop a framework for CAFM user authorization and governance

Introduction

Data is the central component of a CAFM system. If the facility's data is altered or deleted it can have a major impact on data-driven business decisions and operations. Minimizing data corruption and integrity, data backup, and data resilience are essential.

Data Corruption and Integrity

Data Integrity

According to an IBM study, 51 percent of companies that experience severe data loss do not recover.

Data integrity refers to the reliability and trustworthiness of data throughout its life cycle. It describes the state of the data and whether it is valid and accurate. Data integrity should not be confused with data security. Data security refers to the protection of data, while data integrity refers to the reliability, validity, and trustworthiness of data. Data security is covered in Chapter 3 (IT & Security Basics for the FM).

Data Loss and Corruption

Data corruption or loss occurs for a variety of reasons and each poses unique challenges in terms of data integrity, recovery, and resilience. Hard drive/RAID (Redundant Array of Independent Disks) crashes and equipment failure accounts for the highest percentage of data loss and corruption, but human failure, viruses, and hackers follow closely behind. Error checking and validation are common methods to reduce human error and ensure data integrity.

Awareness of the common causes of data loss and corruption, and the risks to data integrity, is essential for a facility manager. Common causes of data loss and corruption include:

- Human Error
- Viruses and Malware
- HD/RAID Failure
- Power Outages
- Internal Data Theft
- Water Damage
- Disasters
- Software & Database Corruption
- Compromised hardware
- Hackers/Cyberattacks

User Authorization and Governance

CAFM is available to a variety of users via networks for the purpose of data input and access. User access and authorization procedures must be in place to ensure the integrity of data stored within the CAFM and other databases. Grouping **users** and **datasets** help simplify the process of administration and governance of FM systems.

User groups: Grouping users and datasets help simplify the process of administration and governance of FM systems. Users are provided a variety of access rights, such as creation, deletion, query, or report generation. Administrators are responsible for adding new users and assigning them to user groups with differing levels of access rights.

Dataset: Datasets are a standardized organization of data into similar categories and groups arranged by hierarchy or data type.

Preserving Data Integrity

You can reduce threats to data integrity by ensuring the following procedures are in place to preserve data integrity (Figure 12).

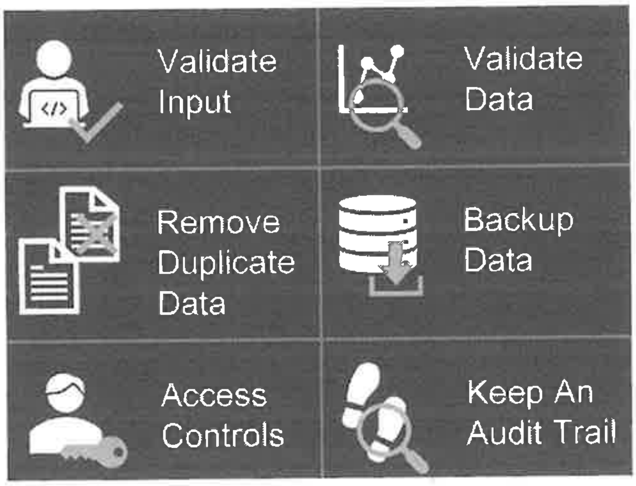


Figure 12 Factors important to preserving data integrity

Validate Input

When data set is supplied by a known or unknown source, such as an end-user, another application, a malicious user, or any number of other sources, validation should be required. The data should be verified and validated to ensure that the input is accurate.

Validate Data

It's critical to certify that data processes are not corrupted. Identify specifications and key attributes that are important to the organization before you validate the data.

Eliminate Duplicate Data

Removing duplicate data ensures that an organization has a reliable and singular source of information. Inaccurate and duplicate data can be found in a document, spreadsheet, email, or shared folders where employees can inadvertently use it to make mission-critical decisions.

Backup Data

In addition to removing duplicates to ensure data security, data backups are critical to the process. Backing up data is necessary and goes a long way to prevent permanent data loss. How often should backups be run? As often as possible. Backups are critical when organizations get hit with ransomware attacks. Ensure that all backups are encrypted!

Control Access to Data & CAFM

Individuals within an organization without proper access and with malicious intent can do grave harm to the data. Implementing a least privilege model, where only users who need access to data get access, is a successful form of access control. Often overlooked is physical access to the server. The most sensitive servers should be isolated and bolted to the floor or wall.

Audit and Document

Whenever there is a breach, it's critical to track down the source. Tracking down the source is often referred to as an audit trail, and provides an organization the information to accurately pinpoint the source of the problem.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 4: Data Backup for Resilience

Lesson 4: Introduction

On completion of this lesson, you will be able to:

- Summarize the significance of data backups and a plan for data resilience

Introduction: Resilience

Resilience is the capability of an organization or system to accommodate changes over time and to continue to function. In a recent market scan, the Business Continuity Institute determined that the top three most concerning threats for businesses include:

- cyber-attacks
- data breaches
- unplanned IT and telecommunications outages

Natural disasters, such as Hurricane Sandy in the United States in 2012, the floods in Europe in 2015, and most recently in 2021, another 7.1 earthquake in Fukushima Japan, caused massive disruption to communities and economies across the world. These and other threats require organizations to put a continual focus on resilience planning and disaster recovery of business information systems, facility information technology, and data backup and recovery.

Data Backup

Introduction

Facilities generate massive amounts of data and information is constantly changing. Data can be lost, corrupted, compromised, or stolen through hardware failure, human error, hacking, and malware. Loss or corruption of data can result in significant business disruption and lost revenue.

What is Data Backup?

Data backup and recovery is the process of backing up facility data in the event of a loss and setting up secure systems that allow for the recovery of data. Data backup requires the

Printed on 100% post-consumer waste recycled paper

copying and archiving of facility data and making it accessible in case of data corruption or deletion.

Developing a Data Backup Plan

A data backup and recovery plan must be an integral part of the organization's business continuity plan, as well as its IT disaster and recovery plan. Developing a data backup strategy begins with identifying what data to backup, selecting, and implementing hardware and software backup procedures, scheduling and conducting backups, and periodically validating that data has been accurately backed up. Coordinate and develop data backup plans with IT and other stakeholders and users.

Identify critical data stored in the CAFM and other FM systems, desktop, laptop computers, and wireless/smart devices that need to be backed up along with other hard copy records and information. The plan should include types of data backup and that they are regularly scheduled — daily, weekly, or monthly. Types of data backup include:

- **Full/Image Backup**: a complete backup of all your data is made available in a single media set Hard Drive (HD), Network Attached Storage (NAS), Redundant Array of Independent Disks (RAID) and Universal Serial Bus (USB).
- **Incremental Backup**: a partial backup of only the data that has changed since your last full backup. This operation is faster and requires less storage media.
- **Differential Backup**: this backup method copies data changed from a specific point or episode/incident. Differential backups fall somewhere in between full and Incremental backups. A Differential backup means you essentially have a cumulative backup of all changes made since the last full backup.
- **Image Backups (also known as disaster recovery)**: Disk image or system image backup, enables the creation of a full disk backup of the entire system or one or more partitions, including the operating system, applications, and all of the data rather than just files and folders. This type of backup is saved as a single file that is often referred to as an image.

Backup Storage Options

The Internet and Cloud contain a multitude of backup solutions such as:

- External Drive/USB
- NAS (Network Shares)
- Tape Drives
- Network Storage

- SaaS
- Cloud Storage Provider
- CAFM Vendor Storage

Backing data up locally and to the Cloud provides distinct advantages. Backing up data to the cloud is more secure than using a local system.

Chapter 2: Progress Check

1. What type of data best describes room bookings?
   a. Alphanumeric
   b. Graphic
   c. Media
   d. Multimedia

2. What standard is closely associated with Building Information Modeling (BIM)?
   a. OSCRE's Industry Data ModelTM (IDM)
   b. Project Haystack
   c. Construction-Operations Building Information Exchange (COBie)
   d. ISO 16739-1:2018- Industry foundation Classes (IFC)

3. What describes the highest level of data governance in an organization?
   a. Level 1
   b. Level 2
   c. Level 5
   d. Level 4

4. What analytic tells you "what happened?"
   a. Predictive
   b. Descriptive
   c. Diagnostic
   d. Prescriptive

5. What should FM do before validating data?
   a. Check the source of the data.
   b. Ensure the access controls are in place.
   c. Identify important specifications and key attributes.
   d. Remove duplicate data.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 3: IT & Security Basics for FM

Lessons

- Objectives
- Lesson 1: Networking Principles
- Lesson 2: Wireless Networks
- Lesson 3: Databases and Software
- Lesson 4: IT Security for Facility Managers

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Objectives

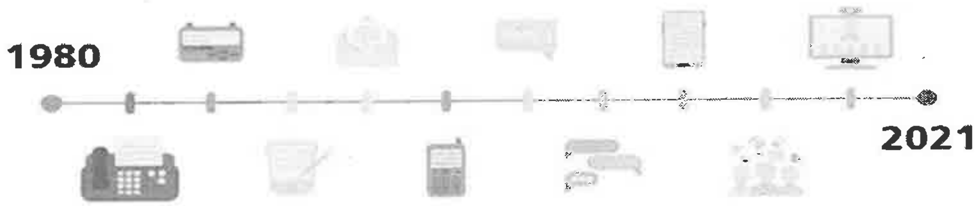
Chapter 3: Objectives

On completion of this chapter, you will be able to:

- Understand networking and the various network topologies
- Describe various types of wireless networks and protocols
- Describe the different types of databases
- Recall the phases of the software life cycle
- Explain the importance of data and network security
- Describe technologies and methods that ensure network security
- Describe protocols to provide users access to networks and technologies

Facility managers must understand and plan for operating in a technological and information-driven world. This requires a strategic mindset and the ability to adapt to trends and risks that affect the organization, building, and its occupants. This chapter introduces you to the basic concepts of information technology and security, such as computer networks, databases, FM software, data protection, and network security.

Information Technology (IT) encompasses the hardware and software needed to store, manage, distribute, and use information that is critical to the demand organization's mission. In 1965, Gordon Moore (Moore's Law) predicted that the number of transistors in an integrated circuit would double every two years, and this remains accurate for the integrated circuit well into the 21st Century. The emergence of Web, mobile, and Cloud technologies has led to an expediential growth in web and mobile applications and data.



The global marketplace requires that IT data and services be constantly available from any location, which means an organization's networks must span multiple facilities, devices, and users. Networks and distributed technologies are an essential enabler for the demand organization and FM; they are offering this benefit at substantial risk. Hackers and cybercriminals use denial of service (DDoS), phishing, ransomware, worms, and other types

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

of malware and cyberattacks to compromise, steal or destroy critical information to disrupt an organization's business operations.

Lesson 1: Networking Principles

Lesson 1: Introduction

On completion of this lesson, you will be able to:

- Understand networking and the various network topologies

Introduction

Wireless and mobile technology is a major trend in business and FM, that does not mean that fiber and copper will disappear. Facility managers need to understand the basic design principles and components of both wireless and wired communication networks to ensure their facilities have efficient and flexible networks.

Computer Networking

Computer networking refers to connected computing devices such as laptops, desktops, servers, smartphones, tablets and an increasing number of IoT devices such as cameras, remote sensors, remote cameras, that communicate with one another. Networks are composed of two or more computers that communicate using various protocols, such as TCP/IP (Transmission Control Protocol) or HTTP (HyperText Transfer Protocol).

Networks make applications available for use and communication between users who share information/data in the form of text (hypertext), data, pictures, video, audio, and multimedia. It is important to remember that the purpose of CAFM and IT solutions is to ensure that data collected manipulated, shared, and utilized meet organizational goals — networks act as a conduit to facilitate this process.

Structure of Network: Topology

Network topology is the way a network is arranged, including the physical or logical structure of links and nodes. Network topology is synonymous with power lines or cables, connecting homes or nodes/computers to a transformer or power station. Computers are the homes or junctions and network connections, cable or wireless are the powerlines.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

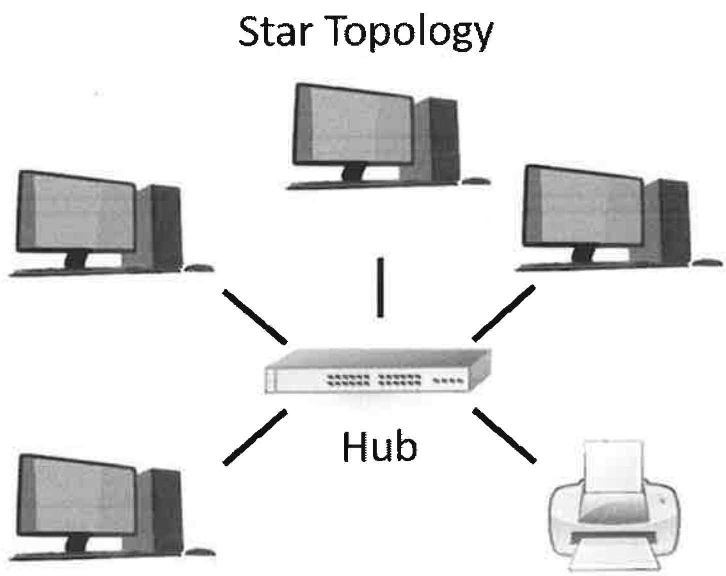
There are numerous ways a network can be arranged, all with different pros and cons, and some are more useful in certain circumstances than others. There are two **categories** of network topology:

1. **Physical:** Physical network topology refers to the actual connections of how the network is arranged.
2. **Logical:** Logical network topology is a higher-level concept of how the network is set up, including which nodes connect to each other and in which ways, as well as how data is transmitted through the network. Logical network topology includes any virtual and cloud resources

There are five common network topologies structures:

Star

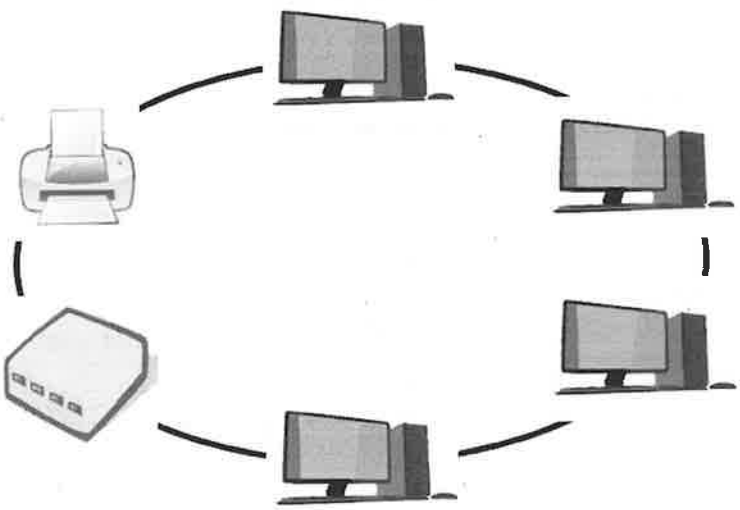
Star: a common network topology where every node in the network is directly connected to one central hub via coaxial, twisted-pair, or fiber-optic cable. A router, switch or hub controls the transmission of all messages sent on the network. The loss of a connected computer does not influence the network's stability, but the loss of the router or switch causes the complete failure of the network.



Ring

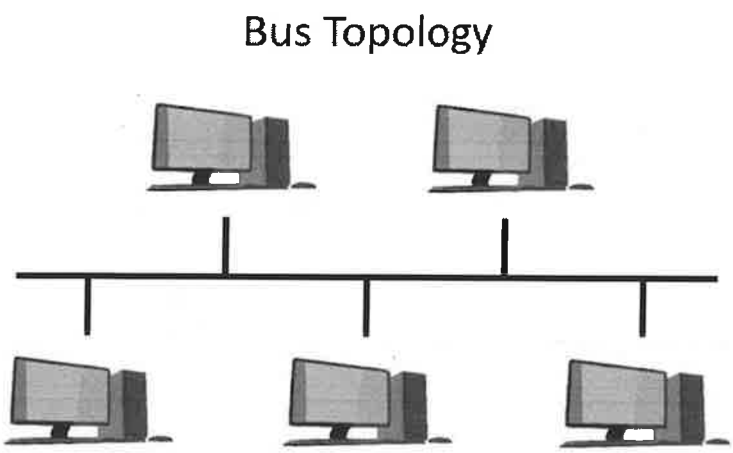
Ring: nodes are arranged in a circle or ring with no central mediator, hub or switch. The data can travel through the ring network in either one direction or both directions, with each device having exactly two neighbors. Data packets are transmitted along the ring moving through each of the intermediate nodes until they arrive at their destination. Loss of a node can lead to total failure of the network; this can be prevented only by double wiring in opposite direction, or by utilizing what is called a Dual-Ring topology. The Ring topology is commonly used in fire alarm systems.

Ring Topology



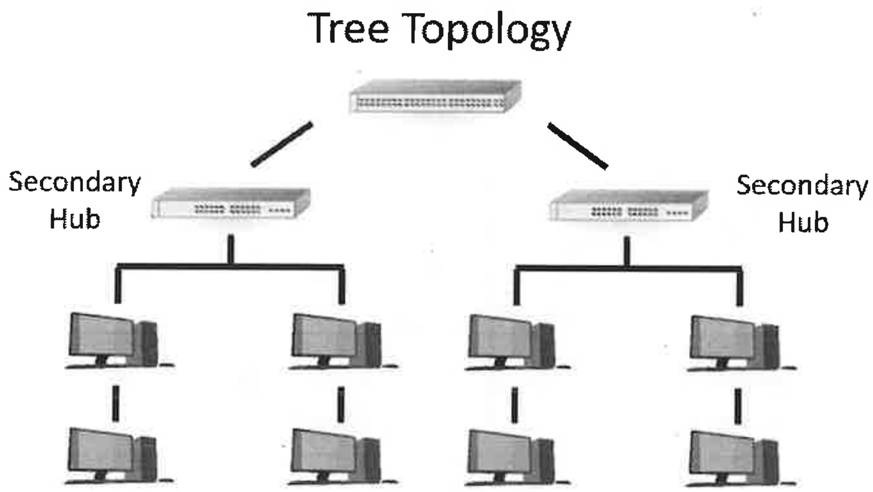
Bus

Bus: orients all devices on the network along a single cable, or common bus channel, running in a single direction from one end of the network to the other. Data flow on the network also follows the route of the cable, moving in one direction. Individual computers or stations request transmission in a bus structure. The loss of a station does not affect network stability.



Tree

Tree: a parent-child hierarchical connection of bus structures. A central node functions as a sort of trunk for the network, with nodes extending outward in a branch-like fashion where each node in the topology is directly connected to a central hub. The loss of a node causes the loss of the subnetworks or trees below it.

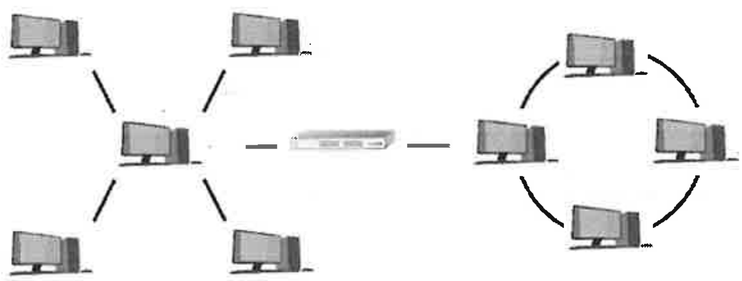


Mixed or Hybrid

Mixed or Hybrid: combine two or more topologies—for example, a tree topology integrating the bus and/or star layouts. Hybrid structures are commonly found in larger companies where individual departments have personalized networking requirements.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

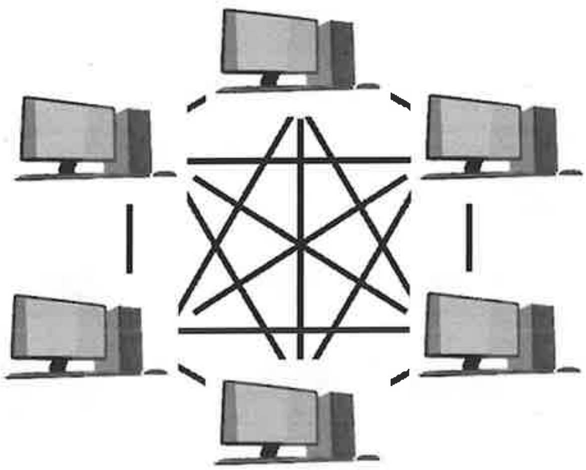
Hybrid Topology



Mesh

Mesh: an intricate and elaborate structure of point-to-point connections where the nodes are interconnected. Mesh networks can be full or partial mesh, and the complex degree of interconnectivity between the nodes makes them more resistant to failure than other topologies. Mesh topologies are labor-intensive and can also be time-consuming to set up but are used for some IoT networks to extend the range by feeding signals from one device to another.

Mesh Topology



Networks: Routers Switches & Wireless Access Points

Switches, routers, and wireless access points are essential features of a network. These devices allow other devices for example, client PCs, servers, connected to your network can communicate with one another, and with other network such as the Internet, Intranet, and Cloud services. Switches, routers, and wireless access points perform different functions in a network.

Switches

Switches are the foundation of facility networks. A switch is a device that connects other devices and manages node-to-node communication within a network, ensuring data packets reach their ultimate destination. While a router sends information between networks, a switch sends information between nodes on the network.

Routers

A router is a physical or virtual device that sends information contained in data packets between networks. Routers analyze data within the packets to determine the best way for the information to reach its ultimate destination. Routers forward data packets until they reach their destination node. Routers connect a facility to the world, protect information from security threats and decide which computers receive priority over others.

Wireless Access Points

A wireless access point (WAP) allows other devices to connect to the wireless network.

Network Cables

The most common network cable types are Ethernet twisted pair, coaxial, and fiber optic. The choice of cable type depends on the size of the network, the arrangement of network elements, and the physical distance between devices.

Data Communication in Networks

Data communication in networks is predicated to two fundamental conditions — the physical connection of computers and/or devices, the network — and the transmission and interpretation of the message, which is determined by various **Network Communication Protocols**. A communication protocol is a system of rules that allow two or more computers or devices to transmit, receive and interpret data.

TCP/IP

Network Communication Protocols. TCP and IP are two separate computer network protocols. IP is the part that obtains the network address to which data is sent. TCP is responsible for data delivery once that IP address has been found.

