THE RELATIONSHIP BETWEEN ENERGY USE AND QUALITY OF THE FACILITY MANAGEMENT FUNCTION IN SMALL TO MEDIUM ENTERPRISES (SMEs)

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THE RELATIONSHIP BETWEEN ENERGY USE AND QUALITY OF THE FACILITY MANAGEMENT FUNCTION IN SMALL TO MEDIUM ENTERPRISES (SMEs)

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DEDICATION

This research is dedicated to my fiancé, Teresa, for having love, patience, understanding, resolve and support in helping me to power up and complete this work. Thank you.

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LIST OF ABBREVIATIONS

AEC	Architect, Engineer, Contractor
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
BAS	Building Automation System
BeQ	Building Energy Quotient (ASHRAE benchmarking platform)
BIM	Building Information Modeling
BOMA	Building Owners and Managers Association
CAFM	Computer-Aided Facility Management
CBECS	Commercial Building Energy Consumption Survey
CMMS	Computerized Maintenance Management Software
COBie	Construction Operations Building Information Exchange
DES	Distributed Energy System (i.e. campus central plant)
ECI	Energy Cost Intensity, USD / ft^2 / year
ESPM	Energy Star Portfolio Manager
EUI	Energy Use Intensity, kBtu / ft^2 / year
FCI	Facility Condition Index
FM	Facility Management, or Facility Manager
HVAC	Heating, Ventilation and Air Conditioning
IAQ	Indoor Air Quality
IEQ	Indoor Environmental Quality
IFMA	International Facility Management Association
IGCC	International Green Construction Code

KPI	Key Performance Indicator
LEED	Leadership in Energy and Environmental Design
MEP	Mechanical, Electrical and Plumbing
NZEB	Net Zero Energy Building
O&M	Operations and Maintenance
PC	Personal Computer
PM	Project Management, or Project Manager
PV	Photovoltaic (solar power, electric)
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SME	Small to Medium Enterprise
USGBC	United States Green Building Council

SUMMARY

The hypothesis of this research is that the level of annual energy consumption of a commercial building is associated with the quality of the facility management function. The constraints of this study are limited to the Small to Medium Sized Enterprise which includes most businesses and building types in the United States.

The comparison was made by graphing energy performance against the quality of the facility management (FM) function. The energy metric used is the United States Environmental Protection Agency's (EPA) Energy Star rating system. The FM Quality score is a metric derived of various factors that are used to define the effectiveness of an FM department. The FM Quality metric was developed as part of this research.

Data was collected by visiting small businesses and conducting an on-site walk through to observe conditions in eleven buildings located in the Southeast United States and interviews with the building operators and/or managers to understand their facility management practices. Additional data collected included one or two years of annual energy use (utility bills) to determine the Energy Star score, and in some instances, maintenance records were supplied.

The conclusions of this study tend to confirm the fundamental aspects of the hypothesis; namely, that there is a positive association with energy use and facility management practices. However, more research is needed, and especially useful would be a greater sample size of subject properties and an expansion of the data across climate zones. Furthermore, it is expected that the facility quality scoring metric can be further developed and that factor analysis and structural equation modeling would further refine the findings.

CHAPTER 1

RESEARCH RATIONALE

This study aims to investigate the relationship between energy use and the quality of the facility management activities in the Small to Medium Enterprise (SME). Many SMEs, for a variety of reasons, rely on under resourced or custodial level personnel to oversee expensive, complex and critical systems and equipment. Much of the maintenance work is outsourced to third-party service providers where the vendors stipulate the terms of the service agreement.

Furthermore, the upper level managers often see the FM activity as a technical rather than a management issue, thus regarding the activity as a "cost center" framing FM as having limited real value to the organization. If the relationship between these two attributes (energy use and facility management) can be quantitatively demonstrated to upper level managers, then one of the most difficult tasks of adapting positive change in an organization, namely convincing managers that quality FM is vital, could be easier to implement. Adopting change in any organization is difficult. In the typical SME, culture and perception may be the greatest barriers to develop a sustainable and quality FM practice.

This research includes a literature review of specific scholarly work on the subject and case studies of actual SMEs. The physical portion of the research included a walkthrough of eleven facilities to observe facility conditions and conduct interviews with building operators and managers. Annual energy performance data was collected (utility bills) and was used to determine an "Energy Star" score. The FM quality metric was developed as part of this research and is made up of several graded factors that define the effectiveness of an FM function.

The data, once collected and compiled, was analyzed for any relational attributes. There appears to be a positive relationship between energy use and the quality of facility management practices although further research is needed. It is anticipated that the information from this and subsequent studies can be used to create better facility management practices and thus achieve optimal energy performance, cost reduction, and improved indoor environmental conditions for small to medium sized enterprises.

1.1 Research Motivation

When a building is newly built and occupied, many in the architect, engineer, and contractor (AEC) industry treat the building as "finished" where, in fact, all the buildings operating costs, productivity, energy use, and environmental impacts are yet to occur. For a building to maintain a high level of performance, a dedicated and professional FM program is necessary. Below are a few of the key drivers and developments that have led to this awareness.

1.1.1 Developments in the LEED Rating System

The United States Green Building Council (USGBC) has developed a voluntary, points based, green building rating system called Leadership in Energy and Environmental Design (LEED). This is a rating system with four levels of certification: Certified, Silver, Gold and Platinum. There is a total of 110 points available and the minimum level needed to achieve certification level is 40. The areas of focus include sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. There are a few additional points available for innovation in design, and through regional credits based on specific environmental issues within a geographic region.

In addition to the voluntary credits, the LEED Rating System has several "prerequisites" which are mandatory requirements for LEED Certification. These include mostly standard or easily achievable design components such as erosion and sedimentation control during construction, no smoking in the building, and minimum ventilation rates.

However, one prerequisite requires a ten percent improvement in energy performance over the reference energy code, currently ASHRAE[1] Standard 90.1-2010. This requirement typically involves the preparation of an energy model that compares a "code minimum" building (the baseline) with the actual building as designed, referred to as the "proposed" building. The energy model is often prepared at or near the conclusion of the design documents and the baseline and proposed models are compared to provide estimates of potential building performance improvements above minimum code levels. Several factors such as operating schedule, occupancy patterns, weather, thermostat set points and occupant behavior are normalized thus making the model a theoretical representation of energy efficiency improvements and not a predictor of actual energy performance.

As noted in the following examples, there has been criticisms made (Gifford, 2010) that fully constructed and operating LEED buildings are not performing as expected.

The New Buildings Institute in a 2008 study, *Energy Performance of LEED for New Construction Buildings* (Turner, Frankel) concluded that, on average, LEED buildings perform as expected; however, there was a large variation in actual building performance with about half of the buildings performing worse than anticipated. This issue entered the public sphere when the newspaper USA Today (2014) published an article suggesting that the LEED Rating System is "*mis-LEED-ing*" since actual energy performance of LEED buildings does not match anticipated performance. Furthermore, Gifford (2010) published a report that claimed the USGBC statement

[1] ASHRAE, previously The American Society of Heating, Refrigeration and Air Conditioning Engineers is a leading force in the development of codes, standards, and methods for high performance green buildings. They re-branded in 2013 to using only ASHRAE as their name since their scope is now greater than HVAC&R systems only.

of 25% to 30% energy improvement for LEED buildings was based on a limited survey response, and that other factors, such as increased energy code stringency, can improve energy performance.

In one example, Gifford points to a New York City skyscraper where the lights remain burning all night long as proof that LEED buildings are not particularly efficient. These reports blame the building for poor performance.

The assumption is that it is the building itself, as a single entity, that drives energy efficiency and sustainable performance. What is missing from these reports is the acknowledgement that operations and maintenance (O&M) have a significant influence on building energy performance. The award of LEED certification (Certified, Silver, Gold or Platinum) is accomplished at or near the end of construction and/or start of occupancy of the building (there are exceptions as the USGBC review and response times can extend a few weeks or months past construction end). At the point of initial award, the building is new and, therefore, only has the "potential" to achieve high levels of energy performance. It is the quality of the lifelong operational practices and attention to systems that determines the actual energy, environmental and productivity performance of the building.

1.1.2 Building Benchmarking Programs

In addition, municipalities, state governments, and some countries, now require disclosure of building performance data both as a condition sale and as an ongoing reporting requirement. For example, New York City passed Local Law 84 that requires buildings to report and benchmark annual energy use and to conduct an energy assessment every ten years. Currently, the requirement is for buildings with an area of 50,000 square feet (ft^2) or greater and may expand to smaller buildings over time. This regulation, Local Law 84, has been in place since 2011 and information emerging indicates that energy performance ranges from very poor to good. One particularly interesting finding of the data analysis from this regulation was that buildings with higher energy use also have higher instances of asthma (New York City Local Law 84 Benchmarking Report, 2012).

Most European countries currently have a building energy labelling program where a notice of building performance is publicly displayed on the building, analogous to the nutritional labels placed on food products. In these cases, energy (and sometimes water) performance is available to prospective buyers and renters and is creating a hierarchy of building quality based on performance metrics.

Peterson, K, & Gammill, R. (2010) in their study point out that "*multiple managers stated that energy efficient features are part of a new shifting class standard for Class A buildings.*" They go on to discuss how energy efficiency improvements are a way to "*differentiate one building from others*" and that "*understood in this context, energy efficient features become tangible, visible qualities of a building*."

1.1.3 Industry Code and Procedure Developments

The current versions of several high-performance building codes and standards, rating systems, design guidelines, and operational guides place a heavy emphasis on building operation and maintenance activities. The high performance green building codes and standards, especially, introduce sections devoted to O&M such as the new ASHRAE Standard 189.1-2014 (*Design Standard for High Performance Green Buildings Except Low-Rise Residential Buildings*) which includes a "Plans for Operation" section where a design team must consider the operational planning and performance reporting aspects of a building during the design phase.

For instance, Standard 189.1 has a mandatory requirement for the installation of consumption measurement devices (i.e. submeters) for main utility services such as electricity, gas, and water. For larger loads, such as chillers, boilers, or lighting systems that exceed stated thresholds, individual submeters that isolate these specific consumptions must be included in the design. This requirement is for both energy and water use (ASHRAE, 2014). Similar requirements exist in the International Green Construction Code (IGCC), also a whole building high performance green building standard developed by the International Code Council (ICC)[2].

The current version of the LEED Rating System (Version 4) includes credits for installation of consumption measurement devices for utility mains (i.e. electricity, gas and water) and gives additional credit for sub-metering individual energy loads such as HVAC, lighting and process equipment. Furthermore, owners and operators of LEED buildings are required to provide actual building performance data for a minimum of five years after occupancy.

There are also building performance benchmarking tools available that allow building operators to document actual energy performance then compare that performance to a database of existing buildings: Energy Star Portfolio Manager and Building Energy Quotient (BeQ).

Energy Star Portfolio Manager, a tool developed by the US Department of Energy, gives the building a "score" compared to the average energy use of a similar building in a similar climate zone. The scale range is 1 – 100 with a score of 50 indicating the median energy use for that type of building. If a building score is 75 or higher, meaning that the building is in the top 25% of highest energy performing buildings, then the building is eligible for an "Energy Star" rating and award. One of the primary inputs to the data analysis for this research paper is the Energy Star score.

[2] Through an agreed Memorandum of Understanding, ASHRAE Standard 189.1 and the IGCC green building standards will be combined into a single document in 2018.

ASHRAE has also developed a building labelling system called Building Energy Quotient (BeQ) which develops two scores; 1) the "As Designed" rating is an energy model analysis of how the building is expected to perform and 2) "Asset Rating" (or "In Operation" score) documents the actual performance of the building. These scores are also on a 1 – 100 scale and have a grading system (A+ to F) based on the score. (ASHRAE 2016)

The primary difference with the ASHRAE BeQ program over Energy Star is that the BeQ score is based on how near to being a Net Zero Energy Building (NZEB) the building performs. A Net Zero Energy Building is one that, on an annual basis, produces the same, or more, energy than it consumes. An A+ score (100) in the BeQ system is equivalent to a NZEB. It is possible to have a score of greater than 100 only if the building, on an annual basis, produces more energy than it needs and is, thus, a net supplier of energy to the electric grid.

1.1.4 Energy Assessments and Technology Advances

Finally, the growth and development of energy audits and assessment procedures allow building managers to benchmark actual energy use and cost with similar buildings in similar climate zones. Extensive databases such as the Commercial Building Energy Consumption Survey (CBECS) and benchmarking tools such as Energy Star Portfolio Manager compile performance data for a variety of building types. Additionally, various tools are available for detailed performance analysis such as energy simulation and building performance measurement instrumentation. Therefore, an auditor can quantitatively demonstrate and grade a buildings performance and compare that with other similar buildings. From this analysis, an auditor can identify where energy (and water) is wasted and provide recommendations for corrective measures. This study examines the link between energy use and quality of maintenance practices in Small to Medium Enterprises.

CHAPTER 2

LITERATURE REVIEW

The purpose of this literature review is to identify how the typical SME manages the FM function, identify specific challenges the SME faces when implementing FM practices, understand the management structures in the SME, and develop data that forms the basis for developing a research methodology for analyzing the relationships between energy use intensity (cost) and the quality of the FM function

Preparation for this research has included the review of previously published scholarly journals, doctoral theses, industry databases, and some trade articles. Although there is an abundance of research regarding FM practice and procedures, there is less research on the specific issues associated with SMEs regarding FM. Most studies and guides are developed assuming that an organization has an FM department in place. This focus implies that the industry and academic emphasis is more on larger organizations such as university campuses, large hospitals, military bases, research institutions, and laboratories.

In the case of the SME, the issues of energy performance, costs, maintenance operations, and productivity issues are equally important as larger organizations. As will be indicated in the literature review that follows, FM activities in the SME are often relegated to custodial style care and are given little attention from the managers and corporate leaders - until a problem occurs. Furthermore, the SME rarely has a professional FM department, the managers have very little time to devote to FM oversight, and often rely on outsourced third-party maintenance providers to oversee equipment operations. Additionally, corporate culture, perceptions, leadership styles, and internal dynamics of an organization can affect the implementation of a high-quality facility maintenance program. High quality FM is not limited to the physical plant but includes oversight of other elements such as cleaning, grounds maintenance, security, purchasing and space allocation.

Although the belief that poor-quality FM practice results in high energy costs is widely assumed, there is very little supporting quantitative data in research literature. However, both quantitative and qualitative approaches need to be taken to understand the quality of FM practice and its impact on a building's energy performance. For instance, quantitative data includes type, area, energy consumption, climate zone of the reference building, and the building type (i.e. office, manufacturing, hospital, etc.) while a qualitative approach must consider the culture of the organization and the relative impression the facility leaders have toward FM practice.

2.1 A review of the Literature

In organizations, such as Fortune 500 corporations, large airports and hospitals, major colleges, large retail malls, government buildings, industrial plants, and organizations with extensive building space, high product deliveries, or large numbers of employees, there are typically formal facility management structures, dedicated FM personnel, and operational plans and procedures in place. Tell and Gabrielsson (2013) point out that the typical SME rarely has a formal FM department and that the FM function is managed by staff who are tasked with other responsibilities.