ISO/OSI Reference Model

ISO developed a reference model that forms the basis for a standard of communication between different networked components and computers. The Open Systems Interconnection Model (Figure 13OSI model) is a conceptual model that standardizes the communication of networked computing systems by ensuring interoperability utilizing standard communication protocols. The OSI Model describes the function of network communication for interoperable open systems, and TCP/IP, for transmission control over networks like the Internet.

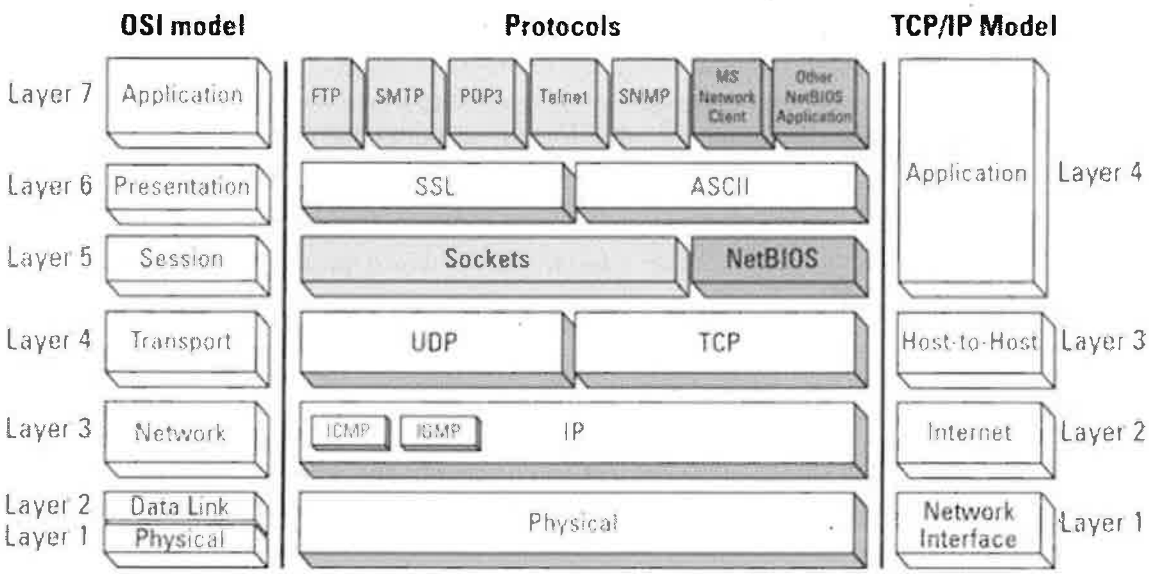


Figure 13 The Open Systems Interconnection Model

Expansion of Network

Networks are not only categorized based on topology or arrangement but also by geographic location. For example, a local area network (LAN) connects computers in a defined physical space, like an office building, whereas a wide area network (WAN) can connect computers multiple facilities or locations. The Internet is the largest example of a WAN, connecting billions of computers worldwide.

- **LAN (Local Area Network):** A LAN connects computers over a relatively short distance, allowing them to share data, files, and resources. The term LAN is usually used to identify a local, privately owned, network inaccessible to the public. LANs are managed and administered by a local IT administrator and IT department.
- **WAN (Wide Area Network):** a WAN connects computers over a wide area, such as from region to region or even continent to continent.
- **MAN (Metropolitan Area Network):** MANs are typically larger than LANs but smaller than WANs. Cities and government entities typically own and manage MANs.
- **GAN (Global Area Network):** A GAN refers to a network composed of different interconnected networks that cover an unlimited geographical area, such as the Internet and World Wide Web.
- **SAN (Storage Area Network):** A SAN is a specialized network that provides access to block-level storage — shared network or cloud storage that, to the user, looks and works like a storage drive that's physically attached to a computer.
- **VPN (Virtual Private Network):** A VPN is a secure, point-to-point connection between two network endpoints. A VPN establishes an encrypted channel that keeps a user's identity and access credentials, as well as any data transferred, inaccessible to hackers.

Internet, Intranet, Extranet & Cloud Services

Internet

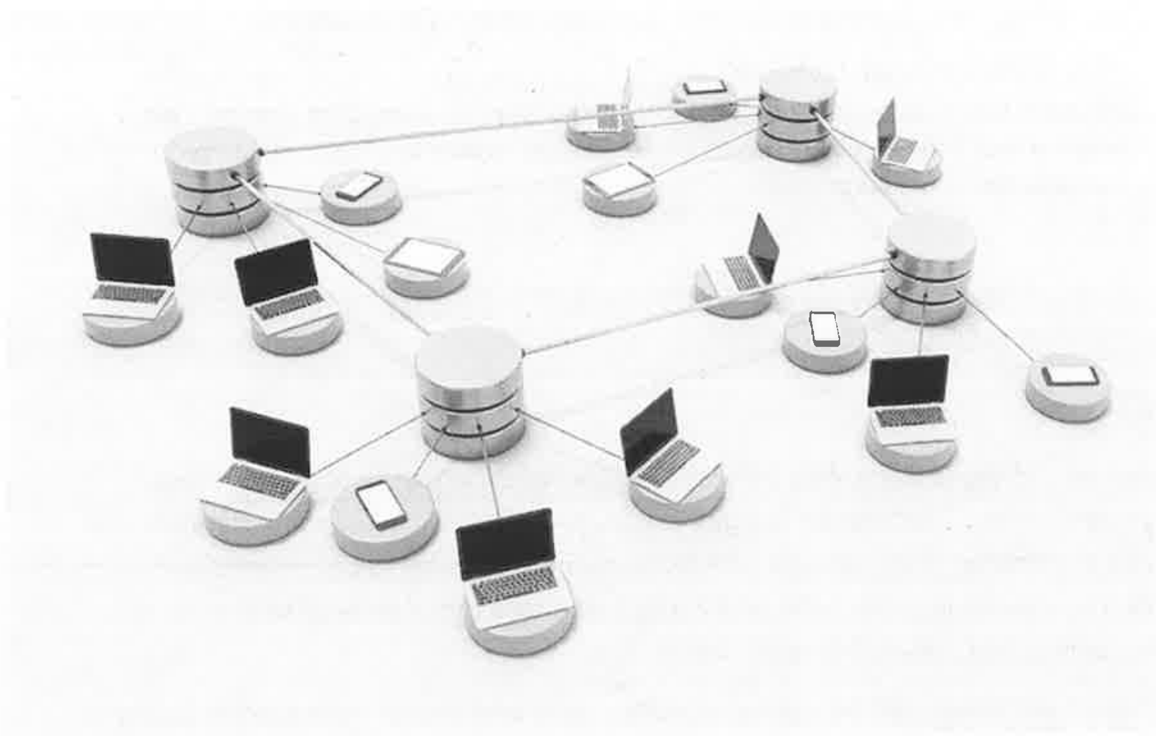
The Internet and World Wide Web (WWW) have changed the nature of business and facility management. The Internet is a global system of interconnected computer networks that uses the Internet protocol suite (TCP/IP) to communicate between networks and devices. The Internet includes LANs and WANs linked by a broad array of electronic, wireless, and optical networking technologies.

The Internet was developed by a group of state, public, and private institutions building on the functionality and ideas of a network used by the DOD (ARPANET) in 1949. The graphical Internet as we know it today was first introduced to the public 1993. The Internet, at its core, is simply a shared network that supports a multitude of services, such as the WWW, email, chat, social media, VoIP and video conferencing.

Today, the Internet is a vital feature of the interconnected and mobile workplace. Network and Internet connectivity is moving the workplace towards ubiquitous service for example, mobile, VPN, Cloud and CAFM and IWMS via SaaS and other hosted solutions.

Intranet

An Intranet is an electronic communications network, based on the same overall design as the Internet, but used for communications among the departments and locations within one company. A company-wide intranet can constitute an important focal point of internal communication and collaboration and provide a single starting point to access internal and external resources. In its simplest form, an Intranet is established with the technologies for LANs and WANs. Many modern Intranets have search engines, user profiles, blogs, mobile apps with notifications, and events planning within their infrastructure. Some corporations blur the line between the private intranet and the public intranet by using one common system to host both services and controlling access to sensitive information via controlled permissions, usernames, and passwords.



Extranet

An Extranet is a collaborative, Internet-based network that facilitates intercompany communications between two or more organizations Intranets. Extranets are typically used as a connection between a facility and its suppliers, customers or other external business partners. Extranets use Internet-derived applications, protocols and technologies to provide secured extensions of internal business processes to external business partners.

Cloud-Based Applications

In cloud computing, users store, access, and process data that is stored on the Internet (Cloud). The major advantages of cloud computing are scalability and lower up-front costs. Organizations can purchase storage in the Cloud and avoid the expense of purchasing hardware and software, as well as operating costs to house the equipment and IT resources. Cloud computing offers greater redundancy in systems and fewer interruptions of service.

Cloud computing services can be public, over the Internet, community-based, clients with similar needs for security or compliance, or private dedicated to a single organization and operated by the organization itself or by a third party.

Figure 14 shows how users interact with Cloud-based services and infrastructure. Remote servers return data and provide access to cloud-based applications

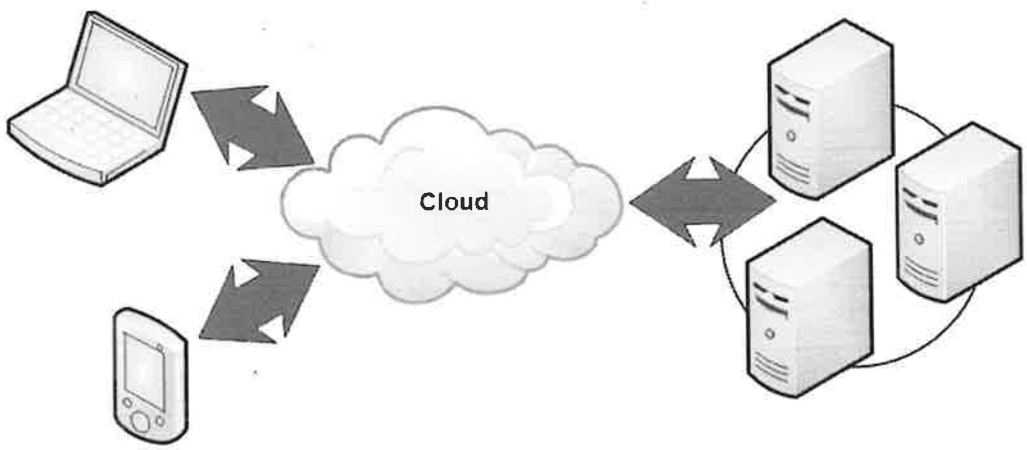


Figure 14 Cloud-based Applications

Cloud-based applications reduce the cost of operating FM software from a capital cost or total cost of ownership, to an operational cost. The advantages to the organization include reduced IT resources and support, savings derived from not having to purchase hardware/servers and establishing a company-owned data center. Cloud services also allow IT to focus on more mission-critical operational support.

Cloud-based applications are like VPNs, including encryption, and include essential structures and functionality of in-house FM applications that support space management, lease administration, and asset management. Some Cloud-based service providers support a "hybrid cloud" that allows an organization to tap into both its private and a public cloud, making internal resources available to the public via the Internet and VPN.

Lesson 2: Wireless Networks

Lesson 2: Introduction

On completion of this lesson, you will be able to:

- Describe various types of wireless networks and protocols

Introduction

Most facilities incorporate wireless, popularly referred to as Wi-Fi, into their overall communication strategies. Wi-Fi is a Local Area Network (WLAN) that uses radio frequency transmission technology to transmit information from one point to another. This trend has been driven by several factors, including the combination of data and voice communication, the adoption of mobile technology, the importance of enterprise data and processes, and the increasingly mobile workplace. Wireless networks are relatively low cost and easy to install and use common protocols, they are vital to the implementation of smart sensors, IoT, and AI.

In general, there are four types of wireless networks:

1. Wireless local area networks (WLAN)
2. Wireless metropolitan networks (WMAN)
3. Wireless personal area networks (WPAN)
4. Wireless wide area networks (WWAN)

Wireless LAN

A WLAN is a wireless computer network that links two or more devices using wireless communication (Wi-Fi) to form a local area network that provides Internet access within a building or a limited outdoor area. Wi-Fi is based on IEEE 802.11, wireless application protocol (WAP) standards that allow users to access information instantly via such handheld wireless devices as mobile phones, pagers, two-way radios, smartphones, and communicators. WLANs are commonly used for local area networking of devices and Internet access.

It is vital to use wireless security protocols and encryption to protect wireless networks. An unprotected Wi-Fi network would be like leaving the front doors open to a building! There are three wireless security protocols Wired Equivalent Privacy (WEP), Wi-Fi Protected Access

(WPA), and WPA2, each with its own strengths and weaknesses. Wi-Fi Protected Access version 2 (WPA2) is based on the 802.11i wireless security standard and contains the highest level of security encryption for Wi-Fi networks.

Wireless MAN

Wireless MAN provides Internet access outside an office or home network. Wireless MANs are local area networks connected to one another within a city and cover a wider area than WLAN or Wi-Fi. MAN access points are located throughout a coverage area, as well as being connected to the Internet and World Wide Web (WWW).

Wireless PAN

WPAN cover a very limited area and use protocols like Bluetooth and Zigbee. Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using UHF (Ultra High Frequency) radio waves. Zigbee uses Bluetooth protocols and can be used to connect remote sensors located in an IoT network.

Wireless WAN

Wireless WAN (WWAN) uses cellular technology to provide access outside the range of a wireless LAN or MAN. These networks enable users to make phone calls to others connecting either through a WWAN or a wired telephone system. Users can also connect to the internet to access websites or server-based applications.

	Wireless LAN (WLAN)	Wireless MAN (WMAN)	Wireless PAN (WPAN)	Wireless WAN (WWAN)
Type of Network	Local Area Network	Metropolitan Area Network	Personal Area Network	Wide Area Network
Goal	Provide Internet access within a building or limited area	Provide access outside office and home networks, generally regional	Transmit signals between devices in limited areas, typically 100 meters	Provide access outside the range of WLANs and WMANs
Connectivity	IEEE 802.11	IEEE 802.16 WiMax	Bluetooth, Zigbee and infrared	LTE

Table 7 Wireless Networks

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Hybrid Communication System

Many wireless networks may be part of a hybrid communication system — providing service to certain parts of the facility while the other parts are served by a cabled network. In some implementations, wireless zones with ceiling-mounted access points operate in a parallel manner alongside conventional cabled networks. This enables occupants to use mobile devices as their primary work tools, which may make sense in an organization with a high proportion of remote workers who use the facility sporadically or visitors who will need connectivity during their stay. Figure 15 shows a wireless installation in which wireless entirely replaces a wired data connection.

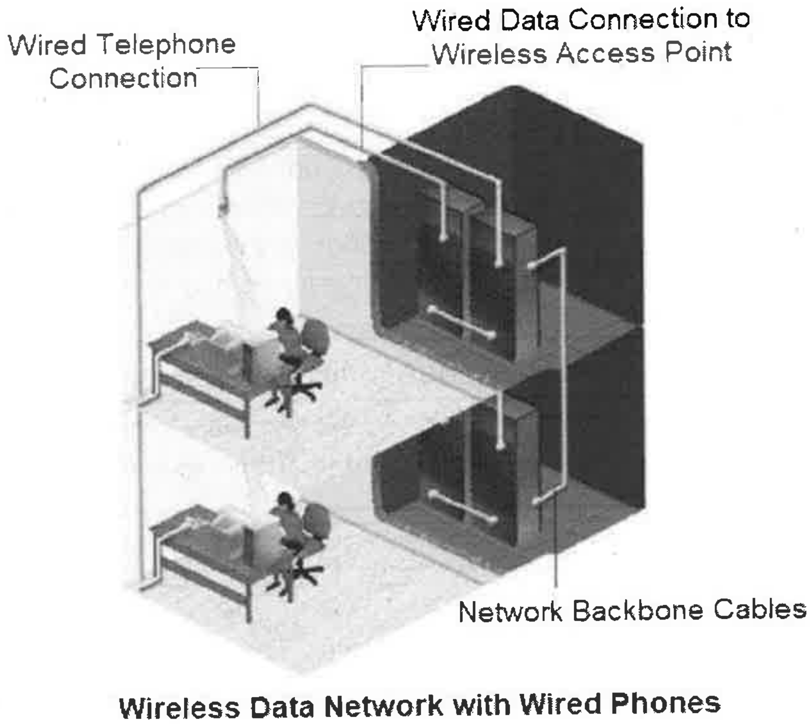


Figure 15 Wireless Data Network

Access points can mount on ceilings, walls, or desks, depending on the coverage area. They can be installed in plenums if local codes allow. Access points must be powered. This can be either through dedicated electrical wiring or by using a system that couples a power supply with Ethernet cables (Power over Ethernet or POE). The system may also require the installation of wireless cards in computing devices, which will involve facility management with IT.

Benefits of Wireless Networks

While wireless networks do not presently have the same bandwidth as wired networks and reliability may be lower, wireless has many offsetting benefits, including:

- Integration with core building systems for increased energy efficiency and security.
- Integration of mobile devices into work processes. For FM, this means that technicians can receive work orders and respond and access online information for example, parts catalogs and ordering, manuals and technical support in real time. Smartphones are increasingly becoming an important tool to increase staff productivity.
- Enhanced value and appeal to tenants.
- Decreased use of cabling and as a result decreased cost in both materials and installation and building fire protection load.
- Networking of hard-to-reach areas. This includes not only providing communication service to occupants but also networking building system elements that would not be feasible to wire into a BAS. In historic buildings, where interiors cannot be disturbed, wireless may be the only option. Some leases may also restrict wiring installations to limit damage to walls.
- Faster setup and connection of new occupants to communications.
- Enhanced productivity since occupants can access and share information wherever they are — especially with the increasing use of smartphones and tablets.

Factors to Consider when Deploying a Wireless Network

The IT department is responsible for the setup and management of a wireless network. Facility managers should consider the following:

Signal Coverage

The type of material used in the construction of a facility has a direct impact on wireless coverage and the reliability of the network and needs to be accounted for. For example, various metallic materials and concrete can interfere with a Wi-Fi signal and/or cause multipath interference where radio signals are unintentionally split into multiple paths. A major component of LEED design is the use of reflective glass and other materials to control facility temperature and to reduce a facility's carbon footprint. Reflective glass and cellular acts as a shield to RF (radio frequency) signals, preventing them from penetrating and causing a reduced Wi-Fi signal. Signal boosters are often required indoors to improve reception.

FM and IT need to ensure adequate coverage by strategically planning where to place wireless access points (AP), in addition to the spacing between APs.

Interference

Whenever dealing with wireless technologies, interference will always be a concern, so prevention is an important aspect to consider when deploying Wi-Fi. Interference is created from other RF (radio frequency) devices that operate within the same frequency band such as other nearby Wi-Fi networks.

Wi-Fi and WLAN Security

Network security is a major concern for stakeholders, IT, and FM. An unsecured network is an unreliable network. Establish encryption mechanisms, such as Wi-Fi Protected Access version 2 (WPA2), and 24X7 intrusion detection and protection of the WLAN and Wi-Fi network.

A facility manager should make sure that the devices that they connect to the Wi-Fi network are also secured. A common entry point for hackers is through IoT devices that have not received updated firmware or are still using their factory administrative password settings.

Lesson 3: Databases and Software

Lesson 3: Introduction

On completion of this lesson, you will be able to:

- Describe the different types of databases in use in FM
- Recall the phases of the software life cycle

What are databases?

Database systems are used for storage data (records) in an extensive and orderly manner. Database systems (DBS) can consist of several databases (DB), which are administered through an integrated database management system (DBMS). The DBMS supervises all the commands interacting with the database and permits only the procedures that are allowed via the user permissions. A common way to classify database systems is by their database model, which specifies the database syntax and semantics.

Hierarchical

Hierarchical database: The hierarchical database stores data in a tree-like structure where data is subdivided into a parent-child relationship to structure the data. These databases have limited use due to the difficulty in recording and maintaining relationships and dependencies at different levels.

Relational

Relational database: A relational database is table-oriented, where every bit of data has a link with every other bit of data (relationships or related fields). Tables include records (related fields) and are referenced by a key field (a unique and atomic record). Relational databases use a process called normalization to reduce data duplication and ensure that records do not appear in duplicate. Relational databases are the most common form of DBS utilized in business and facility management. SQL (Structured Query Language) is a programming language used by nearly all relational databases to query, manipulate, and define data and provide access control.

Object-Oriented

Object-Oriented database: In the object-oriented database, the information is stored in an object-oriented database that is based on object-oriented programming (OOP). The data is represented and stored in the form of objects. OODBMS is also called object databases or object-oriented database management systems.

Object 1: Maintenance Report

Date	
Activity Code	
Route No.	
Daily Production	
Equipment Hours	
Labor Hours	

Object 1 Instance

01-12-01
24
I-95
2.5
6.0
6.0

Object 2: Maintenance Activity

Activity Code	
Activity Name	
Production Unit	
Average Daily Production Rate	

Figure 16 Object-Oriented database

Object-Relational (DBS)

An **object-relational database (DBS)**: Combines the advantages of object-oriented and relational database models. Object-relational databases are used in specialized applications such as multimedia data administration for example, documents, pictures, and audio.

Software

Software is a generic term used to describe any and all computer programs. Software can be separated into two groups: system and application software. System software controls the hardware components, and application software is used to solve specialized tasks.

An example of system software is the operating system of your computer, be it Windows, Mac OS, or Linux. Application software could be CAFM software, ERP software, or office productivity products for example, word processing. Software can be understood as a product, it has characteristics that make it different to tangible products or assets:

- Software is not a tangible asset, nor can it be represented physically.
- Software can be duplicated at nearly zero cost.
- Software has a high potential for errors, or bugs.
- Software is subject to decay or becoming incompatible with current operating systems.

The Software Life Cycle

It's important to note that like other products, software has a limited life cycle (Figure 17).