However, all facilities require some level of facility management. At a 2010 congressional hearing on building operating expenses, Richard W. Greninger with the Building Owners and Managers Association (BOMA), stressed the importance of preventive and predictive maintenance by noting, "*Buildings are designed and built to last for decades*," he said. "*But in order to keep the building in good repair, keep systems running at their optimal* *performance levels and attract and retain quality tenants, buildings must have a management plan in place and adequately budget for repairs and maintenance*." As described by Sullivan, Pugh, Melendez. & Hunt (2010), a well-functioning O&M program is safe, reduces Indoor Air Quality (IAQ) problems, achieves expected life expectancy, and reduces cost. In one project conducted by the author of this study, an energy assessment for a small private college, upon realizing the high cost impact of deferred maintenance decisions, the contrite CFO mentioned that his department had "bragged" over the years on how little was spent on facility management.

For an SME to formulate a plan for good facility management, it is necessary that the upper management of the organization fully understand the benefits and rewards of a professionally managed facility and support that activity. For example, how can the CEO be convinced that a quality FM function will enhance the mission of the organization, improve productivity and morale, and reduce operating costs? How can a small SME create a professional FM management structure with only limited financial and personnel resources? How can an SME gather, understand, and respond to performance tracking metrics and benchmarks?

2.2 Defining the SME

In much of the commercial building literature, an SME is defined by several criteria including the number of employees, the amount of sales, management structure (i.e. usually the manager is the owner), capital worth, geographic area of operation, and/or relative size when compared to similar industries. Furthermore, the Small Business Administration (SBA) defines a small business as independently owned and operated, and with limits on annual sales and number of employees. This definition, as derived, provides useful metrics for business sector analysis but does not include the physical size of the building.

Per the Commercial Buildings Energy Consumption Survey (CBECS), in 2007, out of a total of 4,860,000 commercial buildings in the United States, 4,752,000 are equal to or less than 100,000 square feet (ft^2) in area, which implies that over 98% of all commercial buildings in the United States are less than 100,000 ft^2 in area. Furthermore, the CBECS also reports that of all the commercial buildings, more than half of those were built prior to 1980. Based on this data, most buildings in the United States are smaller sized and it is assumed that many of these will be representative of the SME described in this literature review.

2.3 Characteristics of the SME Work Process and Environment

According to Tell and Gabrielsson (2013), the typical small business manager spends a large proportion of time doing deskwork and talks on the phone an average of 17 times per day. The rest of the manager's day is spent in scheduled and unscheduled meetings and responding to frequent interruptions (Tell, et al. 2013). The conclusion of their work study reinforced the assumption that small business managers are much more reactive than proactive in their work life. The study also concluded that the small business environment is rich for learning because all operating functions are handled by a multi-tasking few. Specifically, in the SME environment, where specific departments (i.e. FM, planning, purchasing, etc.) rarely exist, the relatively few staff and managers are tasked with multiple responsibilities. However, these managers do not have peer support and access to guidance and there is little internal communication and the frequent interruptions tend to limit effectiveness, creativity, and innovation. (Tell et al. 2013)

Furthermore, as pointed out by Harrigan, Ramsay, and Ibbotson (2011), the SME owner-manager faces different constraints and opportunities than the large business managers including lack of resources and expertise in specialized areas (i.e. FM). The dynamics will often cause the

SME to suffer strategic and tactical customer relation problems and are constantly limited by financial resources that suppress growth and potential work. In other words, the SME managers are overworked and must wear many hats within the organization.

The typical SME manager may encounter daunting challenges when he/she is faced with major projects such as building additions, interior renovations, equipment change outs, or Information Technology (IT) makeovers. The time commitment necessary to oversee and mange those types of projects are too much for the typical business manager to fit into their schedule. Therefore, the task of managing that activity must be allocated to several possible entities such as the design architect, the contractor or, ideally, to a professional program manager. Unfortunately, due to tight budgets and/or the lack of understanding of the value of a third-party professional in their corner for major work projects, the oversight of project quality, progress, and costs become part of the service provider’s task which can lead to conflict of interests, costs overruns and/or diminished quality.

The adoption of new ideas and instituting behavioral change must be supported by the CEO and upper management of the organization to be a success (Tell et al., 2013). Although this is true for both large and small organizations, it is especially true for the SME since there is typically not the same employee “momentum” as can occur is larger organizations (Tell et al., 2013). Time is always a valuable commodity and it cannot be expected that any of the upper managers will gain FM competencies and take over that function as a full-time assignment.

Based on experience from the author of this study with numerous building energy and condition assessments, it is rare that a CEO, or other upper level managers, can receive a detailed condition or energy audit report and then can effectively implement the recommended changes.

Since FM activities also tend to be technical and ongoing, it can be difficult for the business manager to comprehend the full scope of the professional FM function.

2.4 Facility Management Issues for SMEs

A review of the literature regarding facility management practices in the SME environment is discussed below. The several examples noted are provided to gain an understanding of the challenges and dynamics typically found in the SME. These examples cover many of the specific ways that the SME manages, perceives, and implements facility management activities.

A general observation from this research is that the SME will not have the resources available, both financial and personnel, to manage the FM function professionally, and the perception of facility management is that of a cost center with no real strategic benefit to the organization.

2.4.1 Maintenance perception in Swedish SMEs

The upper managers' perception on the FM function being a cost center only is a major reason that FM is usually not a discussion line item at regular business planning meetings. Because the FM work is also seen as a custodial activity, there is rarely an FM voice at the boardroom level. In a study of maintenance perception of SMEs, Ablay (2012) noted that "*despite advances in maintenance management, maintenance still has a negative image.*"

Focused on the maintenance activities of small manufacturing plants in Sweden, Ablay notes that in most SMEs, maintenance is viewed as a "necessary expense" and that the maintenance budget compared to production turnover was only 0.97% which is very low. The firms spend very little on technology development and training and only 27% of the study participants strategically use maintenance key performance indicators (KPI). The report noted that there is a need to increase the budget on the maintenance function as well as choose the correct service type and maintenance strategy.

Maintenance of a facility is a complex and interactive activity that requires constant attention, review of performance data, planned and predictive maintenance procedures, development of contracts and oversight. The de-emphasis in importance of this work in many SMEs can lead to expensive and reactionary solutions to problems that could be prevented.

In the conclusion of the research by Ablay (2012), it was noted that there are four specific barriers for a good maintenance activity. These include lack of financial resources, lack of technical resources, lack of qualified labor, and potentially the biggest barrier, organizational and management deficiencies.

Furthermore, Ablay noted certain steps that can be taken to improve the maintenance activity in the organizations: choosing the correct service type (outsourced, in-house, mixed), choosing an appropriate maintenance strategy, then designing and implementing that strategy, and having proper performance measurement and periodical evaluation. These steps toward good facility management can be a great challenge to the typical SME that may not have a full appreciation for the benefits.

2.4.2 Energy and Maintenance Link for Three American Case Studies

In a case study to investigate the link between energy use and maintenance for three American facilities, Lewis, Elmualim, and Riley (2011) refer to several studies that show poor building performance metrics. For example, Piette and Nordman (1996) found that "*more than half of the 60 buildings studied had temperature control problems, 40 percent had heating, ventilating and air conditioning (HVAC) equipment problems and about 33 percent had improperly operating sensors*." Additionally, the study points out that the use of Building

Automation Systems (BAS) and Computerized Maintenance Management Systems (CMMS) are underutilized and incapable of maintaining basic energy savings in hundreds of applications. A primary reason is due to the complexity of these systems and the challenges associated with fully utilizing them. These findings reinforce the motivation of this study in that buildings contain systems that are complex, expensive and require a higher level of operational management skills than currently employed in the industry.