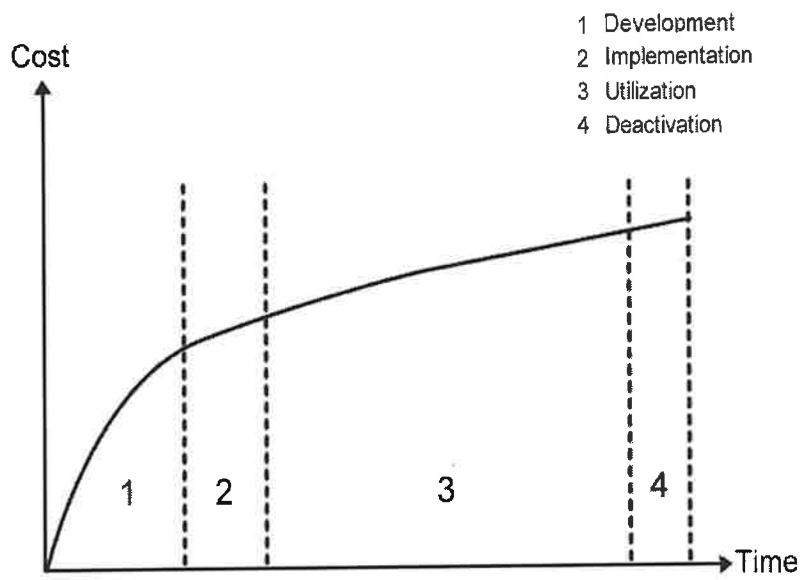


Figure 17 Life Cycle of a CAFM Software

Williams, G. & May, M. (2019) The Facility Manager's Guide to Information Technology. International Facility Management Association

Life Cycle Phases

Phase 1: Development

Software Development: accounts for a very high expenditure due to the cost of the software.

Phase 2: Implementation

Software Implementation and Introduction: adjustments are made by tweaking parameters and populating data, user interface customizations, and leveraging the software's API for integration with other enterprise systems.

Phase 3: Use

Software Use: can range from a few years to several decades. Apart from the software's initial costs, the maintenance and the permanent data administration are primary costs up to and including amortization.

Phase 4: Deactivation

Software Deactivation: results due to data integrity issues and incompatibility with existing enterprise platforms or operating systems.

Edition 2022, Version V2017PAIT_1.0

Lesson 4: IT Security for Facility Managers

Lesson 4: Introduction

On completion of this lesson, you will be able to:

- Explain the importance of data and network security
- Describe technologies and methods to ensure network security
- Describe protocols to provide users access to networks and technologies

Introduction

In 2013, a general merchandise retailer was a victim of a phishing attack that started when an employee of a contract HVAC system company clicked a link that allowed hackers to capture credentials and use them to access a work order system and the store's point-of-sale system. Hackers were able to collect credit card data on 40 million users, which could be sold on the black market.

What is IT Security?

IT security is a set of cybersecurity strategies that prevent unauthorized access to organizational assets, such as computers, networks, and data. It maintains the integrity and confidentiality of sensitive information, blocking the access of sophisticated hackers.

Threats to IT security can come in different forms. A common threat is malware, or malicious software, which may come in different variations to infect network devices, including:

- **Ransomware:** malicious software that infects the computer and displays messages demanding a fee to be paid for the PC or network to work again. Malware can be installed through deceptive links in an email message, instant message, or website.
- **Spyware:** software that enables a user to obtain covert information about another's computer activities by transmitting data covertly from their hardware.
- **Malware Viruses:** software specifically designed to disrupt, damage, or gain unauthorized access to a computer system.
- **Phishing attacks:** sending fraudulent communications that appear to come from a reputable source through email. The goal is to steal sensitive data like the user's login information or to install malware on the user's machine.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Types of IT Security

There are two types of IT security.

1. Internal software and/or application
2. External application, databases and its network

Internal IT Security

Internal IT security includes:

Network security	Network security is used to prevent unauthorized or malicious users from accessing your network. Network security has become increasingly challenging as businesses increase the number of endpoints and migrate services to the cloud.
Internet security	Internet security involves the protection of information that is sent and received in browsers, as well as network security involving web-based applications. These protections are designed to monitor incoming internet traffic for malware and unwanted access. This protection may come in the form of firewalls, anti-malware, and anti-spyware.
Endpoint security	Endpoint security provides protection at the device level. Devices that may be secured by endpoint security include mobile phones, tablets, laptops, and desktop computers. Endpoint security prevents your devices from accessing malicious networks and provide malware protection.

External IT Security

External IT security includes:

Cloud security	Cloud security helps secure the usage of SaaS applications and the public cloud.
Application Security	With application security, software is coded to help ensure that it is not vulnerable to cyberattacks.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Data & Security in FM Software

Organizations use CAFM software to drive maintenance management efficiencies, to meet regulatory and stakeholder requirements, as well as warehouse facilities management and asset-related data. The quantity of business-related data stored in a CAFM makes it imperative that FM work with IT and secure the application. Critical application data that needs to be secured includes:

- Inventory documentation
- Contract management
- Asset management
- Human resources
- Financial data
- Critical infrastructure documentation

General Security

Data security starts well before information is stored in a CAFM. Organizations must provide user access to a CAFM maintain privacy, data integrity, have clear guidelines for system governance, and minimize the vulnerability of data to the following security risks:

- Force of nature
- Lack of governance (user and user group access)
- Organizational issues (lack of resources and organizational guidelines)
- Human error
- Technical failure (defects in equipment and/or data storage)
- Vandalism (vandalism, data manipulation, unauthorized access)

Level of access is simple in terms of a single CAFM but becomes increasingly more difficult when dealing with the multitude of applications in today's enterprise. In this circumstance, authorization and access can be managed using an authentication scheme that allows user to log into multiple applications using Single Sign-On (SSO).

Authorized Concepts

We briefly covered **User Authorization and Governance** in chapter two, but this topic deserves a more in-depth discussion in terms of user access to the CAFM versus network

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

security. Developing and understanding a scheme for user access and administration will ensure user access, data integrity, and network security.

Administration can be simplified by organizing users and datasets into discrete groups with defined rights and scope.

- **User groups:** Organize users by roles and access rights, the need for information based on objective criteria, such as job role or position in the organization. User's rights to create, update or delete data is based on their role and/or access rights.
- **Datasets**: Organize data into sets or groups of similar hierarchy, characteristic or relationship.

Information Security via the Internet

A modern CAFM, whether hosted by a third-party (SaaS) or on a LAN, is accessible via a Web browser on both a desktop computer and mobile device. Communication via a Web browser poses a security risk — particularly when a user accesses the CAFM outside the firewall.

Servers often cache data on the user's computer to speed up the client-server interaction. Cached data can buffer, or persist on the client or server, for a significant period and represents a security risk. Fortunately, the client-side cache has been deprecated and support will be removed from browsers in the future.

In this case, the CAFM web server can use one of two protocols to communicate with the client requesting service. HTTP offers no security and should not be utilized. HTTPS, using Secure Socket Layer (SSL) provides a more secure interface between the user and the server, however, it does not eliminate all security flaws inherent in a Web browser.

Remote Access VPN

VPN is a private network that uses a public network to provide a user remote access to a company's network and CAFM. VPN uses a secure connection (SSH- Secure Shell) with encrypted communication through a public network via the Internet or a third-party provider. VPN provides users with a safe connection to their company's network and applications — like creating a physical cable across the internet.

Firewalls

Firewalls are a network security system that monitors and controls the incoming and outgoing network traffic based on predetermined security rules. A firewall works by establishing a barrier between a trusted network and an untrusted network, such as the Internet. Firewalls protect a facility's network and CAFM from unwanted intrusion and can create permanent VPN tunnels between two networks across the Internet transparent to the user. Firewalls grant valid users access to an application on the WLAN using a variety of methods:

- Using an encrypted username and password
- Using the IP address of the computer
- Using a published security key

Cloud Security

More and more companies are attracted to the benefits of cloud-based applications and hosting. Cloud hosting makes applications and websites accessible via the cloud. Unlike traditional hosting, solutions are not deployed on a single server, but a network of connected virtual and physical servers that host CAFM applications. Cloud-based hosting reduces an organization's operating costs, reduces the complexity of software updates, and increases redundancy and data backups.

One drawback of cloud-based hosting is that the security of a hosted application becomes a collaborative effort between the FM organization, its IT department, and a third-party service provider. Cloud security and level of service vary by provider:

- Software as a Service (SaaS): Cloud service fully implements and manages the CAFM application.
- Platform as a Service (PaaS): Cloud vendor sets up the server, operating system, and implements API (Application Programming Interface), upon which the FM organization or third-party installs and manages the CAFM application.
- Infrastructure as a Service (IaaS): Cloud vendor provides hosting and computing resources and the FM organization or third-party installs and manages the CAFM application.

Security Data in Transit Vs. Rest

Data in transit, or data in motion, is data actively moving from one location to another such as across the internet or through a private network. Data protection in transit is the protection of this data while it's traveling from network to network or being transferred from a local storage device to a cloud storage device. When data is moving it is less secure and at risk.

Data at rest is not actively moving from one device to another or across the network. Data stored on a hard drive, laptop, flash drive, or archived can be considered at rest. Data at rest is just as vulnerable to attack as data in transit. Protecting sensitive data both in transit and at rest and FM organizations should use standard secure transport, such as SSL/TLS and VPN.

Service Availability & Resilience

FM organizations must provide redundant and secure access to CAFM and other applications hosted internally or externally in the Cloud. Loss of service can occur for a variety of reasons. The service provider (host or FM organization) should use the following strategies to maintain available enterprise applications:

- Provide redundant Internet-connect via multiple ISPs
- Utilize redundant computing and infrastructure and data centers
- Extend service endpoints to the customer's premises to allow for service interruptions

FM organizations can decrease the impact of a loss of cloud services by:

- Host critical and time-sensitive applications and functionally in-house
- Backup data to the cloud
- Develop a service level agreement (SLA) where the host shares in the cost of system downtime
- Develop a backup and recovery plan in case of service failure

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 3: Progress Check

1. What technology is required for computers to communicate over a network?
   a. Operating system
   b. Input devices
   c. Network protocols
   d. Ethernet cables

2. What device connects other devices and manages node-to-node communication on the network?
   a. Routers
   b. Switches
   c. Cables
   d. Hubs

3. What protocol does a wireless LAN (WLAN) use?
   a. IEE 802.11
   b. LTE
   c. IEE 802.16 WiMax
   d. Bluetooth

4. What type of network connects computers over a relatively short distance?
   a. Metropolitan area network (MAN)
   b. Local area network (LAN)
   c. Virtual private network (VPN)
   d. Wide area network (WAN)

5. What database uses a tree-like structure?
   a. Object-Oriented
   b. Hierarchical
   c. Relational
   d. Object-relational

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 4: Computer Aided Facility Management Systems (CAFM)

Lessons

- Objectives
- Lesson 1: What is a CAFM?
- Lesson 2: Why Use CAFM?
- Lesson 3: FM Applications and IT Support

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Objectives

Chapter 4: Objectives

On completion of this chapter, you will be able to:

- Explain the different perspectives on CAFM application and the implication on Facility Management
- Describe the benefits of CAFM
- Describe the architecture of CAFM and the integrations of BIM and CAD
- Understand the significance of the FM facility register data documentation and methods for collecting data
- Explain how CAFM is utilized to manage facility space, contracts, cleaning, energy, real estate, and other property

Computer-Aided Facility Management (CAFM) emerged in the latter part of the 20th century when mainframe computers housed most FM technology. In the 21st century, CAFM is far more complex and uses Web, mobile, cloud services and IoT/AI-enabled technology to optimize facility operations, increase efficiency, and boost facility performance.

Lesson 1: What is a CAFM?

Lesson 1: Introduction

On completion of this lesson, you will be able to:

- Explain the different perspectives on CAFM application and the implication on Facility Management

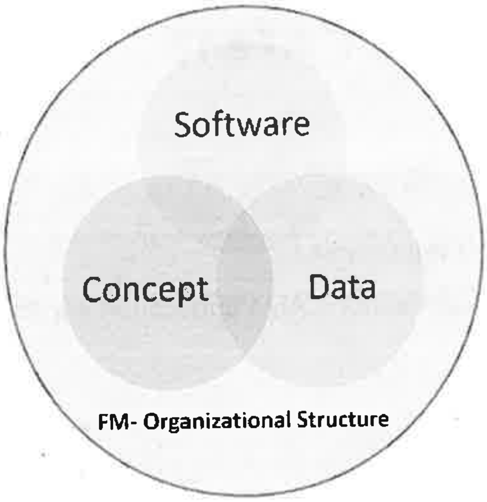
What is Computer-Aided Facility Management (CAFM)?

Computer-Aided Facility Management is a term that has a distinct connotation for many facility managers referring to a platform that focuses on the physical workplace such as floor plans, space utilization and personnel locations. CAFM can be used in general terms to pertain to FM software, and may be used interchangeably with CMMS or IWMS. IFMA defines CAFM as both a system and a tool.

Williams and May (2019) describe CAFM as a suite of domain-specific applications designed to support the FM function, and a system that represents a solution that supports FM and is integral to meeting the specific needs of the enterprise. According to Williams and May, CAFM applications interface between other enterprise applications and automated systems and the organization. From this perspective, the FM organizational structure forms the base and the remainder of the CAFM system includes:

- **Concept:** Initial survey, requirements and functional specifications
- **Software:** CAFM software, enterprise software, and automated systems, and interfaces (ERP, building, etc.)
- **Data:** Inventory, process and other data

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper



The perspectives view CAFM as a software system, or suite of software, and an information technology tool that is used to meet the needs of the demand organization. For the purpose of this chapter, CAFM is referred to as both a suite of software (system) and a tool.

CAFM Systems

CAFM systems can be described as a combination of computer-aided design (CAD) and/or relational database software with specific features to support FM. Fundamentally, CAFM provides the facility manager with the administrative tools and the ability to track, manage, report, and plan FM operations. CAFM systems can be standalone like an IWMS or can include multiple systems through integration by combining two or more tools including:

- Information stored in relational and/or object-oriented database systems
- Enterprise Resource Planning (ERP)
- Computer-Aided Design (CAD)
- Building Information Modeling (BIM)
- Capital planning software
- Computerized Maintenance Management System (CMMS)
- Integrated Workplace Management System (IWMS)

Lesson 2: Why Use CAFM?

Lesson 2: Introduction

On completion of this lesson, you will be able to:

- Describe the benefits of CAFM

The Case for CAFM?

Fundamentally, using a CAFM is about managing information (data) and using that data to make informed operational and strategic decisions. The following case illustrates this point.

CAFM Case Study: Customer ROI - Space Management

Background	An international finance organization with over 5,000,000 sq ft ($1524000\ m^2$) office space (80 percent owned space and 20 percent leased) set a goal to consolidate to a completely owned facility. The company did not have accurate space utilization data. IFMA's benchmark for office space per employee is approximately 110 to 130 sq ft (10 to 12 m^2) per employee. The company hired a CAFM provider to implement a space management solution built on a combination of a database and existing, low intelligence, CAD files.
Results	After gathering, validating and storing the data in a complete space database, the CAFM system confirmed the causes of an average of 256 sq ft (23 m^2) per person: 1) there was a significant amount of vacancy previously obscured inside business units; 2) the lack of space standards was driving up the average square footage per employee and; 3) many executives had offices at multiple locations. As a result, the client was able to develop a detailed program for its new facility that consolidated all of the employees while eliminating over 800,000 sq ft (74,322 m^2) of space. The average sq ft per employee was reduced to 150 (14 m^2) and the cost savings were substantial.

Fundamentally, using a CAFM is about managing information/data and using that data to make informed operational and strategic decisions. The following case illustrates this point.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

CAFM Management and Functional Features

CAFM includes core features that support facility managers and stakeholders in the day-to-day operations of the facility and includes additional functionality that supplements its core features.

Core Features	Other Features
Space Management	Project Management
Inventory Management	Purchasing
Cleaning Management	Fleet Management
Move Management	Access and Control Management
Energy Management	Room Booking
Maintenance Management	Document Management
Security & Access Management	Change Management
Property Management	
Financial Management	
Real Estate and Contract Management	
Occupancy Management	
Asset Management	

What are the Benefits of CAFM?

CAFM assists facility managers to work with greater efficiency, freeing them to focus more on being proactive rather than reacting to day-to-day challenges and crisis. CAFM paired with other technologies, such as AI and IoT, can have a substantial effect on an organization's bottom line. Some of the benefits of CAFM include:

- Efficient space utilization to achieve cost savings and potential reduction in asset inventories.
- Reduced moving and relocation activities resulting in greatly reduced relocation costs and improved occupant productivity.
- Continuous improvement in FM efficiencies.
- Improved project planning leading to reductions in architectural and engineering, construction, and building maintenance costs.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

- Fast and accurate reporting on critical facilities information.
- Existing processes will become more efficient and streamlined, using standardized data that is shared across the enterprise.
- Improved safety and environmental planning capabilities, reducing risk of accident and regulatory compliance violations.
- Disaster planning capabilities are significantly improved by reducing the potential for human injury or death in a disaster. Enhanced planning capabilities facilitate a reduced mean time to recovery.
- Increased data standardization across the organization and the elimination of redundant information held by multiple organizations in various degrees of quality and accuracy.
- Enhanced asset life cycles, particularly when paired with emerging AI predictive maintenance.
- Improved access real-time data and analytics Service-Level Indicators (SLIs) and Key Performance Indicators (KPIs).

CAFM Development and Trends

CAFM Features

Like most enterprise applications, CAFM consists of a relational database and APIs that allow integration with ERP systems, other applications and support Service-Oriented Architectures (SOA) and SaaS.

A distinguishing feature of most modern CAFMs is the ability to integrate CAD and BIM. Both CAD and BIM provide alphanumeric and graphical asset data that can be used for facility planning and management. BIM has a graphical representation but is a fully formed database of its own which is why COBie and IFC are so important to translate data from a proprietary database in the BIM to other databases.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

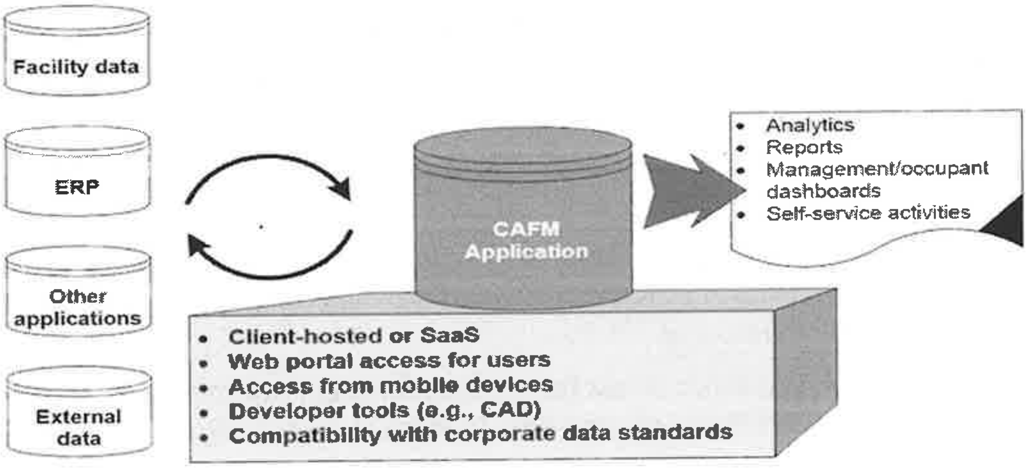


Figure 18 CAFM Features

Business intelligence tools and features that utilize data collection and analysis are more and more common in modern CAFM. These features provide facility managers with the ability to make data-driven decisions and develop metrics and KPIs.

AI, IoT and CAFM and IWMS are integral to the emerging concept of the smart infrastructure. These technologies provide FM with real-time data that is utilized to identify facility faults and proactively implement corrective action — in some cases they even provide real-time predictive analysis.

Lesson 3: FM Applications and IT Support

Lesson 3: Introduction

On completion of this lesson, you will be able to:

- Describe the architecture of CAFM and the integrations of BIM and CAD
- Understand the significance of the facility register data documentation and methods for collecting data
- Explain how CAFM is utilized to manage facility space, contracts, cleaning, energy, real estate and other property

Introduction: The CAFM Model

A CAFM/IWMS creates a model of a facility and its business processes and uses data in multiple formats, graphic or alphanumeric, to quantify and automate system performance and support.

FM Facility Register Data

The integrity and usefulness of a CAFM is dependent on the quality of the facility register data/inventory that is entered into the system. IT and FM business processes rely on accurate and timely data for the entire facility, as well as:

- Land
- Buildings
- Plants
- Equipment
- Facility services

The FM facility register data is available in various formats — documents, spreadsheets, CAD files, images (electronic and scanned). Facility data includes the following categories.

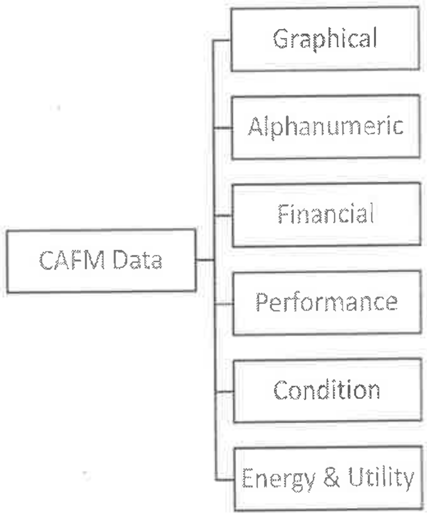


Figure 19 CAFM Data

Methods for Collecting Inventory Data

The primary methods for collecting Inventory data (assets and buildings) that is included in the facility register data include:

- Drawing-oriented/CAD acquisition
- Model-oriented CAD/BIM acquisition
- Alphanumerical data collection
- Semi-automatic data collection

Model Oriented CAD

Computer-Aided Design (CAD) is the application of computer technology to the design of products, including buildings, building sub-systems and structures, using interactive programs. Drawing-oriented CAD is of little value to data acquisition because line drawings and raster graphics are primarily used for low-fidelity graphic and alphanumerical analysis, such as basic space representations.

Model-oriented/BIM acquisition utilizes CAD-oriented modeling to create 3-D representations of a facility. Model-oriented CAD provides flexible and reliable 3-D data for long-term planning, construction, and space management. BIM adds an extra layer of detail and extends object-oriented modeling to construction and occupancy planning. For example, BIM helps FM create conceptual energy modeling which provides early feedback on potential energy implications of a proposed project.

Alphanumerical Data Collection

Alphanumerical data collection is based on analog data stored in existing databases or archives outside a CAFM. Alphanumerical data are generally organized into a hierarchical structure, such as buildings, floors, rooms, assets, and other facility features. Building condition assessments or property valuations are an example of alphanumerical data.

Note: There is a common misconception that CAFM systems can be used "out-of-the-box" like you might when you buy Microsoft Word. However, due to the time, energy, and complexity of data collection (all types) the software cost is typically somewhere between 10 and 30 percent of the implementation cost.

Semiautomatic Data Collection

Semiautomatic data collection combines alphanumerical data collection with mobile devices and barcode or RFID technology. Data pertaining to facility components, equipment, and inventory are collected using preassigned barcodes, or RFID, and reconciled with a database or CAFM. This allows FM and its stakeholders to gain immediate access to data for maintenance or inventory of assets.

Space Management

Space management is the process of controlling, assigning, and managing a building's physical space. It includes tracking and maintaining occupancy information, understanding space utilization, and forecasting future requirements. Space management is critical because it determines technical infrastructure, required services, and capital and real estate investment. The cost of facility management, primarily driven by space costs, are second only to a company's payroll.

The three main objectives of space management are:

- Optimizing the building construction or tenant fit-outs to increase the usable space
- Improving space utilization by the economic occupancy of space
- Enhancing ergonomic and functional design of the workplace

Space management is an integral feature of a CAFM. It uses graphical and alphanumerical data, space allocation, occupancies, and equipment to help the user analyze and effectively plan facility utilization.

The support of space management processes through CAFM includes:

- Organizational structure analysis
- Occupancy analysis
- Allocation planning
- Space utilization optimization
- Internal accounting of space costs
- Rental space management
- Use of specific real estate/facility standards

BIM & Space Management

BIM software is a more robust tool in the space management ecosystem. BIM incorporates 3-D spaces and objects as well as attributes for these components. It can accommodate custom space management requirements and space measurement rules. BIM applications can also be extended to offer additional capabilities such as automated rules checking. BIM offers a more intuitive display of space layouts, supporting better management and communication of space assignments and change scenarios.

Contract Management

Facility managers are particularly concerned with contracts storing data related to them in a CAFM. Some examples of contracts FM manage include rental and lease, insurance and warranty, construction, and cleaning and maintenance. Contract management is composed of:

- Contracts planning
- Contracts design
- Contracts negotiation
- Contracts implementation
- Contracts monitoring and control

CAFM contract management tools allow FM to store contractual data and keep an accurate record of all aspects of the contract, such as:

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

- Obligations and performance
- Duration
- Termination and renewal dates
- Location of contract property

Cleaning Management

The cleanliness of a facility is measured by more than the absence of dust or trash. As an environmental aspect, cleanliness relates to the condition of filters, vents, traps and other maintenance aspects that are significant to the efficiency and air quality of the workspace. Cleanliness may also represent custodial requirements that support the needs of the facility, its operation and its reputation. Cleanliness can become a serious issue when, for example, poor cleaning maintenance results in such high levels of disease-carrying bacteria and occupants become sick or debilitated; then cleanliness is a productivity and safety issue.

IT-supported cleaning management varies by facility. In regulated industries or healthcare, facility cleanliness is monitored with a cleaning management application. In less regulated environments, use of a cleaning management application creates a more aesthetic environment, leads to reduced cost, and satisfied users.

Cleaning management applications assist with the following:

- Planning
    - Staffing
    - Specifications
    - Contract agreements
    - SLAs
    - Green cleaning
- Monitoring
    - SLA Benchmarks
    - Metrics & KPIs
- Quality Control
    - Safety and cleanliness

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Benefits of IT Supported Cleaning Management

IT-supported cleaning management helps reduce labor costs and provides an accurate description of the existing quality-of-service.

After accurately recording the occupancy data, the cleaning procedures are used to:

- Define the daily cleaning services and requirements
- Define the specialized cleaning services
- Document the amount of cleaning activities
- Adjust cleaning procedures to meet demand
- Implement quality-control procedures
- Implement a continuous evaluation cleaning data

Move Management

CAFM move management applications allow the facility manager to track internal and external moves. Move plans are produced graphically with CAD or the tracking of objects or groups of objects in a structured database. CAFM automates the move process through modules such as a move request or space request utility. Modern CAFM software can provide multiple move planning scenarios that help simplify a facility manager's decision-making processes during the move.

Data Collection

Collection of move data in a CAFM system is a prerequisite for documenting the current space inventory. Development of a move plan includes the following tasks:

- Identification of available open space
- Use of installation and move standards
- Inventory of affected assets
- Inventory of workspaces

Facility managers need the following information prior to and during the move:

- Barcode or QR-Codes to mark the destination of the moved inventory
- Updated layouts and facility plans (CAD)

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

- Instructions for move vendor/contractors
- Instructions and/or schedules infrastructure for example, electrical and communication connection requirements
- Instructions for door signage
- Instructions to occupants regarding the schedule and required tasks

During the move, the CAFM software utilizes data, or asset numbers, captured by bar-code readers to query and reconcile existing data tables. These tables containing room assignment, asset inventory, among others are typically captured by a mobile device equipped with a barcode reader.

Energy Management

Energy management is the process of tracking and optimizing energy consumption to conserve usage in a building. Energy management is an operational process that spans the entire facility infrastructure, such as systems, structures, interiors, exteriors and grounds. Facility managers are mandated to reduce waste, increase efficiency, conserve use and meet quality requirements. Energy is used to heat, cool, provide light and run equipment, it is vital to supply and expensive if not used effectively and efficiently.

A process for managing energy includes the following:

- Controlling demand utilizing conservation, green technology, and energy management systems.
- Developing a baseline for energy utilization.
- Considering energy reduction opportunities.

Energy Management Functionality

Energy management functionality is integrated with most CAFM systems, and is referred to as Energy Management Systems, or EMS. The term energy should be understood in a broad sense. Although EMS started with a focus on electrical power, modern EMS track the use of multiple forms of energy for example electric, natural gas, fuel oil and water. The systems monitor use, analyze and provide alarms/reports, and manage demand from the building down to individual assets.

Energy Consumption:

- **Energy consumption:**

  Information derived from online metering devices such as electric energy meters and gas meters.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

System Information

- **System information:**

  Information, such as HVAC systems settings and sensor readings are found in a Building Management System (BMS).

Assets Information

- **Assets Information:**

  Information, such as building size, floor number and area, cooling capacity of installed HVAC systems and maintenance logs are found in a CAFM system.

Weather Information

- **Weather information:**

  Information commonly derived from internet weather feeds or locally installed sensors.

Occupancy/Use Information

- **Occupancy / Use information:**

  Information, such as room occupancy of a hotel or customers served at a retail store, are found in an ERP.

Utility Bills Information

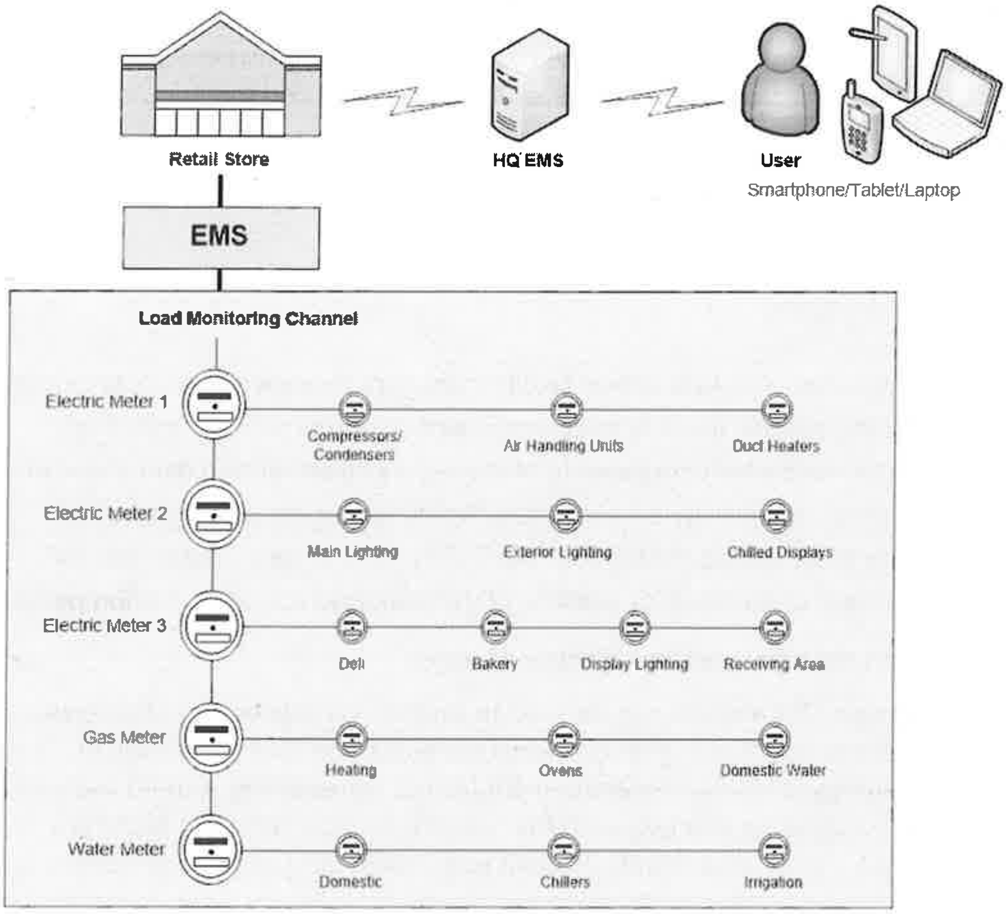


Figure 20 Utility Bills

- **Utility bills information:**

  Information resident in an EAS (Energy Accounting Software)

Energy Management System Components

An EMS includes the following modules:

- Visualization/dashboard module which presents graphical or table illustrations of energy information (from EMS), system information (from BMS) and billing information (from Energy Accounting Software (EAS)).
- Alarm module which will create and manage alarms based on given threshold values and/or Faults Detection & Diagnosis detection methods.
- Work order module which creates and manages notifications of alarms directed towards appropriate users. The Work Order Module manages the actions of users

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

related to each fault along the Fault Cycle such as detection, diagnosis, action, evaluation.

- Data source module which manages the connection to and synchronization with the various data sources such as energy management systems and metering devices, BMS, EAS and ERP.
- Reporting module which manages the creation and distribution of energy and facility reports.

Energy Analytics

Energy Management System software allows facility managers to track and analyze energy use by the whole facility, specific areas or specific systems or equipment. By installing submeters and smart meters which are capable of storing and transmitting data about how much and at what time of day energy is being used, facility managers can get a better picture of how energy is consumed throughout the facility—the largest consumers, the times of day and the days of the week or seasons of the year at which consumption peaks.

This information can then be used in a variety of ways:

- **Forecasting use:** This analysis can be used to support various energy strategies, from capital investments in higher efficiency systems or on-site generation of sustainable energy to demand-management tactics. For example, a trend analysis showing ever-increasing energy use in the facility's data center could become a starting point for a discussion with IT about sustainable data center alternatives.
- **Identification of opportunities for energy improvement investments**: For example, a facility breakdown of energy use by the system might identify opportunities to improve energy efficiency in food service areas.
- **Testing of strategic energy tactics:** Software can support the creation and comparison of scenarios to test the cost-effectiveness of capital investments under different conditions, such as energy rate changes or level of efficiency achieved.
- **Advanced diagnostics:** Performance baselines can be created for most system components, and actual performance can be monitored and trended against that baseline. Problems that are causing inefficient use of energy or may indicate component failure can be identified quickly. Automated diagnostics can capture many times more data points than manual methods, which increases the odds of finding brief and rare events that could cause serious disruption.
- **Verifying service agreements with energy service contractors:** Energy performance contractors (EPCs) or energy service companies (ESCOs) work with facilities to deliver a certain level of energy performance for a fee or percentage of savings. This is essentially a risk-sharing arrangement: the client receives expertise and sometimes energy-saving equipment, and the contractor is rewarded if the

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

client sees the promised increase in efficiency. EMS data can verify the results of the agreement.

- **Compliance:** An increasing number of municipalities and countries are requiring that buildings display their energy efficiency. An EMS can provide data needed to comply with energy reporting requirements.

Building Energy Management Systems (BeMS)

According to Continental Automated Buildings Association (CABA) (2019), a leading international, not-for-profit industry organization for the connected home and intelligent building technologies market, approximately 25-30 percent of energy consumed in buildings is wasted.

IoT has transformed the energy industry. Insight derived from data collected from devices linked to the Internet provide opportunities to improve energy efficiency, solve critical problems and enhance operational performance. IoT applications are helping organizations to dramatically improve building operations and reduce cost.

What is BeMS?

Building Energy Management System (BeMS) is an IoT enabled CAFM system that monitors and controls energy-related facility services such as heating, ventilation and air-conditioning, ensuring the building operates at maximum levels of efficiency. The optimal level of efficiency is achieved by continuously maintaining the correct balance between operating requirements, external and internal environmental conditions, and energy usage. The term BeMS is often confused with BMS, however BeMS only manages energy-related systems, whereas a BMS monitors and controls a wide range of building systems including fire alarms, CCTV and motion sensors. BeMS provides the information and tools that facility managers need to both understand energy usage and control and improve energy performance.

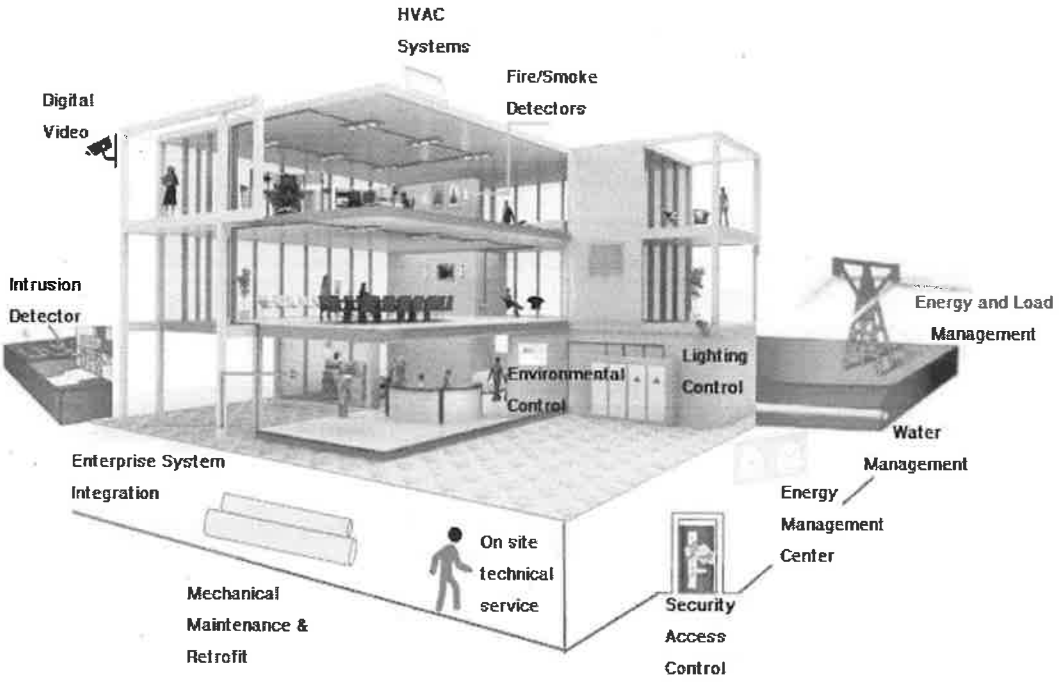


Figure 21 Building Energy Management System

Property Management

Property management is generally described as operating property primarily for business use. Property management typically infers the effective operation and management of owned, leased or subleased real property including land, buildings, assets, equipment and legal commitments for an owner, developer or landlord.

Real estate and leased property are one of the largest expenses for an organization, so it is imperative that FM and stakeholders continually evaluate property value and utilization. IWMS/CAFM is useful in supporting contract management and offering opportunities to optimize real estate life cycle management in three key areas:

- Transaction management provides the decision support for organizations to manage building acquisition and disposal. Real-time visibility of current performance and scenario modeling helps FM and stakeholders make data-driven decisions.
- Lease administration streamlines lease renewals and avoids increased costs, and increases effectiveness through automated tracking, date notification, and invoice validation. This includes providing relevant lease data for the compilation of lease summaries as well as for the management of existing lease/rental agreements. The

required leased/rental areas can be extracted from a space management application integrated in the CAFM.

- Lease accounting helps executives audit numerous financial assumptions, approvals, ensures that balance sheets reflect both assets and liabilities, and supports compliance with financial reporting requirements.

Additional lease/rental data is available in the tracking module of a CAFM application, such as:

- General tenant information
- Duration of the contract, notification periods, options
- Allocation of rentable spaces, open and common/public spaces
- Building access information
- Record of the contract history

Property management applications utilize alphanumerical and graphical data, such as floor plans with room stamps and the location of occupied areas in the building, along with a visual representation of the overall building and the interior.

Maintenance Management

Facilities maintenance management encompasses a range of processes required to ensure that buildings and equipment perform as required. CMMS provides facility managers with a detailed view of the maintenance operations of a facility.

One of CMMS' strengths is its ability to assist in, and/or automatically generate, preventive maintenance work orders on a predetermined schedule.

CMMS applications include procedures for developing the following:

- Preventative maintenance
- Planned maintenance
- Unplanned maintenance
- Condition-based maintenance
- Predictive Maintenance

The focus of a CMMS is on documenting equipment failures, maintenance activities, and contract/warranty management, which can then be integrated to a CAFM system. In addition, the data collected and organized through a CMMS system can help facility managers meet regulatory and compliance requirements.

Chapter 4: Progress Check

1. What kind of inventory data is an Excel spreadsheet containing repair parts information?
   a. Condition
   b. Graphical
   c. Performance
   d. Alphanumeric

2. What is an example of a CAFM core feature?
   a. Access Control Management
   b. Project Management
   c. Room Booking
   d. Energy Management

3. Space management includes all of the following **except**:
   a. Tracking and maintaining occupancy information
   b. Understanding space utilization
   c. Forecasting future requirements
   d. Rental and lease management

4. What information such as HVAC system settings, sensor readings are monitored by an EMS.
   a. Occupancy Use
   b. Assets
   c. Energy consumption
   d. System

5. What component of a CAFM can you use to store graphical data?
   a. Enterprise Resource Planning (ERP)
   b. Alphanumeric data
   c. Computer-Aided Design (CAD)
   d. Analytics

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 5: Tools and Concepts

Lessons

- Objectives
- Lesson 1: Facility Management and Control Systems
- Lesson 2: Building Imaging & Modeling
- Lesson 3: Emerging Tools, Technologies and Applications

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Objectives

Chapter 5: Objectives

On completion of this chapter, you will be able to:

- Describe the features, functions, and benefits of an Integrated Workplace Management System (IWMS)
- Describe the features, functions, and benefits of a Computerized Maintenance Management System (CMMS)
- Describe the features, functions and benefits of a Building Automation and Control System (BAS)
- Describe the features, functions, and benefits of a Building Information Modeling System (BIM)
- Understand the applications and benefit of Internet of Things (IoT) in Facility Management
- Explain the applications and benefits of Augmented Reality (AR) and Virtual Reality (VR) in Facility Management
- Summarize the applications and benefits of Artificial Intelligence (AI) in Facility Management

A facility manager needs to be aware of the effect of current control systems and emerging technology on the facility. Recent innovations in Building Information Management (BIM), the Internet of Things (IoT), Artificial Intelligence (AI), and drones provide FM with the resources and data to intelligently manage the smart building.

Lesson 1: Facility Management and Control Systems

Lesson 1: Introduction

On completion of this lesson, you will be able to:

- Describe the features, functions, and benefits of an Integrated Workplace Management System (IWMS)
- Describe the features, functions, and benefits of a Computerized Maintenance Management System (CMMS)
- Describe the features, functions, and benefits of a Building Automation and Control System (BAS)

Integrated Workplace Management Systems (IWMS)

Introduction to Integrated Workplace Management Systems

An integrated workplace management system (IWMS) (Figure 22) is an enterprise-level software platform with broad functionality. IWMS evolved from traditional CAFM systems and supports the entire life cycle of a facility — from design to construction and operations. IWMS facilitates the integration of data and offers functionality to support maintenance management, space management and planning, real estate and lease management, project portfolio management, and environmental sustainability.

The features and functions of an IWMS are covered in this lesson. To understanding the benefits of IWMS, first examine how facility management software has evolved over time.

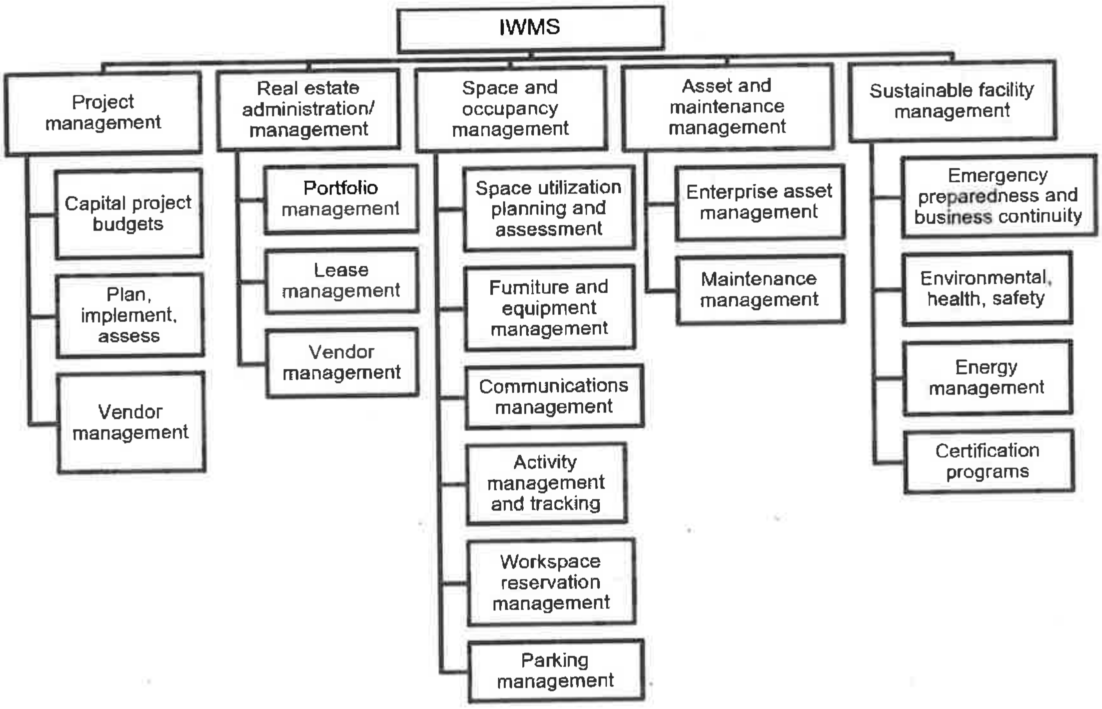


Figure 22 Integrated Workplace Management System

IWMS Evolution

Technologies such as Integrated Workplace Management Systems (IWMS), Computer-assisted Facility Management (CAFM), and Computerized Maintenance Management Systems (CMMS) focus on facility responsibilities other than the physical acts of operating and maintaining core building systems.