Lewis et al. (2011), also pointed out that there was a direct link between sustainability and maintenance management, noting that the achievement of high level building performance metrics (i.e. Net Zero Energy Building) is contingent upon fully utilized BAS and CMMS systems and that "*Without proper maintenance, even the most efficiently designed building with high reaching energy efficiency goals will not achieve its energy goals*." Although the case studies were not directed towards Small to Medium Enterprises (SMEs), the studies, nevertheless, highlight many of the issues present regarding quality of the maintenance activity and energy efficiency.

In one of the case studies (Lewis et al., 2011), a large college campus, the facility department reported there were no standard procedures for energy or maintenance management. The campus was, however, in the process of transforming from a reactive to a proactive maintenance approach, which the facility department believes will improve productivity and further the case for better funding of the FM activities. The results of this case study indicated that 1) reactive maintenance was the most commonly used maintenance approach, 2) the use of preventative and predictive maintenance was minimal, 3) work order requests were the most common FM records, and 4) building performance measurement was limited to utility bill review. When these issues exist at large facilities with formal FM departments in place, it is assumed that SMEs, with no formal FM departments, may have similar operational issues yet the management may not be aware they exist, especially with lack of adequate data collection and record keeping.

The second case study (Lewis et al., 2011), was a laboratory building with a high level of building automation and instrumentation. An energy credit under LEED for Existing Buildings was sought where quarterly metering reports were to be provided to the USGBC. However, in practice, the users found that the annual collection of this data was costly, complicated and cumbersome. A primary question was how this process could be automated. The BAS system in place had various energy consumption points available but those were not of real value since they did not achieve the reporting requirements. The case being an example of a complicated computerized management system poorly commissioned and underutilized.

The third case study (Lewis et al., 2011), was an investigation of a BAS system upgrade for a hospital and to report on the methodology for achieving the upgrade. A part of the study presented a set of recommendations which included an energy program planning guide, a re-calibration program for various instruments and, gauges, and sub-meters in the building, and a guide for selecting critical equipment. The adoption of these recommendations was not a high priority within the FM department and, from the study, three primary lessons were learned:

1. Cost and energy savings alone are not enough to motivate change within a large organization.
2. Criticalities of operations for the hospital make energy efficiency operations more complex.
3. The culture and structure of an organization and project teams greatly influences how new ideas are embraced.

The key findings of this study indicate that there is interdependency with energy and maintenance yet this link is not widely embraced in practice. Also, it was concluded in the report that management tools are needed to assist the FM departments in implementing and operating energy efficient maintenance practices.

2.4.3 Outsourcing Practices for SMEs

The SME, by nature of the organizations size and resources, will be heavily dependent on outsourcing to provide essential services. It would be rare for an SME to have all the FM functions managed in-house. Because the SME management is faced with multiple tasks and concerns, it is unlikely that advanced outsourcing methodologies would be effectively used. Thus, a detailed and critical review and plan of what is specifically needed is rarely conducted. In fact, it is assumed that many SMEs rely on the contractual wording of the vendor and sign their agreement, usually selecting the lowest bidder, without comparing service offerings from competitive vendors.

In a research paper that defines a roadmap for outsourcing for SMEs, Cigolini, Miragliotta & Pero (2011), found that adoption of advanced outsourcing practices by SMEs is "*very low*" and concluded that "*FM suppliers should assume a proactive role in the relationship with the SMEs. Moreover, a cultural change is advocated in the SMEs. They should embrace Six Sigma philosophy and apply it to FM*." Such an approach may introduce more diligent oversight of outsourcing practices and include cost and service level comparisons, means for tracking performance and accountability, and full transparency in the outsourced services. In many instances, it appears the vendor dictates the scope of service and because the managers in an SME are otherwise overstretched, there may not be adequate scrutiny of the agreements and an accompanying assumption that service agreements are common across industry.

2.4.4 Strategic FM Planning and Implementation

Professional facility management in today's environment requires a wide range of skills and is increasingly complicated because of automated systems, cloud based information platforms, and higher levels of technology. Awang, Mohammed, Sapri, & Rahman (2013), in the Journal of Global Management, develop a comprehensive list of facility manger competencies and describe how these are important to transforming organizations (in this study, a university), towards new and improved performance. Although the case study was not an SME, the statistical conclusions indicated that communication, working with people and leadership and management skills are of the greatest importance for a facility manager.

2.4.5 Organizational Ecology / Space Planning

How are workers organized for optimal performance? This question does not only apply to large organizations with large budgets but is equally important to the SME. Becker and Steele (1995) identified "Organizational Ecology" as "*…how work and workers are convened in space and time*" and explained at length how modern design ideas for the workplace can be a fundamental catalyst for increasing productivity, encouraging the sharing of knowledge, and creating a more cohesive workforce.

2.4.6 Physical Plant Operation and Preventative Maintenance

The physical plant of a facility is typically made up of the heating, ventilation and air-conditioning equipment (HVAC), the service hot water and plumbing system, lighting and electrical services, and, if present, elevator, cooking equipment, and other "process" equipment used by the facility. These systems, collectively called the mechanical, electrical and plumbing, or MEP, systems, account for about one third (1/3) of the construction cost of a new building.

Furthermore, these systems are critical to comfort and durability of the building, and are complicit in all the utility costs of the building.

Modern MEP systems in commercial buildings are typically complex in nature and have automated controls, communication links with a building automation system, and have integrated components that must work together (i.e. a boiler and a pump and an automatic valve) and require constant attention as to performance monitoring, component functionality, sensor calibration, regular planned maintenance and system tune ups.

As is often the case in the SME, the management of the physical plant operation and maintenance is delegated to a custodian level manager for almost all aspects of operation and maintenance tasks. This almost invariably results in poor performance, high costs, early equipment demise, and comfort problems as was observed in this study by this researcher.

Regarding operation and maintenance of the physical plant, it is imperative that the FM function within the organization have sufficient expertise to manage complex systems. This activity would include the effective use of management tools, such as computer aided maintenance management software, and project management skills to ensure systems perform as expected. Although much of this work would be outsourced in the typical SME, the facility manager would still require expertise to ensure the outsourced work is understood, managed, and reviewed for quality on a regular basis.

2.4.7 Performance Measurement and Benchmarking

Wong, Leung & Gilleard (2013), in their analysis of FM benchmarking applications, note that "*FM performance benchmarking analysis is often unsophisticated. Relying heavily on simple statistical representation, [and] linking hard cost data with soft customer satisfaction data is often problematic*." By defining the FM role as an activity that is intended to provide a pleasant and productive work environment it was also noted that the FM professional has responsibilities beyond the physical plant that include oversight of activities such as cleaning, security, and inventory control. Even though collecting of this data may be routine for larger organizations, the typical SME will simply not have the time or resources to strategically collect and manage benchmarking data.

The challenge, then, is to determine which benchmarks are the most important, and to devise means for capturing the essential data needed to monitor those parameters. Wong et al. (2013), point out that proper performance benchmarking involves statistical evaluation of data which, though complex in nature, further reinforces the need for planned benchmarking with well-defined metrics. Can an SME benefit from a formal benchmarking activity? Most likely so and the challenge for future research on this subject to not only identify what needs to be measured but how to collect, interpret and report that data.

2.4.8 Security / Business Continuity / Risk Assessment

Nicoll and Owens (2013) have discussed emergency response and business continuity planning as it would apply to a small SME. In their report, it is noted that companies without a plan or with inadequate plans, not only reduce their market viability but when an SME loses market share due to a catastrophic event it can severely affect the ability to stay in business. In fact, an insurance industry statistic was noted (Nicoll et al., 2013) that "*one in four small businesses that close due to a disaster will never reopen.*"

The importance of developing a plan cannot be overemphasized for an SME and the security plan must be more than an "*evacuation plan*." However, business continuity plans take time and effort to develop and a risk assessment analysis must be part of the plan's development process. Furthermore, the staff and occupants must be aware that a plan for specific events is in fact developed, and must know how to react in certain situations. In other words, training and practice runs are critical to having adequate response in a real emergency.

Furthermore, the SME must address information, space, and equipment issues when planning for catastrophic events. How soon can business operations re-start after a tornado or fire and are sensitive and non-sensitive information adequately preserved and backed up?

What would be risks to the business function for a typical SME beyond disaster preparedness? As a small business owner, a fundamental risk would be losing important client and financial data by not having an adequate information backup system. Furthermore, relying on outdated technologies can place the SME at a competitive disadvantage by not being a “first responder” to work opportunities in a rapidly changing environment. The SME must develop a detailed information backup plan and implement the plan to ensure that unexpected losses can be quickly recovered.

2.4.9 Indoor Environmental Quality

Indoor Environmental Quality, or IEQ, is the term used to describe all factors that contribute to the indoor environment and include air quality, temperature, humidity, drafts, odors, glare, noise, and cleanliness, to name a few. These elements contribute to the health, productivity, and morale of the employees and maintaining good IEQ is typically a major part of the FM function.

Per the ASHRAE Indoor Air Quality Guide (2009), “*It is well understood that in mechanically ventilated buildings, HVAC systems can have a significant effect on IAQ, energy use, and occupants’ well-being*.”

The challenge, therefore, is to introduce ongoing IEQ procedures to ensure that the indoor quality stays at a good level for human functioning.

2.4.10 Sustainability

Sustainability and environmental stewardship are active practices that cut across all sectors of society and the business world. These concepts apply to governments, large corporations, SMEs, and to be fulfilled, require an organization to take steps to reduce energy use, natural resource depletion, and waste. In realizing these goals, the FM department would be a key player in overseeing many sustainability initiatives and this activity would apply of all sizes of organizations. However, for the SME, lack of resources can be a persistent barrier to implementing change.

Cordano, Marshall & Silverman (2010), in their study of how a small business enterprise (a winery) went "green" touch on some of the challenges faced by SMEs in this area. For example, they pointed out a variety of management and organizational motivations for greening and noted that the managers' attitude toward adopting various green measures was important. Primary drivers to going green were identified as "*benefits, regulation, norms, internal and external pressures and employees*." One of the conclusions from this study was that having formal environmental measurement programs in place were important to the continuing progress and improvements of the initiative.

2.4.11 Managing Major Projects

For the small business owner, taking on major facility improvements or constructing new space can be a daunting and frightening experience. Not only does this activity require planning and preparation, but the management of major work projects must include vigilant oversight and attention by the owner. Often the SME management staff is not skilled in construction management and, as noted elsewhere, is universally stretched for time and attention.

As is often the case, the SME relies heavily on design teams and contractors to oversee quality, progress and schedule of major work activities. The problems that can arise are less than expected quality of final product, especially related to performance and appearance, but also in quality of the physical plant systems and inadequate operator training of the physical plant. The SME, when considering a major renovation or new construction project is well placed to hire a program manager to manage and provide the oversight needed for a complex and expensive project.

Jackson (2004), in a study of small national parks in the Southeast, elaborates on the concept of competitive sourcing within the government sector but also highlights some of the challenges faced by SMEs. The report presents the notion that procuring services in a detailed and programmatic manner leads to lower costs and fewer problems. In the report, Jackson lists several best practices to employ when undergoing a major project.

2.4.12 Summary of Facility Management Issues in SMEs

Based on the above review of FM practices in typical SMEs, a major barrier to effective FM quality is the perception that the FM function is a cost center rather than a catalyst for cost savings, enhanced building performance and worker productivity. Additionally, the literature review suggests that many SMEs have less than optimal oversight of the FM function with no standard FM procedures, poor data collection and outsourcing methods, unsophisticated benchmarking and performance management and poor sustainability management practices. Furthermore, many of the management skills necessary for the modern facility manager are lacking and this is evident in the quality of space planning, preventative maintenance, security, managing of indoor environmental quality and management of major renovations or upgrades.

The organizational and operational issues outlined above appear to be indicative of typical modes of operation in SMEs.

2.5 Energy Star Rating System

A key component of the reporting procedure for this study includes the building benchmarking system developed by the United States Environmental Protection Agency (EPA) known as Energy Star Portfolio Manager (ESPM).[3] This benchmarking tool utilizes a large database of building types and their energy use which is drawn from the Commercial Building Energy Consumption Survey (CBECS). Building energy use and cost, based on building type and climate zone, are reported on a per area basis. Energy is reported as kBtu/ft^2/year (known as Energy Use Intensity, EUI) and cost is reported as USD/ft^2/year (known as Energy Cost Intensity, ECI) and both are measures on an annual basis. Additional data is mined from this benchmarking system including site and source greenhouse gas emissions, water use, and the Energy Star "Score."

The Energy Star Score is a representative value of how a subject building compares to other similar buildings in similar climate zones. The score is on a scale of 1 – 100 where a score of 50 indicates average building performance. A score below 50 implies a building that is performing less efficiently than the reference population of buildings and a score above 50 indicates better than average performance. If the building achieves a score of 75 or higher, then that building qualifies as an "Energy Star" building and receives certification and building labeling from the EPA.

To qualify for an Energy Star score, the subject building must be one of the twenty-one building types currently in the Energy Star database. However, other building types can still

[3] Refer to Reference section of this report for Energy Star Portfolio Manager citation. This entire section references and describes this building rating system.

register with ESPM to track performance but are not eligible to receive an Energy Star score or award.

The procedure for entering the ESPM system requires that the subject building register with Energy Star and input basic information such as building type, gross area, geographic location, occupancy and quantity of PCs. Every month, utility information (usage and cost) is input into the online system and a running score is maintained for the facility. The building operators can easily monitor energy use over time, track the effects of energy improvements and monitor changes in the building Energy Star score as they move toward achieving performance goals.

An additional tool developed by Energy Star is the “Target Finder” calculator which allows a facility to input past performance data to get a snapshot of status and the current Energy Star score. Then, the user can establish a target performance goal and Target Finder will identify the performance goals (EUI, ECI) needed to achieve the desired score. Target Finder is also a useful tool for designing new buildings by establishing a target energy performance goal and, usually though energy modeling, the designers can analyze various energy efficiency measures needed to achieve that goal. In developing the Energy Star scores for this research, the Target Finder tool was used for each project based on past energy use data.

2.6 Literature Review: Conclusions

Pulling together the available data and experience with SMEs, a picture emerges which fundamentally leads to the conclusion that the typical SME does not have the resources, knowledge, personnel, and funding for a fully engaged facility management structure. However, the need for professional FM practice is equally important for the SME as it is for the larger organization.

Some SMEs, however, may be too small to fund a full-time position and in those instances, would need to have a small business FM "roadmap" of procedures and guidelines. This guideline would allow for detailed examination of outsourcing vendors, develop a contract template for vendors that meet the needs of the organization, and provide procedures for determining the appropriate level of services needed within the organization. Not all outsourced services need to be "best in class" but it is necessary that the services provided are applicable to the needs of the organization.

CHAPTER 3

CASE STUDIES

To further elaborate on the dynamics of SME FM practices, case studies from energy assessments (conducted by the author) are described below. These studies are taken from actual projects where the FM structure was studied as part of energy assessments and form part of the data set for this thesis.

In all cases, high energy costs were unknown to management, utility data was difficult to retrieve, the maintenance function was outsourced to the lowest bidder and the terms of the contract were written by the maintenance provider. Almost all of the problems encountered would be resolved through management changes rather than the purchase of new equipment, services, or technologies.

3.1 Three Case Studies of SME Facility Management Practices

3.1.1 Case Study 1: Garden Apartment Complex

This property was a large garden apartment complex made up of approximately 50 buildings and 300 apartments. The buildings were 1970's vintage and many had original heating, ventilating and air conditioning equipment (HVAC) and most had serious building envelope problems such as insufficient or damaged insulation, failing single pane windows, and poor weatherproofing. Many of the units suffered water damage and there were mold and mildew issues. The property needed a major renovation and makeover.