FM technologies have evolved since the late 1980s, leveraging the personal computer (PC) to provide an interface for the collection of FM information and automated tools to digitize the management of many FM functions. After the emergence of the Internet, computer networks, and relational databases, Computerized Maintenance Management Systems (CMMS) and IWMS applications provided the facility manager with the tools necessary to track, plan, manage, and report on facilities information. The evolution of the IWMS is depicted below:

Departmental Tool Prior to CAFM and IWMS, FM used discreet/not integrated software applications such as spreadsheets, CAD or in some cases CMMS, to track, plan, and manage information and data.

Organizational Tool As organizations began to focus more on achieving higher productivity and increasing the enterprise's value, space

	management processes became integral to the organization's success. CAFM applications evolved to provide detailed information on how space was being used and the ability to manage it more efficiently.
Enterprise Performance Management Tool	At this stage in the evolution of IWMS, FM focuses more on integrating building data throughout the organization, and to support business strategy and goals. IWMS were starting to be used to analyze the value of property and assets, as well as manage assets through their complete life cycle. Real-time data is available to support senior management and to provide accountability to stakeholders.
Strategic Tool	As business trends emphasized accountability and metrics, IWMS became an essential tool for not just FM but the organization to measure its performance. For example, being able to calculate true total cost of occupancy allowed organizations to improve leasing decisions and investing in infrastructure that lowered costs.

Table 8 IWMS Evolution

IWMS Architecture

IWMS allows FM to manage costs and realize other outcomes over the life cycle of a project, space, building, or system. Central to the concept of IWMS is the integration of information from various data sources or databases so that it can be used across the organization. Information stored in an IWMS can be graphic such as CADs, flowcharts, scanned images and alphanumeric, such as spreadsheets, asset histories, documents, and data.

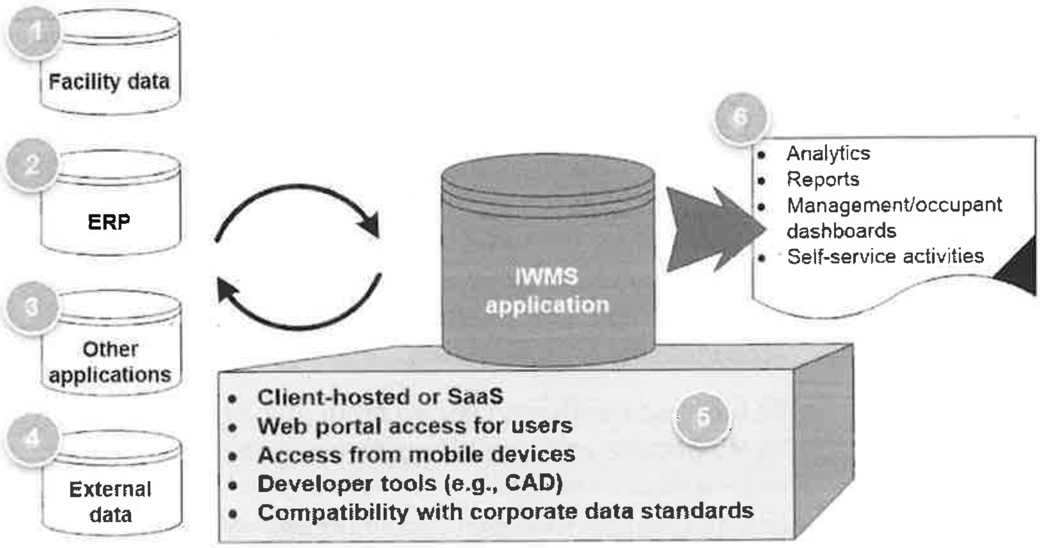


Figure 23 IWMS: Integration Information

IWMS Architecture includes:

1 IWMS integrates facility databases, including information such as facility assets, computer-aided design (CAD) images, performance data, event histories, warranty information.

2 IWMS integrates with ERP databases. This data often describes strategic objectives, provides budgets and forecasts, tracks project cost and schedule data, defines current employment numbers and per employee costs, documents vendor information, or details business continuity plans.

3 Databases that include other special-purpose applications specific to the facility or operation.

4 External databases, used, for example, to convert currency or document local legal and regulatory compliance.

5 IWMS are client-hosted or use cloud-based (SaaS) hosting that provides access, allows remote users to access the system using VPN and mobile devices. Probably the most important feature of IWMS is the use of data standards that allow integration with other applications, such as ERP.

6 IWMS are client-hosted or use cloud-based (SaaS) hosting that provides access, allows remote users to access the system via the Internet, by using VPN and through mobile devices. Probably the most important feature of IWMS is the use of data standards that allow integration with other applications, such as ERP.

Benefits of Integrated Workplace Management System

IWMS is a strategic management tool that provides FM with the following benefits:

- **Transparency:** Data can be analyzed to show how well FM is performing on the entire range of strategic goals—financial, operational and sustainable goals.
- **Control:** FM can account for its assets, their use and their return on investment. The organization can analyze its vulnerability to various risks more accurately and manage complex outsourced relationships.
- **Agility:** Data can support faster and better decisions. Business continuity plans can be implemented and updated quickly.
- **Flexibility:** IWMS applications can be tailored to organizations of different sizes and business types, including global organizations using different language and dealing with multiple currencies, exchange rates and with unique local legal requirements. Systems can accommodate an increasingly mobile workforce.
- **Compliance:** Applications track required data and generate necessary reports in a timely manner. Many real estate IWMS, ensure compliance with the requirements of the Financial Accounting Standards Board (FASB) and International Accounting Standards Board (IASB).
- **Quality Improvement tools:** The trend in IWMS is to build applications around process blueprints that can be considered best practices—a practice that can improve and standardize organization performance.

Application of IWMS in FM

Project Management

IWMS applications can manage organization-level capital improvement budgets, supporting management decisions on how to allocate resources and providing transparency about the degree to which a project has achieved its various goals. It can help users plan a project, allowing them to use project histories to create rough, estimated costs and schedules and to test different scenarios. During the implementation phase, the system tracks schedules, the achievement of milestones, labor and cost budget, and vendor issues. Team managers have access to common documents, and the application controls document versioning. At project close, the system can support an analysis of the project execution against its original objectives and parameters. Stored information provides an opportunity for institutional learning to be applied to future projects. Vendors can be given

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

access to the system to perform various activities, such as entering progress or supply orders.

Real Estate Management

A real estate portfolio management application performs on both strategic and tactical levels. It can support the development of strategic goals in real estate management, define appropriate metrics and visually present performance against these key performance indicators (KPIs) in a dashboard. This information can be used to implement decisions based on the organization's strategies for example, disposing of inefficient properties. Some systems can evaluate real estate portfolios, identify underperforming properties and suggesting alternative strategies. Systems can support improvement by implementing efficient workflows and benchmarking improvement efforts.

On a tactical level, the IWMS:

- Manages property-related documents. Missing documentation at the time of property sales can directly impact a property's sale price.
- Organizes and tracks lease and agreement details.
- Communicates agreement details to FM and other parties.
- Supports reporting for tax and other compliance purposes.

At any point in time, a facility manager can access the most current information about a particular property, as well as its history.

Space Management

Figure 24 represents a composite of data from a study of fifty facilities. Operational costs represented the smallest share of new building costs for these facilities, but in the course of the facilities' life cycles, those costs represent an increasingly large share of a building's capital outlay. Within twenty years the cost of space had outpaced the cost of maintaining infrastructure. These facilities were not a balanced cross-section of facility types, but the essential message of the data applies to all facilities. Underutilization of space should be a major concern for FM because it is common and becomes increasingly expensive for organizations over time.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

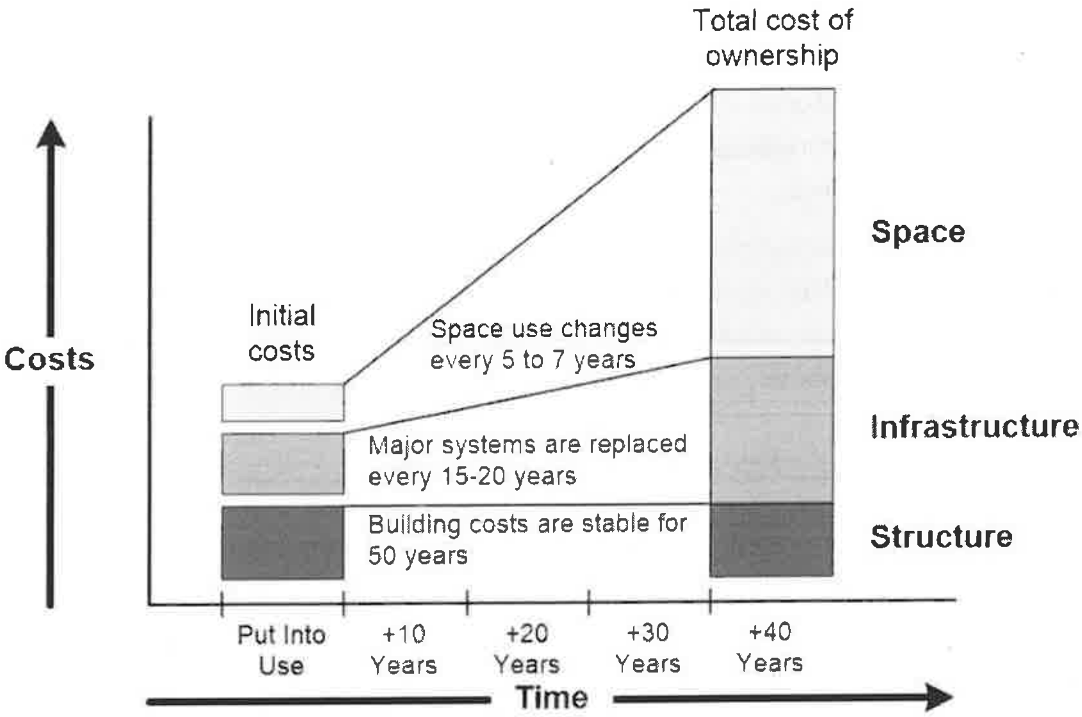


Figure 24 Life-Cycle Facility Capital Costs

Benefits of Space Management Applications

IWMS space utilization applications help FM manage space and its associated costs better by using facility and ERP data to:

- Analyze use of space and assets throughout the organization
- Develop and apply organization-wide space standards
- Align patterns of use with the organization's strategic goals
- Plan for future needs by applying business forecasts to project space needs and best use.

The IWMS identifies opportunities to increase usable space, to allocate space in a more productive manner, and to use space more efficiently. Data about space use can be analyzed to assess how assets such as meeting rooms and unassigned desks are being used and to determine appropriate space costs for chargeback or internal leasing purposes. Organizations may discover that space use becomes more efficient when business units must include space in their budgets.

The systems can also support planning through CAD applications that can illustrate proposed floor plans and efficient reconfiguring of spaces—applying organizational standards for space use.

Occupant Self-Service

The self-service capability included in many IWMS allows occupants to perform many tasks themselves. Departments can reserve resources, such as meeting rooms, temporary workstations, or parking spaces.

From a safety and security perspective, IWMS applications provide control access and share data with facility security so that visitors can receive appropriate clearances. IWMS applications can inform occupants of the location of the closest exits, emergency/first aid equipment, and assigned assembly areas in the event of facility evacuation.

Mini-Case: Real Estate & Space Management

An international logistics firm uses an IWMS to manage 800,000 sq ft (about 74,000 square meters (m^2) in nine different locations. The organization struggled with the amount of time it took to develop accurate space utilization reports.

In the five years since implementing an IWMS, the firm achieved the following results:

- 3 percent reduction in vacancy rate
- 2 percent increase in space utilization rates
- Better lease administration— no critical deadlines were missed in five years
- An estimated cost savings of €4.8 Million (Euro) ($5 Million US Dollars)

Asset Management

The first CMMS systems were designed to run on mainframe computers to manage the maintenance of assets—typically in a manufacturing setting. These CMMS essentially automated what had been a manual work order process used to schedule planned and unplanned maintenance. They were stand-alone programs that served single functions, departments or facilities.

Like other IWMS products, asset and maintenance applications have strategic and tactical uses.

Benefits

Strategic

From a strategic perspective, IWMS help FM to:

- Document and track the value of the organization's assets.

- Provide greater security for assets; loss prevention and control.
- Track work orders and create forecasts.
- Track costs to specific assets to identify issues.
- Create metrics and evaluate actual performance against these metrics.
- Improve maintenance processes.
- Ensure compliance by generating audit data—particularly for hazardous materials.
- Document completion of required inspections and maintenance.

Tactical

On a tactical level, the system can help manage and track specific projects and automate planned and unplanned maintenance work assignments. Automation of these tasks reduces time and expense associated with the administrative overhead of maintenance management, improves response times, and extends the lifespan of facility equipment.

IWMS includes self-service capabilities that allow occupants to report facility issues via the web. The system associates the request with the space in question so that facility management can verify that the request is covered and meets agreed-upon SLA's (Service Level Agreements).

The system supports mobile and web apps so easy access to features that assist in completing and documenting work requests. For example, technicians can check on the availability of parts and place orders completely from a mobile app.

Selecting and Purchasing an IWMS

The decision to implement an IWMS requires considerable planning and investment of organizational resources and facility management. Facility managers should begin the selection process by focusing on organizational needs, current and future goals, how those needs are prioritized by management, and then select a diverse team of stakeholders to participate in the selection process.

The next step is to examine the features included in the various IWMS products on the market and how they support the needs and use cases identified by the selection team. Beyond these needs, facility managers should consider how well these features are implemented by the application vendor. Partnering with IT is essential at this phase, and they should take an active role in validating the IWMS selection can be integrated into the existing IT infrastructure.

Examples of important systems features to consider include:

- User-friendly and intuitive interfaces
- Integration with enterprise applications/APIs
- Speed of transactions
- Multiple clients capability
- CAD integration
- Web and mobile capability
- Access control and security
- Workflow modeling capability
- Document management
- GIS functionality
- Enterprise portal compatibility
- Role-based Web portals/access, VPN
- Analytics and metrics
- Reporting tools and dashboards.
- Wireless access
- Level of Customer support

Mini-Case: IWMS Selection

FM in one region of a global organization requested funding for planning an IWMS to replace an existing 10-year-old CAFM system. The project scope included researching organizational needs to establish detailed user requirement specifications and describing the optimal procurement process.

Stakeholders noted the following in support of the project:

- A major planned refurbishment project could be completed only with an IWMS.
- Delay in IWMS implementation would increase risk and financial loss in the event of a CAFM data corruption or crash.
- Major benefits of acquiring an IWMS included cost reduction in system operation and facility management and better integration into the existing information system.
- Additional benefits would result from:
    - Advanced facility services outsourcing tools.
    - The ability to transform a system used by only a few personnel into a standardized tool that could be accessed by a broader user base.
    - Support of increased compliance requirements and regulation by providing more accurate and timely building operation documentation.

Results:

The proposal included a 14-month schedule for review, design of system requirements, building and testing, and implementation. Budgeting occurred in two phases: US$80,000 for design and US$400,000 for delivery of the IWMS.

Note: The sponsors noted that the organization would own all data.

Computerized Maintenance Management Systems (CMMS)

CMMS Introduction

Computerized Maintenance Management Systems (CMMS) is a software package that maintains and manages information about a facility's maintenance operation. The basic functions of a CMMS are work order management, asset management, and planned maintenance scheduling. In addition, a CMMS generates reports related to any asset or building maintained by FM. For example, a CMMS can be used to schedule and document preventive and planned maintenance in a facility and generates and prioritizes work orders, and schedule staff to complete the work. Upon completion of a task, the CMMS generates a detailed description of the work completed, and this information is used for SLA tracking and future labor planning.

Evolution of the CMMS

1960's

In the 1960's, FM used punch cards and mainframe computers to handle maintenance tasks. Technicians would punch work-order data, such as failure codes, into punch cards which were then entered into the mainframe computer data entry clerks.

1970's

In the 1970's, advances in computing allowed organizations to move from punch cards to paperwork orders. After technicians completed a maintenance task, they filled out the work order forms and returned them to data-entry clerks, who then entered the information directly into a mainframe computer.

1980's

As computers got smaller and more powerful, CMMS technology became more accessible and affordable to small and mid-size organizations. CMMS software was installed on micro-computers (IBM-PC) and the data was entered by technicians after the work orders were complete.

1990's

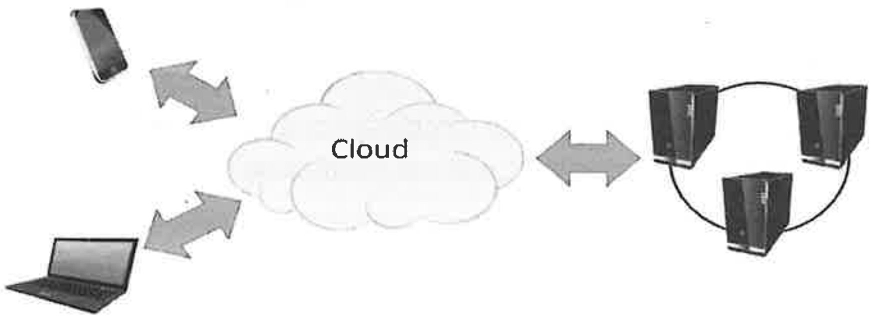
Advances in networking allowed organizations to share information across a local-area network (LAN). CMMS were still evolving, and many were "homegrown" and developed using desktop applications and databases like MS Access and FileMaker.

2000's

The 2000's, saw the emergence of the World Wide Web, and the birth of the browser-based CMMS.

2010+

Cloud-based (SaaS) CMMS emerged in the marketplace. Cloud-based CMMS includes the benefits of reduced implementation costs, modular integration with enterprise systems, ease of upgrades, and redundancy.



CMMS Architecture

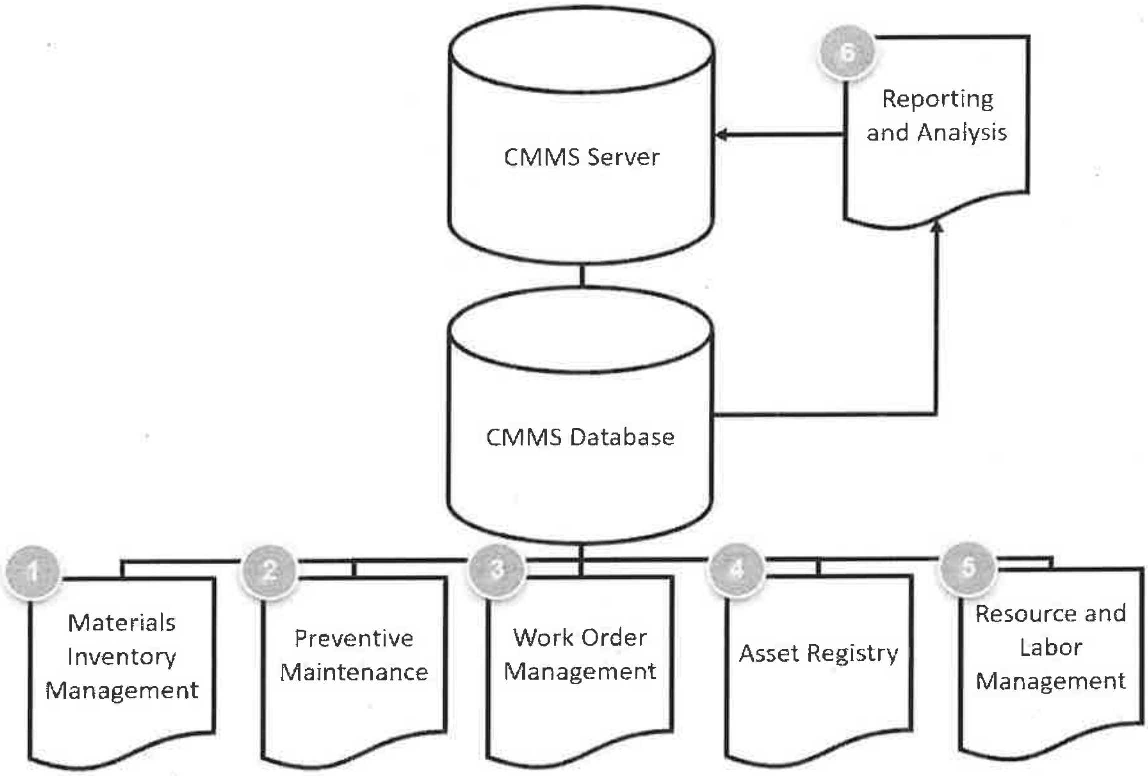


Figure 25 CMMS Architecture

The core of a CMMS is its database. The CMMS data model organizes information about assets FM is charged with maintaining, as well as the equipment, materials, and other resources. The information in a CMMS database supports various functions of the system, which enable the following capabilities (Figure 25):

1 **Materials and inventory management:** Inventory, distribute and reclaim maintenance and repair operation (MRO) equipment and materials across storage areas, distribution centers and facilities. Manage suppliers, track inventory costs and automate resupply.

2 **Preventive maintenance:** Automate work order initiation based on time, usage or triggered events. Use preventive maintenance to organize and associate assets across multiple orders. Sequence and schedule preventive work orders.