The ownership of the property was through a property development firm that had a large portfolio of properties and assigned individual asset managers to oversee the financial performance of the portfolio. At the site level, the management consisted of a property manager and assistant who were primarily responsible for renting and marketing the property. In addition, the on-site property managers hired a Facility Manager, whose primary responsibility was minor repairs, managing a small custodial staff, and responding to emergencies – basically a handy-man role. All the utility billing and cost reporting were managed by a third-party provider who had the ability to report individual meter performance and variations in utility trends. However, attaining energy use data was a challenge and the information was not readily or easily available, nor were the performance trends known to the managers.

This property had a central distributed energy system (DES) in place that included five chiller and boiler plants that supplied chilled and heating water, via underground piping, to the individual apartment units. One block of apartments had been retrofitted to individual residential style split system HVAC units and were no longer on the central system.

The maintenance and operation of the central systems was outsourced to a mechanical contractor who was very familiar with the system operation, control, and was adept at keeping the system operating and orchestrated the manual winter/summer changeover procedures. The property managers were pleased with the performance of the contractor, especially since the system shutdowns were addressed quickly.

However, the system condition was extremely poor and energy costs were more than double at approximately $600/unit when compared with benchmarks for other similar properties ($200-$300/unit). The management did not monitor performance of utility costs and therefore were unaware that the utility bills were exceedingly high.

Furthermore, long term planning did not appear to be part of the organizational duties, and project management of upgrades was relegated solely to the outsourced contractor identifying, pricing, and performing the work.

The upper level asset management department was considering a major replacement of the physical plant equipment but there did not appear to be any efforts made to reorganize the management structure to incorporate professional FM procedures. It was an example of the FM function seen as an expense and with no real appreciation for the immediate and long term benefits of well operated facilities.

3.1.2 Case Study 2: Large Place of Worship

This example was a large place of worship (approximately 120,000 ft^2) and was compromised of offices for staff, a morning kindergarten, and a bookstore, meeting spaces, fellowship hall and sanctuary. The management structure included the presiding clergy, a business department that included accounting, stewardship, membership, education, outreach, music, business management and administration. The facilities staff was made up of about ten individuals however most those were custodial and/or were involved in various room set up and break down activities.

The facility manager was responsible for managing the custodial staff and for operations and maintenance activities. This individual was under-resourced and did not employ modern facility management practices, and was responsible for managing approximately $850,000 (off the shelf price) of physical plant, the grounds maintenance, and cleaning. The office space for this individual was far removed from the management offices (literally and figuratively) and was adjacent to the mechanical room. On-site staff did not have the skills to operate the physical plant control systems, program automatic controls, adjust critical flows and pressures, and did not operate a planned preventative maintenance program. Administration level FM duties, such as space planning, new works, and acquisition of supplies, for example, were managed by other individuals in the business unit.

Although there were over twenty-five rooftop air-conditioning units and over twenty split system heat pump units in addition to the chiller / boiler / air handler systems, there were no skilled technicians employed by the organization and almost all minor alterations or repairs were outsourced. The contract maintenance provider was on site often, conducted maintenance duties according to a contract developed by the provider, and had very little or no communication with the senior management.

The HVAC systems were found to be in manual, constant flow condition at all hours (24/7) rather than under automatic control mode. Most system functionality problems had improvised solutions and, by conservative estimates, the facility was wasting $100,000 per year in excess energy use alone. A chiller was replaced after six years of operation due to component failure (life expectancy is twenty-three years) and the replacement cost was $200,000.

Furthermore, this equipment was replaced under “emergency” mode, and therefore equipment selection was relegated to an available, in-stock unit that was larger than the unit it replaced. The replacement process did not include detailed engineering analysis to confirm correct sizing or design conditions for the new equipment. The reactive and emergency decision resulted in an oversized chiller and, under normal operating conditions, will be a critical part of the building life for well over 20 years.

High performance FM practices such as strategic or tactical planning, benchmarking of performance, tracking utility costs, or development of operational procedures were not in place. The buildings and grounds committee, made up of volunteers, were given almost free reign to manage the activities of the facility management department. This organization was in desperate need of a professional FM manager at the mid-to upper level management level to oversee and manage all FM functions.

3.1.3 Case Study 3: Private K-12 School

The final study of a SME FM operation was a private k-12 school where the main school building was approximately 65,000 ft2 and included other buildings such as a gymnasium, arts and sciences wing, and cafeteria. The original scope of activity was to perform an energy study of the main school building. The school had recently constructed a new LEED Certified gymnasium and a new LEED Certified classroom building. This energy study focused on the main school building and resulted in a major renovation that delivered a LEED Gold building.

The facility management of this enterprise was unique in that the FM functions were performed on a part-time basis by a teacher. In this dual role, almost all maintenance and operational upgrades were outsourced and the building scored an extremely low Energy Star Portfolio Manager Score of 23 (on a scale of 1-100 where 50 is the average energy use of similar buildings) and about $37,000 more energy cost per year than the average school and about $75,000 more than an “Energy Star” school. Furthermore, management of the physical plant was the primary activity of the facility manager and the other management duties such as cleaning, ordering supplies, or equipment purchases were typically handled on an ad-hoc basis by individuals within various departments.

As the campus grows in size and complexity, the physical plant equipment and facility management duties will increase in complexity, space planning will require standardization, products and supplies must be strategically purchased, and the facility management will not function well if treated as a part time activity.

However, the organization was not willing to create a full-time professional Facility Manager position because this function is perceived as an additional cost and the function is provided solely by outsourced vendors. FM was not perceived as a professional, strategic, and vital activity but more as a task, like cleaning.

The importance and value of FM is lost in the day-day-needs of this SME and the plan is to carry on with business as usual. In this instance, business as usual implies allowing equipment to "run to failure" and deal with the issue at that time. The cost implications of this approach were not fully understood by the SME, and any additional FM resources would not be considered.

3.2 Commonalities of FM Practices Shared by SMEs

Compiling notes and observations from the three case studies above, and drawing from data in the literature review (Chapter Two), there appears to be a fundamental set of commonalities regarding FM practices in SMEs.

A summary of the commonalities is noted below:

1. High levels of deferred maintenance.
2. Under-resourced FM department.
3. Potential energy savings that would fund (whole or in part) an FM position.

4. Facility Manager also responsible for multiple non-FM related tasks.
5. Facility relies heavily on outsourced service providers.
6. Outsourced vendors used their own standard contracts and defined the level of service provided.
7. Outsourced vendors allowed to specify and install equipment with little or no engineering design (i.e. replacements were “like-for-like”).
8. Upper level management does not appreciate that constant attention is needed to preserve functionality and longevity of the physical plant.
9. No short or long term strategic FM planning.
10. No formal procedure for reporting, tracking and resolution of problems.
11. Very few or no operational procedures and standards.
12. No tracking of key performance indicators (benchmarking).
13. No review of utility bills or tracking utility costs.
14. No formal training or procedures on building automation system use or other critical systems.
15. The oversight, management and quality control of major renovations or new construction projects was entrusted to the design professional, the contractor, or a volunteer. There were no third-party program managers hired to protect the interests of the organization.

CHAPTER 4

DEVELOPMENT OF A METRIC TO SCORE FM QUALITY

Professional facility management (FM) is a complex undertaking that requires a wide range of skills. The work covers a multitude of activities including oversight of maintenance, system upgrades, renovations, and new construction, as well as planning, budgeting, and performance tracking. The skills required are many and include project management, communication, contract negotiation, technical and financial understanding, and control of outsourced vendors such as HVAC, landscape, cleaning, and security providers. (Cotts, Roper, & Payant (2010, p 5)

The Facility Management function, as in any management function, can be performed exceptionally well, exceptionally poorly, or somewhere in between these two extremes. As part of this research, a metric for evaluating the effectiveness of FM function has been developed. The level of effectiveness at which this function is administered is referred to as "FM Quality" in this study.

4.1 Derivation of FM Factors and Quality Indicators

To evaluate the quality of an FM function, both quantitative and qualitative methods of evaluation were employed. Quantitative methods are those aspects that can be directly measured and include such metrics as utility costs, deferred maintenance, and comfort complaints, etc. The qualitative approach includes observations of various aspects such as cleanliness of back-of-house area, technical information storage methods (i.e. existing drawings, equipment manuals), and the competency of utilizing formal management tools, etc.

The first step in arriving at a metric that describes FM Quality included the development of an extensive list of major FM related attributes which capture the breadth and scope of FM related activities. The creation of this list started with the general, unedited listing of every activity of the FM function that could be envisioned. Resources for this list included graduate level FM coursework material, text books, industry journals and procedure manuals, and, generally, the canon of information which make up the literature research for this study. These FM attributes were then categorized into areas of similar topical areas and then vetted and condensed into a manageable list that was deemed to effectively capture the scope of FM activities. Once the final list of attributes was prepared, they were organized into four primary themes, or "Factors," which became the primary headings for the final list of attributes that are used to effectively determine FM Quality.

The four primary themes, or "Factors" for categorizing the FM attributes are listed below:

1. Corporate Organizational Structure in Relation to the FM Function
2. Facility Management Expertise and Planning
3. Facility Condition
4. Facility Department Data Management Practices

There are five attributes under each Factor and these attributes are referred to as "Quality Indicators" in the following text. These are the final and specific FM characteristics that, taken together, were determined to provide an overall indication of the quality of the FM function. The five Quality Indicators listed under each of the four Factors amount to a total of twenty specific points from which FM Quality is determined.

To arrive at a "score" for the FM Quality, each Quality Indicator is graded using a Likert scale with a range of 1 to 5 where a low range score represents a poor performance and a high score represents excellent performance. A score of 3 would indicate average FM practice.

There is a qualitative aspect to the scoring of FM Quality in some of the Quality Indicators and this is especially true for the "in-between" scores of 3 and 4. For instance, the cleanliness of a facility, or the level of utilization of computerized FM software, may be somewhere between average and poor and these are the cases where a researcher would indicate an in-between score.

The ability to understand and discern the nuances of the scoring method is one of the primary reasons that the researcher must have tacit knowledge of facility management activities, be trained in conducting the survey, and understand the scorecard grading system. It is also a major reason why the FM Quality Scorecard must not be completed by staff or outsourced FM providers of the facility being graded.

The FM Quality attributes developed for the FM Quality Scorecard (Factors and Quality Indicators) were condensed and derived from a variety of sources which are cited in this research study, these sources include:

1. Current graduate level coursework in Facility Management
2. Literature reviews
3. Facility Management Journals
4. Industry organizations, i.e. IFMA[4]
5. Practical experience with facility management functions
6. Comments from industry professionals (Peer review)

[4] International Facility Management Association; www.ifma.org

A complete matrix of all Factors and associated Quality Indicators, including descriptions of grading scale rubrics for determining the score, are contained in Appendix A of this report. Section 4.3 of this chapter describes in detail each Quality Indicator and lays out the rationale for determining the various levels of scoring used for this study.

4.2 Peer Review

Once the Quality Indicators were derived in near-final form, the list was sent to several industry experts for review and comment. These individuals are all experts in their fields and include energy auditors, commissioning experts, professional engineers, facility managers, facility management consultants, academics, and construction professionals.

The feedback from these professionals was, for the most part, comprehensive, detailed and reflected the experience and knowledge of the group. Several Quality Indicators were modified and or added to because of this peer review.

An interesting feedback from all reviewers was the belief that there is, in fact, a lack of resources and operational tools available for the typical SME, and that this area of research is important and needed within the in industry. The participants involved in the peer review process are acknowledged in the Preface this study.

4.3 FM Quality: Factors and Indicators

4.3.1 Corporate Organizational Structure in Relation to the FM Function

For an FM department to be robust and effective, there must be support and buy-in from the highest levels of corporate governance. "*Research suggests that executives often perceive FM as a support function, with minimal strategic value. As a result, many facility managers face a "glorified custodian" stigma that prevents them from gaining traction with the C-Suite*" (Kadzis, 2015). Furthermore, were management to understand that the benefits and rewards of a well-functioning facility effect the core mission of the organization, formal, supported and well-resourced FM activities may be implemented.

The following Quality Indicators represent an organizational structure and culture that is supportive of a high functioning FM department.

4.3.1.1 Facility Manager's position within organization

For a facility manager to be effective, he or she must have a respected and viable place within the management organizational structure. Per Cotts et al. (2010), the best position on an organizational chart for a facility manager is two levels directly below the Chief Executive Officer. In most examples from this study, the facility manager was essentially an under-resourced custodian with numerous additional duties with scant access to upper level management.

The scale factor for this Quality Indicator is low when the facility manager is at a custodian level and with few technical or management skills, is considered average when the position is mid-level management and with FM management tasks being only a small portion of their official job duties. The FM quality would be considered excellent if the person is dedicated to the FM activity, has refined technical and management skills, and has an array of tools and resources available to perform the FM function.

4.3.1.2 Key Performance Indicator (KPIs) utilization

Barret and Baldry (2003) maintain that "*When the facility management unit lacks reliable and comparable data on building performance and costs, its ability to make its most basic decisions is impaired, as well as its ability to make a convincing case for its recommendations*." Therefore, the gathering of key performance indicators (KPIs) and utilization of this data by management is important in classifying the quality of the FM function. Per Sullivan, et al (2010), KPIs can include energy use and cost, backlog of unfinished work (deferred maintenance), or amount of comfort complaints. An additional metric for this study adds frequency of unplanned site visits by outsourced vendors.

A poor level of quality for this indicator would be no KPIs available and/or are never used where an average score would be achieved if some KPIs were available but only derived when needed from standard sources (i.e. utility bills) and only undergo cursory review. An excellent quality score for this indicator would be KPIs actively gathered, regularly reviewed by the FM department, reported to upper level management, and reviewed at the highest levels.

4.3.1.3 Long and/or short term strategic planning for facility equipment and operation

Strategic planning, both long and short term, is an activity where a high functioning facility manager would play an important role. In fact, Rondeau, et al. (2008) point out that "*Strategic planning with respect to the corporation's facilities is at the heart of an effective facility management function*." The facility manager may not be responsible for the ultimate planning scope, but would provide input and be a part of that process.

If an organization has very weak or nonexistent strategic FM management plans in place, problematic FM issues may only be brought to the attention of upper level managers when there is an emergency failure resulting in a reactive FM style. This would be considered a poor-quality indicator where the average score would be a scenario where plans are considered and/or loosely developed but not fully developed or utilized.

An excellent score for this indicator would be an organization where short and long term strategic plans are in place, regularly updated and are treated as a crucial tool for management and budget decisions.

4.3.1.4 FM manager participation in and contribution to management meetings

A skilled professional facility manager will have deep knowledge of the status, condition, and needs of the facility and understand the budgetary constraints inherent to any organization. This person will have information, KPIs, and progress reports available for review and can communicate these issues at management meetings. This facility manager will have a clear idea of the needs and challenges of the facility and develop data necessary to confirm these issues. However, Friday (2010) point out that "*One of the biggest complaints among facility managers is that they are often left out of decisions that will affect facilities…left out of meetings where they could have made a valuable contribution*."