3 **Work order management:** Typically viewed as the main function of CMMS, work order management includes information such as work order number, description and priority, order type, cause and remedy codes, and personnel assignment.

4 **Store, access and share asset information:** Information such as manufacturer, model, serial number and equipment class and type, associated costs and codes,

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

location and position, performance and downtime statistics, associated documentation, videos, images, availability of meters, sensors, and IoT instrumentation.

5. **Resource and labor management:** Once this feature is complete, the system can automatically assign work orders and balance workloads.
6. **Reporting, analysis and auditing:** Generate reports across maintenance categories such as asset availability, materials usage, labor and material costs, supplier assessments and more. Analyze information to understand asset availability, performance trends, MRO inventory optimization and other information to support business decisions and gather and organize information for audits.

Benefits

Benefits of a CMMS include:

- Tracking and Reporting

  Centralized information in the CMMS database enables maintenance managers and teams to access information on an asset. Control costs by tracking and reporting, avoid rework and scrap, and save energy.

- Workflow Visibility

  Dashboards and visualizations can be tuned to technician and other roles to assess status and progress virtually in real time. Maintenance teams can rapidly discover where an asset is, what it needs, who should work on it and when.

- Automation

  Automating manual tasks such as ordering parts, replenishing MRO inventory, scheduling shifts, compiling information for audits and other administrative duties, helps save time, reduce errors, improve productivity and focus teams on maintenance.

- Streamlined processes

  Work orders can be viewed and tracked by all parties involved. Details can be shared across mobile devices to coordinate work in the field with operational centers. Material and resource distribution and utilization can be prioritized and optimized.

- Preventative maintenance

  CMMS data enables maintenance operations to move from a reactive to a proactive approach, so an advanced asset maintenance strategy can be developed. Data derived from daily activities as well as sensors, meters and other IoT instrumentation can deliver insights into processes and assets, inform preventive measures and trigger alerts before assets fail or underperform.

- Compliance Management

  Compliance audits can be disruptive to maintenance operations and asset-intensive businesses. CMMS data makes an audit exponentially easier by generating responses and reports tailored to an audit's demands.

- Health, safety and environment

  - In line with compliance management, CMMS and EAM offer central reporting for safety, health and environmental concerns. The objectives are to reduce risk and maintain a safe operating environment. CMMS and EAM can provide investigations to analyze recurring incidents or defects, incident and corrective action traceability, and process change management.

- Efficiency

  Increases efficiency by standardizing processes, optimizing maintenance schedules, and improving access to resources.

- Metrics and KPIs

  Collects data and information by tracking metrics and KPIs and accessing historical information.

- Labor management

  Can be used for forecasting of labor needs, comparing planned times against actual, deriving labor utilization, efficiency, and/or providing preliminary evidence that performance management may be needed.

Building Automation Systems (BAS)

A Building Automation System (BAS) is an integrated, automated system that controls several aspects of building operations, such as HVAC, lighting, energy, elevators, fire alarm and security.

BAS is known by a variety of names and acronyms, including BMS and building automation and control systems (BACS). The diverse names may be related to the fact that these FM tools have evolved over time, taking advantage of advances in computing, and facility automation and control.

BAS Architecture

A BAS is essentially an automated feedback loop, where controllers communicate with devices and sensors, which in turn communicate back to digital controllers. For example, HVAC systems are dependent on BAS, and include a variety of sensors and interfaces.

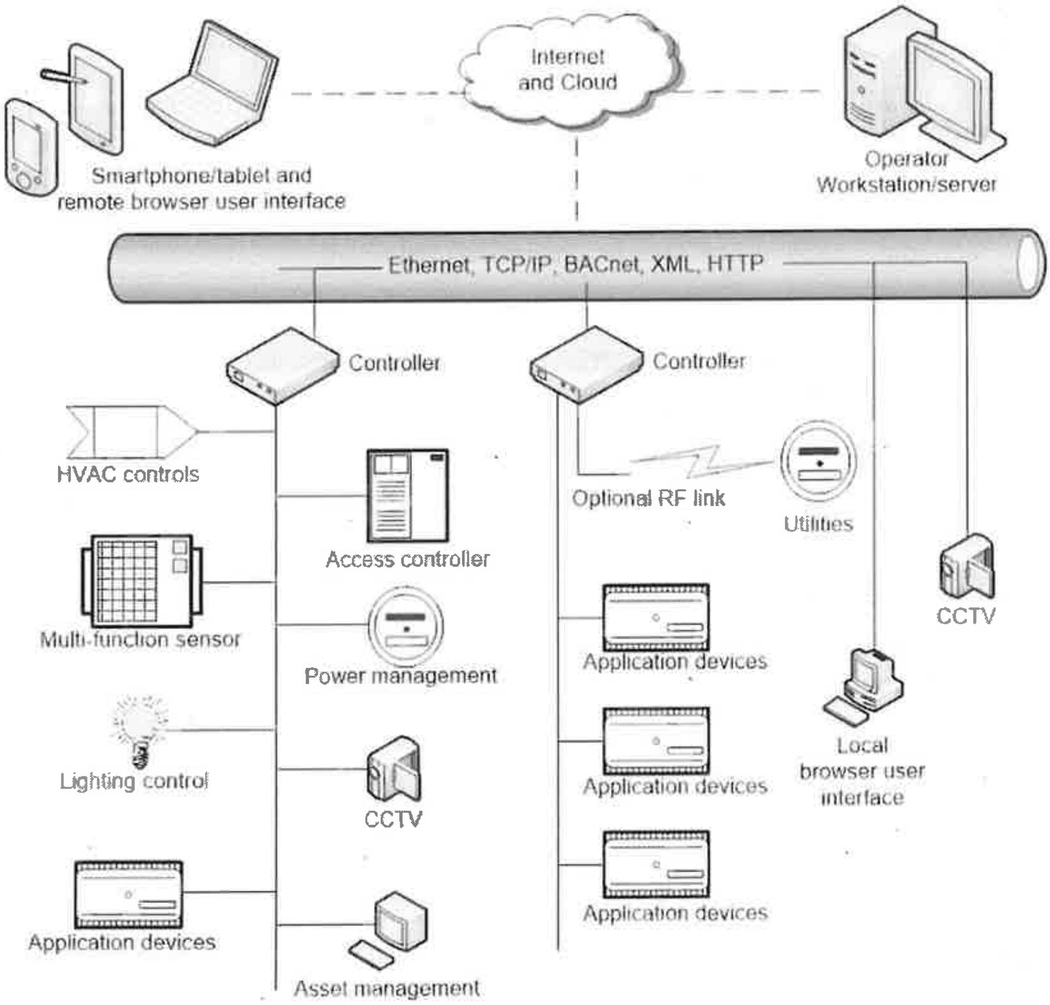


Figure 26 BAS Architecture

BAS includes:

- A user interface—which can be a conventional workstation in the facility or a remote device, such as a laptop computer, a tablet or a smartphone—that allows facility managers and technicians to access and share system information so that the facility manager can:
  - Act - set climate parameters, determine sequences and schedules.

  - Monitor - diagnose performance issues and respond quickly.
  - Analyze data - to support future actions that are wise for the facility and for the entire enterprise.
- Server(s) on which applications are run and data is stored. Alternatively, the user may access applications as SaaS over the Cloud.
- A supervisory network that manages communication via a communication protocol, such as IP, between the user, the server(s), and the controllers for devices such as HVAC. A software firewall protects the system from attacks that may come in via the Web and mobile devices.
- Controllers that manage communication between the network and the applications, devices, or sensors.
- The applications, devices or sensors that store performance history that can be retrieved for analysis.

Features and Benefits of a BAS

BAS include the following features and benefits:

Real-Time System Status

BAS provides real-time status information from every system component, including temperature and carbon dioxide (CO_2) sensor readings, variable frequency drive (VFD) fan speeds, and damper positions. This feature is further enhanced by IoT and smart devices communicating over wireless networks.

Benefits:

- Optimized start and stop times for equipment to reduce energy waste
- Inclusion of multiple factors, such as seasonal daytime temperature trends and occupancy levels
- Reduced energy cost due to on-peak and off-peak scheduling
- Greater occupant comfort

Monitor Energy Consumption

BAS monitors energy consumption and applies controls to reduce waste and/or avoid increased charges based on demand. These functions are performed by the energy management module of the BAS.

Benefits:

- Better understanding of facility energy consumption patterns
- Identification of wasteful areas and practices and more targeted energy conservation measures

- Lowering peak usage and avoiding additional demand-related energy charges

Monitor and Issue Alarms

An alarm indicates that a specific system component is not performing within defined parameters; alarms can be sent by e-mail, phone, text or other means to designated contacts. The system will also store alarm histories. This function facilitates the identification and speedy resolution of performance issues.

Benefits:

- Faster detection of problems, which means faster technician response time, which means greater occupant satisfaction.
- Improved and timely information for dashboard reports of facility performance, which leads to increased stakeholder satisfaction.
- Increased security at facility or data center, which lowers organizational vulnerability and chances for business disruptions and loss.

Sequence & Schedule

Sequence equipment for greater efficiency or to reduce the risk of over-tasking a system through simultaneous demands. Schedule operations, such as HVAC and lighting according to hours of occupancy.

Benefits:

- Reduced risk of possible future interruptions of service and management/occupant dissatisfaction
- Potential energy savings
- Longer equipment life
- Reduced maintenance costs

Control Processes

Implement complex processes such as demand-controlled ventilation, in which the delivery of fresh air into a workspace is controlled dynamically according to carbon dioxide levels. This ensures a healthful indoor air quality but also reduces energy spent conditioning fresh air that is not required.

Benefits:

- Increased fresh air intake to reduce levels of CO_2 and to dilute airborne contaminants, which improves indoor air quality and lowers rates of illness and increases productivity
- Decreased space conditioning costs since only enough unconditioned air is taken into the building as is actually needed to produce acceptable CO_2 levels

Trend Analysis Data

Trend and analyze data to support implementing a system, planning maintenance and replacement schedules, and building a case study for system improvements.

Benefits:

- Greater transparency regarding investments
- Economic analysis to support better decisions about technology investments
- Increased credibility with management
- Improved operations and efficiency and decreased costs

Note: While many contemporary BAS systems have all of the features described above, many buildings will have BAS but not access to all of these features. This could be for many reasons:

- age of building
- type of controls system, and
- decision not to purchase add-ons

Lesson 2: Building Imaging & Modeling

Lesson 1: Introduction

On completion of this lesson, you will be able to:

- Describe the features, functions, and benefits of a Building Information Modeling System (BIM)

Building Information Modeling (BIM)

Building Information Modeling (BIM) is not a specific software application. It is an intangible approach, methodology, and process for managing a building or asset through its entire life cycle. BIM typically represents real components stored in a database with three-dimensional objects.

The National Institute of Building Sciences defines BIM as:

> *"A digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward."*

Perspectives on BIM

The term **"model"** in "Building Information Modeling," is viewed from two perspectives:

1. As a 3D representation, and
2. As a logical system

3-D Representation

BIM is not just a three-dimensional imaging tool. BIM tools use parametric objects for example walls, doors, floors, windows that have defined attributes and rules. Object attributes include data such as dimensions, geospatial location, physical properties such as material, color, texture, acoustic characteristics, energy performance, age, and cost.

Object information is available to FM and anyone involved in constructing and operating a building. Information can be viewed as a 3D image, and as alphanumeric tables that contain data used to complete a detailed analysis or develop simulations. Objects are non-redundant—when an object is changed, that change applies to the object in any view.

Facility managers utilize BIM data layered into each phase of a project, from building planning, design, to construction.

Logical System

BIM can also integrate the element of time, adding a fourth dimension, or what is referred to as 4D imaging. 4D imaging allows FM to examine the impact of current decisions on future facility performance and requirements, and if BIM data is maintained over time, post-construction changes can also be captured and quantified.

From an FM perspective, BIM is useful because it has the potential to provide the data needed to manage properties more effectively and efficiently.

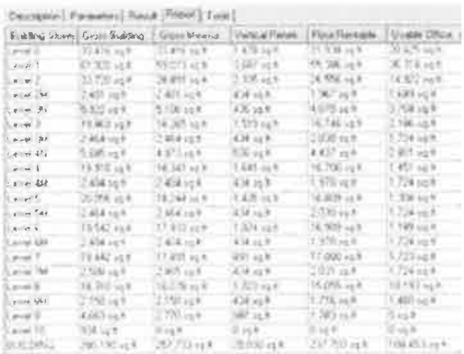
BIM Example: GSA Implementation

The U.S. General Services Administration (GSA) used BIM in a pilot project. Note the diversity of the data, and the three methods using to depict the data:

- 3-D Object (Graphical)
- Spreadsheet detailing categories of space (Alphanumeric)
- 4-D image depicting the project at a specific time (Hybrid)

3D Object

4D Image



Spreadsheet

BIM Architecture and Integration

Figure 27 illustrates BIM's relationship to existing enterprise and facility control and integration systems. During a project, FM will make facility data available to stakeholders and contractors, and that same data is then integrated with other enterprise applications, such as IWMS and BAS. FM utilizes BIM data throughout a building's life cycle.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

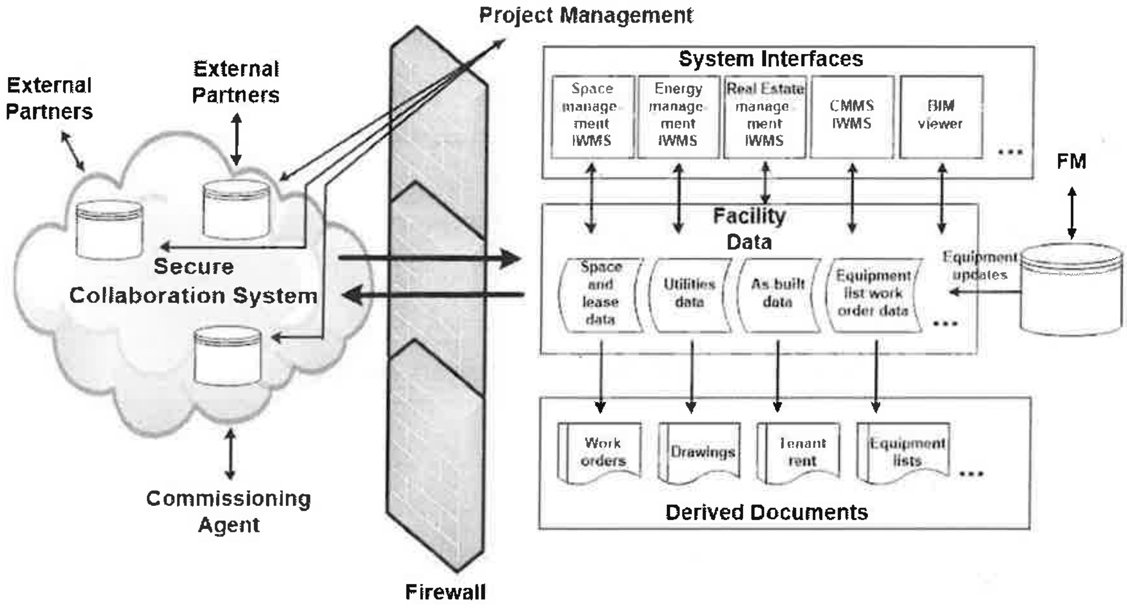


Figure 27 BIM Architecture and Integration (Retrieved from www.gsa.gov/bim)

BIM Advantages

BIM offers many advantages particularly during the planning, design, build, and operational phases of facility construction.

Planning and design phase advantages include:

- Modeling and testing facility designs before implementation
- Improved accuracy of shared information and data
- Rapid calculation of costs and other parameters
- Robust analytics to keep the project aligned with space and energy management goals
- Clash detection to reduce the potential of conflicts among other facility technology such as plumbing, HVAC, or electrical systems.

Operational phase advantages include:

- Accurate population of various enterprise FM databases and CAFM
- Space visualization to quickly identify and repair sources of problems
- Real-time data from facility sensors
- Historical data of changes made to a facility or process
- Identification of factors that contribute to or assist in life-cycle cost savings

Implementing BIM

Before implementing a BIM facility managers must understand the constraints related to data integration and interoperability between enterprise systems. Implementing BIM with the construction of a new building is simple compared to implementing it in an existing facility. In the case of an existing building, the biggest challenge is getting an accurate representation of what is above the walls and behind the ceilings before building the model.

In order to successfully implement a BIM, facility managers need to:

- Gain C-Suite support
- Assemble a team
- Develop a plan
- Set SMART goals
- Train FM staff and stakeholders
- Monitor implementation
- Evaluate effectiveness
- Adjust implementation plan as needed

Mini-Case: Implementing a BIM in the 2012 London Olympics

The importance of effective data preparation and management processes is apparent in the implementation of a £7.2 billion CAD/BIM application during the 2012 Olympics in London.

A common CAD/BIM platform was utilized to assist in the management and sharing of design and other project data. Inadequate system governance, processes for data sharing, and usability issues presented a major challenge for FM and subcontractors utilizing the BIM/CAD platform on Olympic construction projects.

Lessons learned from implementing a common CAD/BIM in the London Olympics include:

- Establish a detailed plan for data requirements, standards, and governance prior to the start of a BIM implementation.
- Provide clear guidance to stakeholders but be flexible.
- Develop user-friendly interfaces that allow the average user to utilize and platform.
- Leverage the value of fully integrated 3D that is provided by a BIM platform.

Conclusion and Recommendations: The team managing the Olympics project determined that the integration of CAD and GIS data in the BIM environment would have helped to achieve better integration of spatial data, as well as eliminate the time spent transcribing data between different platforms.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 3: Emerging Tools, Technologies and Applications

Lesson 3: Introduction

On completion of this lesson, you will be able to:

- Understand the applications and benefit of Internet of Things (IoT) in Facility Management
- Explain the applications and benefits of Augmented Reality (AR) and Virtual Reality (VR) in Facility Management
- Summarize the applications and benefits of Artificial Intelligence (AI) in Facility Management

Assessing Emerging Tools and Technologies

It's important to be objective and pragmatic when assessing and selecting new tools and technology for facility management. First, define the problem or challenge, then select and implement technology.

New technologies are constantly emerging, particularly web and mobile applications. The following technologies have the potential to make an immediate impact on FM:

- IoT (Internet of Things)
- AI (Artificial Intelligence)
- AR (Augmented Reality)/VR (Virtual Reality)
- Drones and Aerial Imaging

Internet of Things (IoT)

The Internet of things (IoT) is a network of physical objects embedded with sensors that connect and exchange data with other devices and/or systems over the Internet. This network and sensor-related technology are referred to as the Internet of Things (IoT). IoT is not only about networks and connected sensors, but a wider range of components that communicate and interact with one another, and with people. The building, sensors, and the people they support, and the data they generate, are a subset of the Big Data ecosystem.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

The application of IoT is best illustrated by looking at a building as an ecosystem of feedback loops between occupants, environment, services, and sensors. The interaction between people and things within the system/building provides valuable information for automated decision making and corrective action, perhaps accomplished by AI. The "things" (people and sensors) provide feedback on things like comfort, climate/air quality, energy and waste, and the condition of assets and automation (Table 9).

Building	**Experience**	User comfort & satisfaction	User Feedback
	Climate	IAQ, Temp, CO_2,	IAQ sensors
	Consumption	Sustainability	Smart metering
	Condition	Maintenance, Monitoring	Electro-mechanical sensors
	Demand	Just-Time facility use	Space/ Occupancy sensors

Table 9 IoT and Building Ecosystem (Williams and May, 2017)

Smart sensors provide "real-time" monitoring, and the data they generate helps FM develop more targeted strategies to manage the built environment.

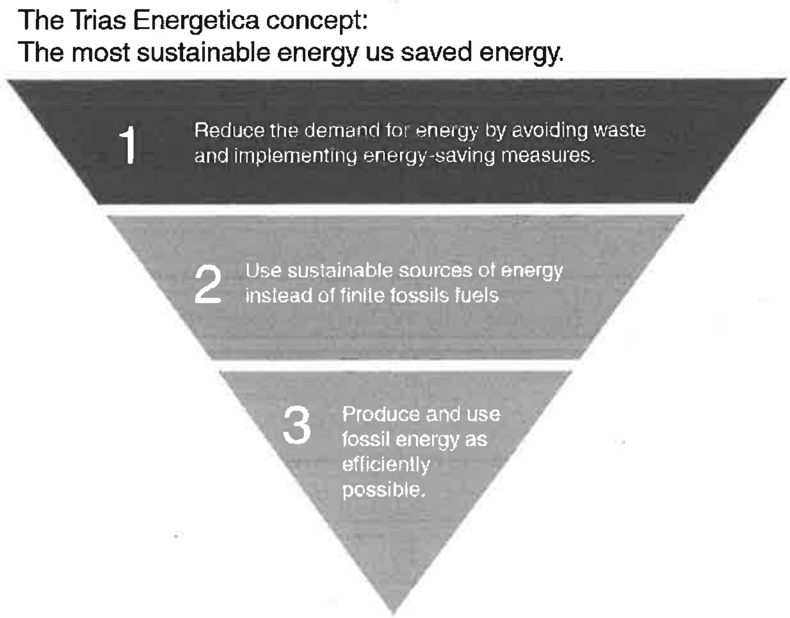


Figure 28 The Trias Energetica model

IoT has tremendous potential to impact energy consumption in a building. An IoT-enabled building can utilize smart sensors and BMS to achieve sustainability goals set by LEED, GSA, and The Trias Energetica model (Europe) developed by the Delft University of Technology.

Benefits of IoT

The benefits of IoT in FM are limitless. IoT, Big Data, and Data Analytics are closely related and provide a means for automatic data generation and analysis, and the development of metrics and KPIs.

Some of the applications and benefits of IoT in FM include:

- **Safety and security:**
  - Technologies such as video, sensors, and alarms can be linked to provide early warning of potential security risks.
  - Fire and safety devices can be monitored centrally and programmed to initiate automatic messaging to users when unsafe conditions are detected.
- **Operations and maintenance:**
  - Smart devices can be installed on equipment and machinery, monitor their status, and automatically intervene when specific parameters are exceeded.
  - Data generated by smart devices assist with the prioritization of preventative and predictive maintenance.
- **Energy Management:**
  - Smart meters can be installed to assist with managing and monitoring energy usage.
- **Occupant Experience:**
  - Smart appliances can request feedback directly from users and update environmental control and cleaning systems in real-time based on user experiences such as smiley buttons in restrooms.
- **Information Management:**
  - Improved accuracy of shared information between FM and stakeholders.
  - Rapid quantification of data utilizing AI.
  - Robust analytics derived by AI and Machine Learning (ML).

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Challenges in Adopting IoT Technology in FM

Implementing IoT does not come without challenges. FMs must consider the challenges of increased acquisition costs, cybersecurity, and handling the sheer volume of diverse information generated by an IoT-enabled building.

Simplicity & Acquisition

Cost is always a concern when implementing new technologies. For IoT, FM must consider the combined cost of smart devices, integration, installation, and training costs.

Security

Smart buildings are the epitome of Big Data. The success of implementing IoT depends on the accurate collection and detection of data over a network and capturing data from IoT-enabled sensors over a network creates a tremendous cybersecurity concern because every connected device is a potential gateway for a malicious attack.

Scalability

The IoT is all about data and the amount of data that smart buildings create. FM and IT managers are simply unprepared to handle the new demands for data transmission, storage, processing, and the complex analysis inherent in implementing IoT— the sheer volume of the information generated can be overwhelming.

Speed

The speed at which data emerges in an IoT-enabled enterprise can be a challenge. Systems need to be upgraded to immediately process and integrate data and decisions into facility operations and management.

Augmented Reality (AR)/Virtual Reality (VR)

Augmented reality (AR) is an interactive experience where computer-generated 3D objects are displayed in the real-world environment. Virtual Reality (VR) is the use of a computer and head-mounted display (HMD) to create a simulated 3D environment. Virtual reality (VR) and augmented reality (AR) may seem the same, but they are two completely different technologies— VR puts the user in a rendered 3D space, and AR projects a 3D object in the real world.

Both AR and VR have potential applications in facility management. The use of AR in operations and maintenance is an example of a practical application of these technologies.

Technicians can use AR to troubleshoot and repair equipment, and VR can be used in BIM and space management.

Artificial Intelligence (AI)

The McKinsey Global Institute estimates that by 2030, AI (Artificial Intelligence) will deliver $13 trillion in additional economic output worldwide. (McKinsey Global Institute Report: AI the Next Digital Frontier, 2017).

IFMA defines Artificial Intelligence (AI) as devices and applications that exhibit human intelligence and behavior including robots, expert systems, voice recognition, natural and foreign language processing. It also implies the ability to learn and adapt through experience. Leading AI textbooks define the field as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.

AI is not new—computers have been beating humans at Chess since the late 90's. Recent advances in AI and Machine Learning (MI) are due to advances in computing power, storage and the massive amount of data generated on the Internet. Much of "AI" currently is handled through algorithms in FM. However, the advent of Quantum computing will significantly improve the situation.

AI is perfectly suited to facility management and buildings in general. It can easily analyze the massive amount of data buildings generate. For example, in energy management, AI can analyze a facility's energy consumption data and compare it to data on weather, occupancy, and other factors. AI determines the dependencies between weather and facility energy use, and then builds a model to represent these relationships and their effect on the built environment. Finally, AI compares actual or future weather data against its "known model" and develops various scenarios which later serve as facility decision support. These scenarios/decision support allow the FM to proactively manage energy in the following ways:

- Project future demand for energy and sustainable use of energy in the facility
- Optimize HVAC and IAQ (indoor air quality)
- Utilize predictive analysis to reduce unexpected equipment outages
- Develop metrics and SLA's

Drones and Aerial Imaging

Drones carry cameras to hard-to-reach areas and allow facility managers and technicians to inspect roofs and rooftop equipment for damage or decay. Drones eliminate the need to erect tenuous scaffolding or ladders which pose a workplace hazard and are a significant safety risk.

Drones are revolutionizing the use of BIM in construction and facility management.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 5: Progress Check

1. What makes an Integrated Workplace Management System (IWMS) a benefit as a strategic management tool?

    a. Open Source
    b. Application programming interface (API)
    c. Interoperability
    d. Transparency

2. Which statement about Building Information Modeling (BIM) is correct?

    a. The usefulness of BIM in facility management is restricted to the planning and design phase of a new building project.
    b. The term "model" in BIM implies both 3D representation (CAD) and the element of time (4D imaging).
    c. The term "model" is based solely on the integration of 3D CAD applications in BIM.
    d. The term "model" implies the use of BIM for space management.

3. At what stage in the evolution of the IWMS did FM use discreet (not integrated) software applications?

    a. Enterprise
    b. Strategic
    c. Organizational
    d. Developmental

4. What is NOT a key concern with the implementation of the Internet of Things (IoT)?

    a. Diversity
    b. Simplicity
    c. Scalability
    d. Speed

5. What feature of a BAS allows an FM to access and share BAS information?

    a. User Interface
    b. Servers
    c. Controllers
    d. Sensors

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 6: Assessment

Lessons

- Objectives
- Lesson 1: Needs Assessment
- Lesson 2: Implementation
- Lesson 3: Facility Condition Assessment
- Lesson 4: CAFM Return on Investment (ROI)

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Objectives

Chapter 6: Objectives

On completion of this chapter, you will be able to:

- Describe the process of conducting a technology needs assessment
- Identify ways to formulate a business case for technology
- Describe the steps and methods required to conduct a Facility Condition Assessment (FCA)
- Understand the importance of CAFM in a Facility Condition Assessment (FCA)
- Calculate the return on investment (ROI) for a Computer-Assisted Facility Management (CAFM) application

Selecting FM technology is a complicated task, and the amount of emerging technology such as IoT, AR/VR, AI, robots, and drones don't make it easier. FM needs to assess a technology's potential and whether it is suited to meet the needs of an evolving enterprise.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 1: Needs Assessment

Lesson 1: Introduction

On completion of this lesson, you will be able to:

- Describe the process of conducting a technology needs assessment

Assessing the Potential of Technology

Start the selection process with a needs assessment instead of developing a long list of specifications or a wishlist of tools and technologies. The process of identifying problems/gaps and an appropriate solution begins with defining the root-cause and context of the problem, and whether technology will make a difference.

Successful technology projects share some common characteristics:

- **Stakeholder buy-in is ensured:** Technology projects are usually resource-intensive. Their support is conditional on stakeholder participation in envisioning what the proposed technology can do for them and, if necessary, prioritizing pain points.
- **The project is aligned with organizational needs:** Organizational need should drive change, rather than the availability of new technology.
- **The project's requirements are realistically assessed:** A realistic assessment of the selection and implementation process will prepare an organization for foreseen challenges and costs.
- **The organization is prepared for change:** A facility manager and project team must gauge the organization's ability to accept change.
- **Processes are analyzed and corrected before the project:** Process analysis and improvement should occur before implementing technology.
- **The project team communicates effectively:** Project leaders must define channels of communication and communication expectations.
- **The project schedule and budget are managed:** The designated project manager must track milestones and budgets and communicate issues as quickly as possible with the team and stakeholders.
- **The project is well documented:** Every change and milestone must be communicated and documented.
- **The implementation strategy is well planned and executed:** Implementation includes quality control, a transition plan, pilot test, and documentation of standard operating procedures.

Edition 2022, Version V2017PAIT_1.0

- **Training needs are identified and addressed:** A training needs assessment must be conducted for each group planning to utilize the new technology.
- **The right metrics are chosen and used:** The project should end with evaluation of results against objectives.

The Project Planning Process

The planning process involves gathering and analyzing information to determine the best solution. The remainder of this chapter will focus on **Needs Assessment** and the **Implementation** of facility technology. These steps are an integral part of the **Plan, Do, Check, Act (PDCA)** model (Figure 29) introduced in IFMA's Project Management course and competency.

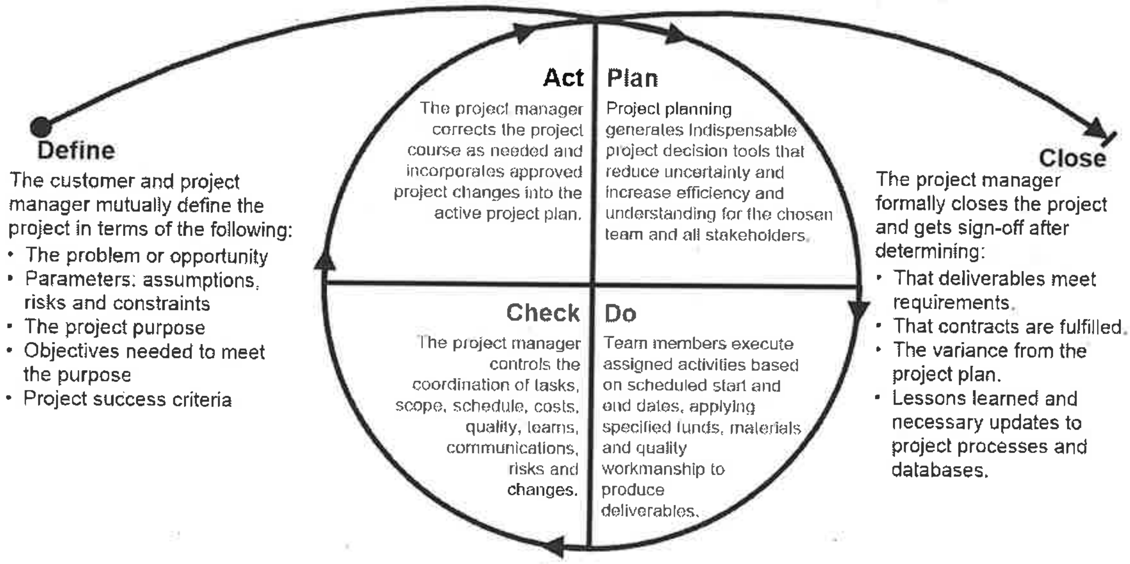


Figure 29 Project Management Model

Technology Needs Assessment

A technology needs assessment can be a useful place to start. It is a good practice to perform a general technology assessment periodically. A general assessment focuses on information such as:

- What applications are being used by facility management?
  - Have the applications been reviewed for conformity with standards by IT? Besides avoiding technical problems, IT review may also help the organization

manage the acquisition of software licenses more economically. Duplicate licenses and maintenance fees can be avoided.

- Have the applications been maintained properly?
- Are they being used in accordance with licensing requirements?
- Are the applications being underused, in terms of the number of licenses purchased?

- How well is each application fulfilling the function and organization's needs? Brief interviews with users and clients can help answer this question.
- Is the application adequate to meet the organization's future plans and anticipated facility changes?

To support a particular project, facility managers may have to use questionnaires, focus groups, observation and interviews to gather information from those involved or affected by the project:

- Management, who can discuss the organization's strategy, the results of SWOT analyses and strategic priorities
- Facility management clients—occupants who can describe the desired output of the technology, their goals and limiting factors
- Users, such as technicians, who can suggest project criteria from an operational perspective

Facility managers should also look outside their own organizations to peers in other facilities. Facility tours can help facility managers better define their needs and narrow their alternatives. They can also prevent a project from proceeding too far down a dead end.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 2: Implementation

Lesson 2: Introduction

On completion of this lesson, you will be able to:

- Identify ways to formulate a business case for technology

Developing a Business Case

To secure organizational resources in most instances, facility managers will need to present a business case to senior management. Business cases are discussed in more detail in the Project Management competency but include:

- The project's scope and objectives
- Overview of the process in question and identification of all associated and dependent processes that may be affected by this project
- Needs that the projects answers
- SWOT (Strength/Weakness/Opportunity/Threat) analysis of alternatives identified
- Cost-effectiveness analysis, using a spreadsheet to compare various options with each other and/or with the cost of not doing anything:
    - If necessary, "what if" scenarios should be included—for example, how will the project team respond if a significant new technology becomes available during the project? How will this affect the costs assessment?
    - If necessary, the analysis should include sensitivity factors to indicate range in a value based on some uncertainty about the estimate used.
- Recommended solution
- Proposed next steps (implementation steps, schedules, budgets)
- Proposed metrics for evaluation of the project's effectiveness

Technology Implementation Process

The technology implementation process shown in Figure 30 is a method of ensuring that new technology is implemented smoothly and to the satisfaction of everyone involved.

Edition 2022, Version V2017PAIT_1.0

Printed on 100% post-consumer waste recycled paper

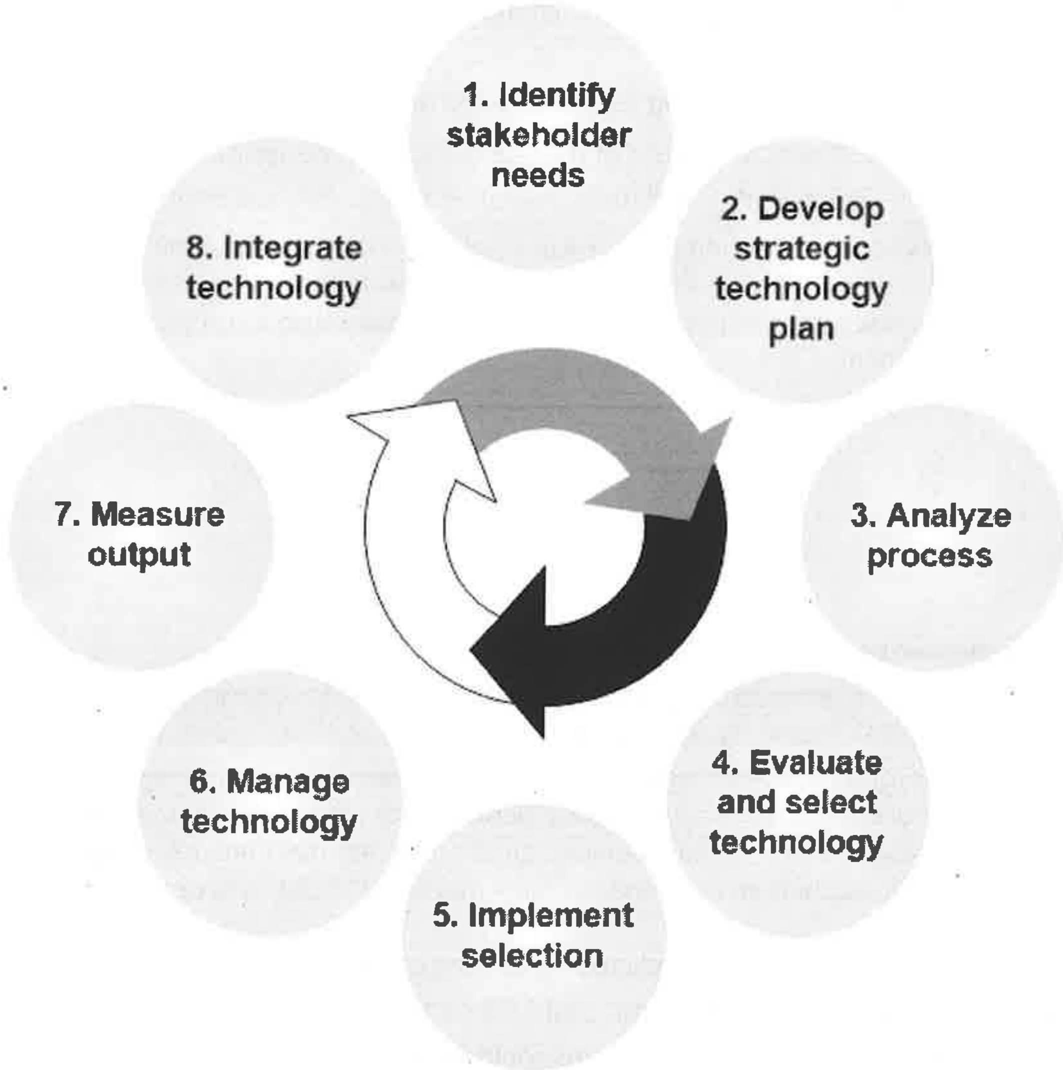


Figure 30 Technology Implementation Process

The Technology Implementation Process includes eight steps:

1. **Identify stakeholder needs:** Alignment of new technology with stakeholder requirements.
2. **Develop strategic technology plan:** Ensuring the plan is aligned with the organization's strategy and stakeholder needs.
3. **Analyze process:** Ensuring that the technology project is built around an effective process that will meet user requirements.
4. **Evaluate and select technology:** Using various analytic tools, such as SWOT (Strength/Weakness/Opportunity/Threat) analysis and cost-effectiveness analysis, to support sound choices.

5. **Implement selection:** Managing system configuration, database population and system roll out.
6. **Manage technology:** Maintaining technology and documenting changes.
7. **Measure output:** Assessing the use of the technology to produce desired metrics in specific functions, such as space management or energy management.
8. **Integrate technology:** Ensuring that the technology becomes part of the organization's enterprise management system, integrating technology and enterprise databases and supporting integrated processes, such as project and asset management.

Case Study: CMMS Implementation (PDCA)

Plan

CMMS Implementation for a Medical College: Planning

CMMS Implementation for a Medical College: Planning

The facility manager for a medical college campus identified specific shortcomings of the existing workflow process that were hindering the performance of both facility management and the entire organization. Facility management could not access maintenance-related data in a manner that would support analysis and decision-making. Without data on maintenance costs:

- Budgets could not be accurately predicted for coming periods.
- Performance against the current budget could not be tracked.
- The performance of equipment and systems could not be completed.

The project team then began the process of compiling equipment-related data to define more accurately the new system's technical requirements. Users and clients of the current system were interviewed in-depth to establish present and future needs for the maintenance function The team then began to research CMMS options. Cost and SWOT analyses were performed for different options.

Do

During this project phase, budgets and timelines are created, and team members are selected. Project leaders should use available project management technology to develop, maintain and revise as-needed budgets and schedules and to share information among the team. Payment schedules to vendors should be tied to meaningful and measurable project milestones.

Team management is critical. Team members should represent not only those with technical expertise but clients who have a vested interest in the project's outcome. Sales representatives and technical consultants from vendors should be part of the team as well, and the project leader must be alert to any disagreements or inconsistent messages from these two members.

Roles, responsibilities and decision-making authority must be defined, as should guidelines for:

- Communicating for example what needs to be communicated in what time frame and to whom, and what issues merit escalation.
- Conflict resolution.
- Change order.
- Documentation.

The team should also be prepared for succession issues since technology projects can span years. Documentation, such as a team charter, will help in ensuring continuity in team activities as team members change.

CMMS Case Study: Doing

The alternatives considered for the medical school campus were a CMMS integrated into an IWMS solution or a CMMS included in a maintenance service RFP. The maintenance service vendor proved a less expensive and more flexible option. The IWMS was robust but, given the cost, probably more than the organization needed. Purchasing the CMMS as a service meant that the facility would not be locked into a system that it was likely to outgrow quickly. Historical data would be owned by the facility. The service provider would assume responsibility for modifying the software to meet emerging facility needs. Based on FM's recommendation, senior management approved purchasing CMMS as a service. The service provider worked together with its client to import data into the system and to tailor it to the facility's requirements.

Check

During this phase, the case study project teams focused on problem solving and testing to ensure a smooth rollout of the technology. Testing can help prevent launch or cutover disasters. When designing the project, team members should look for ways to test components separately and at earlier stages in development. The goal is to identify issues and possible improvements in a dynamic manner during development.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

CMMS Project: Checking

Evaluations of the project revealed two issues that were resolved before implementation:

- After data was entered into the CMMS database, additional equipment was identified and had to be added to the plan.
- Tests of the user experience of the system outputs revealed the need for customer work orders as an option in the system.

Act

The Act phase includes providing training, launching the technology, monitoring and evaluating its performance, and maintaining the technology going forward.

Training and support

Training must be designed for the technology's different audiences:

- IT personnel, who may need to support the technology after launch.
- Facility management technicians, who need to know how to use it and where to turn for help. Technician training must consider both information about the new system and current technician skills levels. Does the new technology require skills the technicians lack? How will that gap be addressed?
- Clients, who need to know not how the technology works but how they interact with it—what actions they need to perform, what they should be receiving and where to turn for help.
- Future audiences—newcomers to the facility who will require training on the technology. Can the original training be repurposed for this audience? Can training be offered at intervals or "just in time"? Can training be accomplished through coaching or peer training?

Launch

Facility managers should choose a launch date with thought. It should be realistic; repeated postponements will undermine the new technology's credibility with management and with clients. New technology should be launched at a time of low stress for the organization. The launch date should avoid peak work periods such as, end-of-quarter reports, introductions of other changes such as installations of new equipment or organizational events so that attention must be parceled out among competing issues.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

The facility manager should take advantage of all ways to announce the launch of the new technology:

- Presentations to management and affected departments
- Facility newsletters
- Social media

Post-Launch Activities

A system care process, including a maintenance contract with a vendor, must be implemented. An organized user community/committee should be established to support rapid reports and resolution of issues and identify opportunities for improving the technology.

After an appropriate period, the technology should be evaluated to determine whether it has delivered the promised value. Metrics identified in the business case and modified during development should be used, and a report prepared for senior management. Clients and staff can be included in the evaluation report in a more informal manner, through e-mails or regular staff meetings.

Evaluation should also include another question: Is there anything that could be done better? The answers to that question bring the project full cycle, as proposed improvements must be sold, developed, implemented and evaluated.

Any changes—from small fixes to major revisions—must be documented as defined in the appropriate SOP. This is the only way that the organization can manage its knowledge over time and ensure that knowledge does not exit the organization with an employee.

CMMS Case Study: Doing

The launch went well, except for the fact that training sessions were much larger than the team had anticipated. This meant that additional materials had to be produced quickly, and trainers had to revise their presentation methods on the spot. This could have compromised the quality of the training. The team noted this experience for future projects.

The project was evaluated in terms of on-time delivery, end-user experience and satisfaction, and the CMMS data entry process. Management liked the automated scheduling of preventive and non-emergency tasks, the ability to compile equipment histories and the flexible reporting features. For example, the facility manager could identify maintenance costs by building, room or piece of equipment. Technicians liked the fact that they could use smartphones and laptops at the job site to scan in bar codes on equipment and update status. Because the system monitored inventory levels and issued alerts when supplies were running low, technicians were rarely delayed by not having the right parts.

Lesson 3: Facility Condition Assessment

Lesson 3: Introduction

On completion of this lesson, you will be able to:

- Describe the steps and methods required to conduct a Facility Condition Assessment (FCA)
- Understand the importance of CAFM in a Facility Condition Assessment (FCA)

The Facility Condition Assessment (FCA)

What is a Facility Condition Assessment (FCA)?

A facility condition assessment (FCA) is a continuous systematic approach of identifying, assessing, prioritizing, and maintaining the specific maintenance, repair, renewal, and replacement requirements for all facility assets to provide valid documentation, reporting mechanisms, and budgetary information in a detailed database of facility issues. Known by many names such as property condition assessment, facilities assessment, facilities survey, conditions survey, facilities audit or condition audit. Facility condition assessments record a property's present condition and forecasts the long-term capital that might be expected in order to maintain the property, correct deficiencies, and keep it in compliance.

It's important to understand FCA because it is an FM process that utilizes an integrated IT solution, such as CAFM or CMMS. If properly planned and executed an FCA, used in conjunction with a CAFM, can be a powerful planning tool. The application of FCA reports generated by a CAFM goes well beyond the FM department and affects the profitability of the entire organization.

A facility condition assessment is conducted to evaluate the condition of the following building components:

- Architectural
- Structural
- Roof
- Civil
- Electrical
- Mechanical

- Plumbing
- Accessibility and building code compliance

The FCA Process

A Facility Condition Assessment involves a team of one or more specialists inspecting each system in a building to understand its condition. You can even start with a model of each building before sending teams to do the assessment. Systems include all mechanical, electrical, plumbing and architectural elements in a building; so for example, the team would review the chiller, electrical panel, and roof.

There can be upwards of 80 systems in a building. The condition is based on any deficiencies and the remaining useful life of the system. With this information, it can be determined when system repairs and renewals will be required. Summing up the condition of each system can give the overall facility condition, allowing the proper level of investment based upon the function of the facility to be targeted.

Why Conduct an FCA?

A facility condition assessment is a valuable planning tool to determine the physical condition, functional performance, and operating cost of a facility. It is an industry-accepted standard method for the comparison of building conditions. Conducting FCAs on a regular and recurring basis is a key component of an effective maintenance and repair program for any facility.

The information collected is used to:

- Identify and budget for the repair, rehabilitation and replacement needs of a facility.
- Analyze life-cycle costs of facility components for long-range planning and budgeting purposes.
- Calculate the cost of facility upgrades.
- Develop an inventory of assets, including facility components, warranties and maintenance manuals.
- Calculate an FCA score to rate the overall condition of the facility.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

The Facility Condition Index (FCI)

What is the FCI?

The **Facility Condition Index (FCI)** is a key component of the Facility Condition Assessment (FCA). The FCI is a standard facility management benchmark that is used by facility managers to indicate the relative physical condition of a facility, group of buildings, or entire portfolio independent of building type, construction type, location, or cost. The Facility Condition Index (FCI) is used to support asset management initiatives and as a key performance indicator (KPI) to objectively quantify and evaluate the current condition of a building.

FCI is the ratio of **deferred maintenance** and **capital renewal** requirements to the **current replacement value**:

$$FCI = \frac{Deferred\ Maintenance + Capital\ Renewal}{Current\ Replacement\ Value}$$

The purpose and value of the FCI is:

- To assist in making resource allocation decisions amongst the buildings in a portfolio, particularly with limited budgets that are not adequate to address the deferred maintenance in all the facilities. It is therefore a means of identifying priorities.
- To determine the annual reinvestment rates to prevent further accumulation of deferred maintenance.
- To calculate catch-up costs.
- To provide a KPI for resource allocation decisions.
- To help track the extent of condition drift over time.

What are Catch-up Costs

The FCI provides a measure of the catch-up costs of a facility. Catch-up costs are one of three reinvestment categories identified by a Facility Condition Assessment (FCA).

Types of Catch-up Costs

There are three types of Catch-up costs:

1. **Observational Catch-up**

   The accumulated backlog of deferred maintenance associated with the assets of a facility. This is based upon empirical data derived from site observation and is referred to as Observational Catch-up. Some examples of catch-up cost items include water stains, peeling paint, corrosion, and moss growth.

2. **Roll-over Catch-up**

   The costs to repair or rehabilitate capital assets that have exceeded their useful service life. Rollover Catch-up is based primarily on theoretical data and is usually generated by a software algorithm or CMMS.

3. **Transitional Catch-up**

   All work orders that have not been completed at the time of the assessment, sometimes called Work Order Backlog.

How to Calculate Facility Condition Index (FCI)

$$FCI = \frac{Deferred\ Maintenance + Capital\ Renewal}{Current\ Replacement\ Value}$$

The formula for the FCI calculation (often expressed as a percentage):

$$FCI = \frac{Cost\ of\ deficiencies}{Current\ replacement\ value} \times 100$$

For example:

$$FCI = \frac{US\$325{,}000}{US\$12{,}300{,}000} FCI = 2.64\%$$

Facility Condition Scale

The relative measure of the condition of the facility or facilities is usually organized into a four-tiered condition scale, called the Facility Condition Scale. The FCS is organized as follows:

Condition	Range (FCI)
Good	0%-5%
Fair	5%-10%
Poor	10%-30%
Critical	30% or higher

Table 10 FCI Scale

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

FCI Scale

Figure 31 FCI Scale

Based on the previous example, a facility with a FCI of **2.64%** is in **"Good"** condition.

For example:

$$FCI = \frac{US\$325{,}000}{US\$12{,}300{,}000} FCI = 2.64\%$$

FCA Deficiencies

FCA Deficiencies

A fundamental issue in facility management is the proper planning and allocation of maintenance and repair dollars. Especially when a facility manager is responsible for multiple properties, the FCI value calculated for each facility provides the baseline data to compare overall facility conditions. Deficiencies found during the FCA are as building, programming or policy deficiencies.

- **Building deficiency.** A building deficiency is any flaw, defect or imperfection related to a building's components or systems. Building components include the substructure, foundation, support structure, building envelope, building interiors, building services - mechanical, plumbing, electrical and the grounds - paving and landscaping.

  Examples:
  Poor ventilation, overloaded electrical panels, inadequate or inefficient lighting, cracked or heaving sidewalks, chronic chiller failure, accessibility or component age, even though the component is currently performing satisfactorily.

- **Programming deficiency.** A programming deficiency means that the building and/or the grounds do not adequately or appropriately support the mission or needs of the occupants. Programming deficiencies revolve around the amount of space available or how the existing space is utilized.

  Examples:
  Lack of conference room space, insufficient space to house an expanded staff,

not having enough real estate for parking or storage or having excess space in a building for the number of occupants

- **Policy deficiency.** A policy deficiency means that there are shortcomings or inadequate systems within the building needed to support organizational standards or practices.

  Examples:
  No emergency generator, an emergency generator that is too small to carry the entire load of the building or lack of an electronic security system

The Facility Condition Report (FCR)

The results of an FCA provide timely and qualitative data to support a master plan as well as the decision-making process and prioritization of the projects and/or facilities that need to be repaired. FCA data is typically compiled in a facility condition report (FCR). The report often includes photographs and diagrams outlining problem areas, needed updates or improvements, and problems. The FCR provides valuable information for real estate and property management decisions.

The following is a typical outline for a Facility Condition Report:

- **Executive Summary of the property, general findings**
- **Building types on property**
- **Condition of site improvements**
  - Utilities
  - Parking lots and paving
  - Drainage systems
  - Topography and landscapes
- **Architectural and structural systems**
  - Foundations
  - Building superstructure
  - Roofing
  - Envelope (walls, doors) and stairways
  - Patios and balconies
  - Circulation (corridors, common areas, etc.)
- **Mechanical and plumbing systems**
  - HVAC

  - Plumbing and domestic hot water
  - Gas distribution
  - Electrical
  - Elevators
  - Fire protection systems
  - Security systems
- **Interior systems**
  - Finishes (floor and wall coverings, paint, etc.)
  - Furniture, Fixtures, and Equipment (FF&E)
    - Customer furniture
    - Administrative furniture
    - Kitchen equipment
    - Light fixtures
- **Other as appropriate**

Adapted from: Lowry, D. (2017). The Complete guide to facility management. Lowry Digital.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Lesson 4: CAFM Return on Investment (ROI)

Lesson 4: Introduction

On completion of this lesson, you will be able to:

- Calculate the return on investment (ROI) for a Computer-Assisted Facility Management (CAFM) application

CAFM & Return on Investment (ROI)

Today's business environment is competitive and executive management is focused on bottom-line results and return on investment. On an economy of scale, FM information technology is a small percentage of an organization's overall expenses. Regardless of the economics, FM needs to be proactive and keep a watchful eye on costs and the return on investment (ROI) of CAFM projects.

It is important to anticipate the need to justify the investment in CAFM because some organizations and stakeholders view FM as a "non-revenue generating" department that contributes little to the bottom-line. Of course, this perception is myopic. A well-implemented and managed CAFM can improve the operational efficiency of the organization, reduce maintenance and inventory costs, minimize overtime, reduce downtime, and increase the efficiency and effectiveness of FM.

There are numerous ways to calculate ROI. For simplicity, examine the ROI of a typical CMMS (Computerized Maintenance Management System).

Calculating Return on Investment

There are numerous ways to calculate CMMS ROI, and the method used depends on the type of organization FM serves. ROI is important for justifying the CMMS purchase internally and ensuring future funding from upper management.

Use the classic ROI model to calculate CMMS return on investment:

$$ROI(\,Return\ on\ Investment) = \frac{Value - Cost}{Cost}$$

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Note: CMMS ROI is commonly assessed at one-year, three-year, or five-year intervals. The one-year calculation will include the initial CMMS implementation costs will have a reduced ROI.

The initial cost of purchasing a CMMS (first year) include:

- Cost of initial software or SaaS/Cloud hosting
- Implementation and training
- Hardware and equipment purchases
- Annual vendor support

Determining CAFM "Value"

In order to calculate return on investment, the facility manager needs to determine the value, or expected reduction in maintenance expenses - including any combination of equipment, inventory, downtime, overtime resulting from the implementation of the CMMS. The value of a CMMS can be determined by quantifying the following in dollars:

- Reduced maintenance
- Reduced downtime
- Reduced inventory
- Reduced labor
- Increased productivity
- Reduced utility costs

Once the total estimated CMMS value has been determined, FM can utilize it to calculate return on investment.

Mini-Case: Calculating ROI at ABC Manufacturing

Rapid Lock manufacturing produces fasteners for a variety of industries. The company generates work orders manually and uses MS Excel to generate and track preventive maintenance (PM).

Rapid lock received a quote for $10,000 for a CMMS, and will use the classic ROI model to evaluate savings:

What kind of ROI can Rapid Lock expect after implementing a CMMS?

$$ROI(\,Return\ on\ Investment) = \frac{Value - Cost}{Cost}$$

Calculating CMMS Value

First, Rapid Lock needs to determine the annual savings (value) from the CMMS implementation and then calculate the ROI by completing the following:

Asset Life

To determine the annual cost of an asset, divide the total cost by the lifespan. If an asset costs $50,000 and is used for ten years, the asset's cost per year is $5,000.

Rapid Lock determines extending the life of key assets would produce savings of $9,000 annually.

Expected Annual Savings: $9,000

Downtime

Due to inefficient preventive maintenance performance, there was a recent incident in which one of Rapid Lock's assets was disabled.

The real-dollar cost of this incident was $5,200 in repair parts and $1,200 in unforeseen labor. The company determined that this incident could have been preventable with a CMMS. Similar incidents have occurred at least twice per year.

Expected Annual Savings: $12,800

Part/Inventory

Last year Rapid Lock ordered a surplus of maintenance parts. The money tied up in these parts was money that could not be invested elsewhere.

Parts inventory revealed that a number of items were obsolete. $2,500 worth of inventory was useless and written off.

On the other hand, depleted inventory slowed maintenance performance. Rapid Lock determined that $1,800 could have been saved if emergency orders had not been required to meet immediate parts inventory needs.

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Expected Annual Savings: $4,300

Labor/Productivity

Rapid Lock wanted to reduce time wasted waiting for work orders, parts and the completion of paperwork.

The company estimates that 260 labor hours per year (5 hours per week) could be saved with an efficient CMMS. If the average labor hour costs the company $15, the total savings is $3,900.

Last year, $3,600 had been spent on contract labor to provide emergency asset maintenance which could also be eliminated.

Expected Annual Savings: $7,500

Utilities

HVAC systems in typical commercial buildings are responsible for more than 40% of total energy use. HVAC units that have been properly maintained will perform more efficiently and fail less often. ABC estimates that the total annual reduction in utilities will be $2,000.

Expected Annual Savings: $2,000

Calculating ROI

Rapid Lock can easily justify the cost of a new CMMS. The sum total of their savings potential (CMMS Value) is $35,600.

CMMS ROI = ($35,600 – $10,000)/$10,000 = **2.56**

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 6: Progress Check

1. What is a core driver for performing a Facility Condition Assessment (FCA)?
   a. Emerging technology
   b. Business Competition
   c. Cost reduction
   d. Regulatory compliance

2. What step in the optimization process ensures technology becomes part of the organization's enterprise resource management system?
   a. Integrate technology
   b. Evaluate and select technology
   c. Manage technology
   d. Manage output

3. Who provides the best guidance concerning the implementation of a move management application?
   a. Application vendor
   b. Senior Management
   c. Facility Management
   d. Department Managers

4. What step in the technology implementation process ensures that the technology project is built around an effective process that will meet user requirements?
   a. Develop a strategic plan
   b. Manage Technology
   c. Analyze process
   d. Measure output

5. CMMS ROI is commonly assessed at:
   a. Every year
   b. Three-year or five-year intervals
   c. One-year, three-year, or five-year intervals
   d. Five-year intervals

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Progress Check Question Answer Key

Chapter 1: Information Technology, FM, and the Organization

Objectives

1. c
2. b
3. a
4. d
5. c

Chapter 2: Data Collection and Information Management

Objectives

1. a
2. d
3. c
4. b
5. c

Chapter 3: IT & Security Basics for FM

Objectives

1. c
2. b
3. a
4. b
5. b

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

Chapter 4: Computer Aided Facility Management Systems (CAFM)

Objectives

1. d
2. d
3. d
4. d
5. c

Chapter 5: Tools and Concepts

Objectives

1. d
2. b
3. d
4. a
5. a

Chapter 6: Assessment

Objectives

1. c
2. a
3. d
4. c
5. c

Edition 2022, Version V2017PAIT_1.0
Printed on 100% post-consumer waste recycled paper

References

In alphabetical order:

Albrice, D. (n.d.). Catch-up costs. Asset Insights. https://www.assetinsights.net/Glossary/G_Catch-up_Costs.html

Atta, N. (2019). Internet of things for facility management: Strategies of service optimization and innovation (1st ed.). Springer Nature.

Back to Basics – Growing into a Successful CAFM Implementation [Poster session]. (2010). IFMA/Information Technology Council, Houston, Tx.

Bagadia, K. (2010). Computerized maintenance management systems made easy: How to evaluate, select, and manage CMMS (1st ed.). McGraw Hill Professional.

CMMS ROI: Calculate in three easy steps. (2019, November 3). Hippo CMMS | Maintenance Management Software Solution | Get Free Trial. https://hippocmms.iofficecorp.com/blog/calculate-cmms-roi-in-3-steps

Contributor, G. (2018, October 28). 5 steps to a successful facility condition assessment. Facility Executive – Creating Intelligent Buildings. https://facilityexecutive.com/2018/10/5-steps-successful-facility-condition-assessment/

Contributor, G. (2019, October 1). Tech trends in facility management: The 2019 total geek's guide. Facility Executive – Creating Intelligent Buildings. https://facilityexecutive.com/2019/10/tech-trends-in-facility-management-the-2019-total-geeks-guide/

Contributor, G. (2020, August 25). Cyberattacks: Cybersecurity and facilities systems. Facility Executive – Creating Intelligent Buildings. https://facilityexecutive.com/2020/08/cyberattacks-cybersecurity-and-facilities-systems/

Costanzo, P. (2017). Breaking Down BIM. IFMA FMK, 27(6), 34-37.

Facilities management building automation: BAS has BACNET VPN – Reliable controls – building-components and services releases. (2021, April 5). Facilitiesnet. https://www.facilitiesnet.com/buildingproducts/details/BAS-Has-BACNET-VPN-Reliable-Controls-Reliable-Controls--8895

Falkin, S., & Sellers, W. (2005). Wireless Systems in the Facility. Allsteel and IFMA Foundation, 1(1).

IFMA. (2012). Technology for facility managers: The impact of cutting-edge technology on facility management (1st ed.). John Wiley & Sons and IFMA Foundation.

Kumar, N. (2010). Facility Condition Index. Facility Management Journal (FMJ), 28(2), 3.

Levitt, J. (2013). Facilities management: Managing maintenance for buildings and facilities (2013 ed.). Exter Premedia Services Private Ltd.

Lewis, A., & Whittaker, J. (2014). BIM and a Future Vision for FM. IFMA FMJ, 24(2), 40-44.

Litton, A. (2010, January). Facilities Management Data Input, Editing and Management [Paper presentation]. ESRI 2010 Federal User Conference, Washington, D.C.

May, M., & Williams, G. (2016). The facility manager's guide to information technology: An international collaboration (1st ed.). International Facility Management Association.

Space And Project Benchmarks From IFMA. (n.d.). https://facilityexecutive.com/2013/02/space-and-project-benchmarks-from-ifma/#:~:text=Companies%20enjoy%2C%20on%20average%2C%20295.feet%20of%20individual%20workspace%2C%20respectively

Suriyakumar, S. (2020). Retaining the Library. IFMA FMJ, 30(1), 24.

Vandenbussche, K. (2009, July 21). Critical CMMS Launch Timing [Webinar]. Barton Malow/IFMA.

What is a CMMS? Definition, how it works and benefits. (n.d.). IBM – United States. https://www.ibm.com/topics/what-is-a-cmms

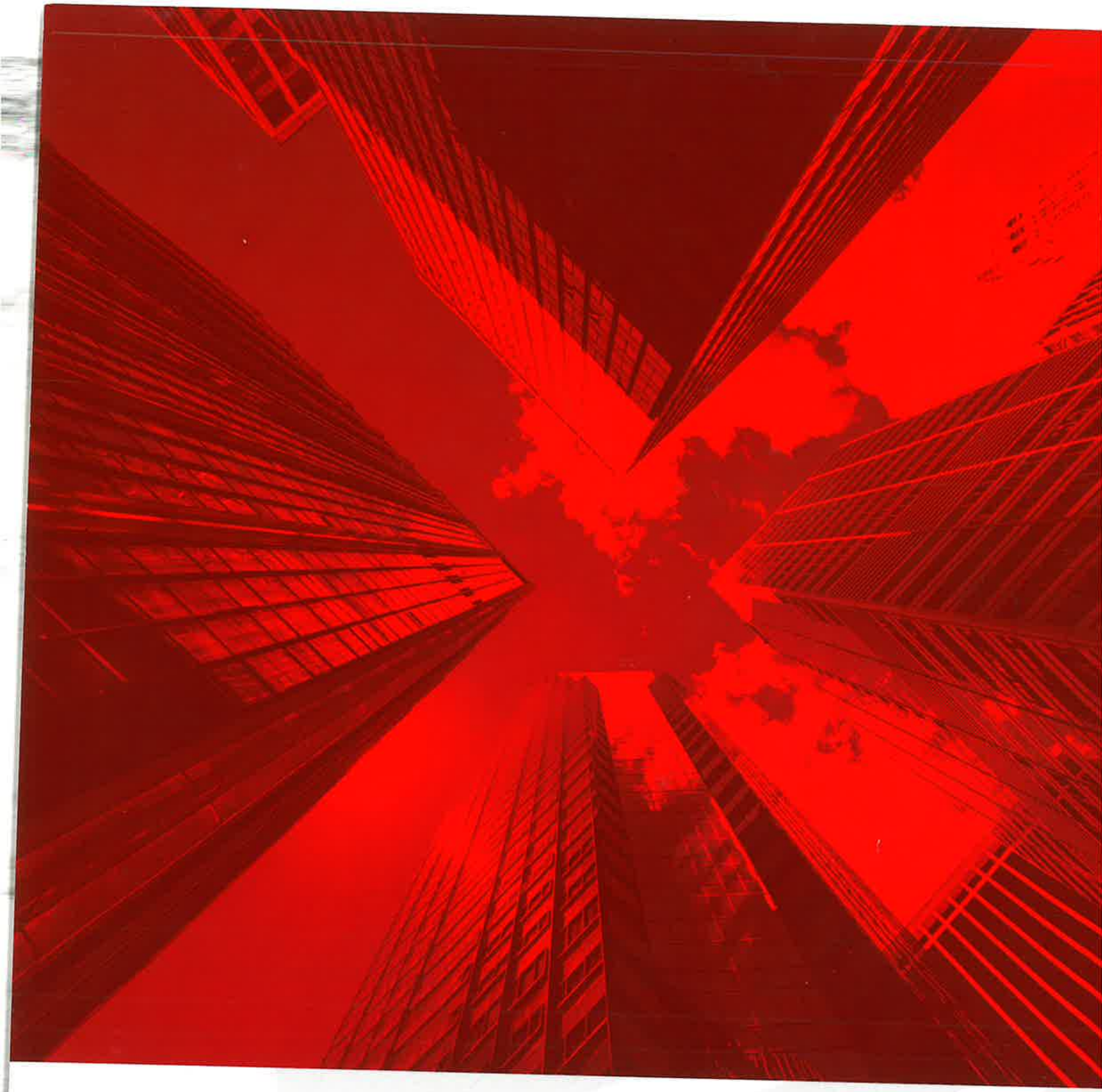
Wiggins, J. M. (2010). Facilities manager's desk reference (3rd ed.). John Wiley & Sons.

Williams, J. (2018). Facilities management operations handbook (1st ed.). Facilities Management for You.

Wireless Solutions for Building Automation & Energy Management [Poster session]. (2009, November). IMFA – ITC, Houston, Tx.

Edition 2022, Version V2017PAIT_1.0

Printed on 100% post-consumer waste recycled paper



www.ifma.org
T: +1-713-623-4362 | F: +1-713-623-6124
800 Gessner, Suite 900 | Houston, Texas 77024 USA