If the facility manager position is placed at a low-level custodial position, it may be rare that this person is invited to attend management meetings or that person may attend meetings but only offer a historical perspective of past events. The level of this activity constitutes the low to average range of FM quality. An excellent facility manager indicator would be a facility manager that has agenda time at management meetings, makes presentations on current FM status and needs, and actively participates in the decision-making process.

4.3.1.5 Corporate sustainability initiatives and measures

Most large organizations now address corporate sustainability in some fashion. The international accounting firm, KPMG, in their 2015 "Survey of Corporate Responsibility Reporting," found that now most of the world's biggest companies produce annual sustainability reports. Since 2008, the rate of growth has moved from 74 percent to 86 percent (KPMG, 2015).

Although this, and most studies focus on large corporations, Bos-Brouwers (2009) studied sustainability initiatives in SMEs and looked at the various initiatives in place. These initiatives may take the form of waste management, environmental policies, energy management, materials and emissions tracking (Bos-Brouwers, 2009). The professional facility manager would play an important part in these and other sustainability initiatives. Implementing many of these activities would fall directly under the scope of the FM department. Therefore, culture of sustainable operations and the adoption of such measures by upper level management is considered an important indicator of FM quality.

A poor indicator of this attribute would be no corporate sustainability program in place and is not part of upper management focus. An average score would be limited sustainability efforts in place, usually started by an internal group outside the corporate suite, and with cursory or weak support from management.

However, an excellent corporate sustainability initiative would have full support from upper level management, would have several measures in place, and the FM department would be fully engaged in implementing measures and reporting performance.

4.3.2 Facility Management Expertise and Planning

To effectively manage the FM function in today's changing and increasingly complex world, a facility manager needs to have familiarity with current management tools and resources. Additionally, the FM department must utilize management techniques and procedures that enhance the efficiency of the department. The following Quality Indicators highlight various management techniques and processes that define quality of the FM function.

<u>4.3.2.1 In-house structured maintenance procedures and tools</u>

Facility professionals use tools to manage the planning and day-to-day operations and maintenance activities required for a single facility or a large complex. These tools also provide all the information required to manage the work, the work force, and the costs necessary to generate management reports and historical data.[5] The availability of tools and software to aid the facility manager are seemingly endless. Computerized Maintenance Management Software (CMMS), Computer Assisted Facility Management (CAFM) software, and Construction Operations Building Information Exchange (COBie) are only a few of the resources and tools available. These tools allow the facility manager to manage work orders, keep histories of equipment and track key performance indicators within ever increasingly complicated systems. Although the level of tools utilized will be commensurate with the facility complexity, there must be some level of organized data management in place.

However, a few of the subject facilities for this study either had no structured maintenance management tools in place, or, in some instances, had the software available but its understanding and utilization was limited. These instances would represent a poor to average score for FM quality. An excellent FM practice would be a robust utilization and application of management software and preparation of regular reports and good data management of past performance.

4.3.2.2 Management of outsourced work and agreements

Whether a large organization, or an SME, there is usually some level of work provided by third-party outsourced vendors. Cotts et al. (2010) point out that outsourcing saves money, responds to fluctuating needs, provides better quality specialized skills, and allows the organization to focus more on the core business. Outsourcing, therefore, can be an important part of an organizations management strategy and, given the complexities of modern systems, can provide specialized expertise to the SME that is not needed on a full-time basis. As with all

[5] Whole Building Design Guide, National Institute of Building Sciences. Computerized Maintenance Management Software (CMMS). https://www.wbdg.org/om/cmms.php

contractual arrangements, oversight, and performance of outsourced vendors must be managed and reviewed on a regular basis to be effective.

A facility that allows outsourced vendors to not only dictate the contract provisions, but also make decisions regarding equipment repair and replacement, combined with no in-house capability for simple repairs and/or little or no formal preventative maintenance activity would be an example of poor FM quality. An average facility would still rely on outsourced vendors for much of the basic FM functions, still rely on vendor prepared contracts, but may have some expertise in house to manage small repairs and regularly scheduled maintenance activities.

An excellent example of FM management may continue to utilize outsourced vendors except these vendors will be performing to owner prepared contracts and be monitored for performance and be required to meet stated performance levels. Furthermore, a well-functioning FM department will have the capability to determine the financial decisions of either using experienced in house technicians or outsourcing work to others.

4.3.2.3 FM staff understanding of system operation and control

Unfortunately, most the subject facilities for this study had facility managers who were unable to effectively operate the building systems (HVAC, hot water, fire alarm, communication, etc.) and were forced to retain outside services for relatively simple operational adjustments (resetting an automatic control, for example). For this study, it is assumed that the in-house personnel responsible for maintaining equipment and systems would need basic understanding on operation of equipment such as automatic controls resets, turning systems on and off, and simple maintenance checks.

Therefore, a poor FM Quality Indicator is one where all adjustments, calibrations and controls settings require outsourced vendors. In-house staff are unable to program automatic control systems or perform system diagnostics. The average facility would have the basic ability to set thermostats and turn equipment on and off and re-set parameters and may know how to navigate an automatic control system. An outsourced vendor is required for all other functions.

An excellent FM department would have personnel that are trained to operate equipment and troubleshoot problems. Staff would be familiar with automatic control system operation and resets. Furthermore, many repairs and adjustments can be performed in-house.

4.3.2.4 Active tracking of utility use and cost performance metrics.

Capehart et al. (2012) state that "*…the primary objective of energy management is to maximize profits and minimize costs*" but also point out that some of the sub objectives include improving energy efficiency, developing and maintaining effective monitoring, reporting, and management strategies for wise energy use, and finding new ways to increase returns from energy investments. Adopting a good energy management strategy will require, at a minimum, active tracking and review of the buildings energy use.

A low functioning FM department would not have access to utility data and, therefore, would not review these bills for potential irregularities or problems. In this case, it was common for the accounting department to pay and store utility records and no communication procedures in place with the FM department. The average FM Quality Indicator would be a department that also does not actively track and review utility performance but does, in fact, have this information available if needed.

With an excellent facility, the utility bills are input and tracked monthly using a spreadsheet, dedicated software program, or web-based tool such as Energy Star Portfolio Manager. Data is regularly reviewed for potential problems and to monitor improvements.

4.3.2.5 Participation in continuing education or industry events

The International Facility Management Association, IFMA, is a strong proponent of the FM profession, has various levels of certification available, has numerous active chapters across the globe, and has a large pool of resources available to its members. Also, IFMA, offers a wide range of training and continuing education opportunities for members. The Building Owners and Managers Association, BOMA, also has an FM focus to much of their activities and continuing education programs.

A poor FM quality score for this Quality Indicator would be given to an organization that does not have any association with these organizations (or similar groups) and has no education or training opportunities available to FM staff. The average FM department may agree to some educational events, have a membership with an industry organization but not fully utilize the opportunities of membership with these groups. An excellent quality score for this Indicator would be a facility that was engaged with professional organizations, encouraged staff to participate in continuing education, and attends conferences on a regular basis.

4.3.3 Facility Condition

A third factor developed to determine the quality of the FM function is looking at the actual condition of the facility itself. This analysis takes the form of simple observation as to cleanliness and orderliness of not only the visible public areas but also the “back-of-house” areas that are not seen by most building occupants or visitors. A key premise of this factor is the position that a clean and orderly facility reflects very good FM practices.

Additionally, other facility condition indicators may not be openly visible and include the level of deferred maintenance (if known) and the level of occupant complaints. A sub-component of these Quality Indicators is whether the FM function is tracking and reporting deferred maintenance and occupant comfort.

4.3.3.1 Condition of back-of-house areas

Public areas within many facilities look good and are well maintained, clean, and have an appealing presence. However, the non-public areas of facilities can often reveal the true nature and care taken by the FM department. These back of house areas include mechanical rooms, janitor closets, storage spaces, attics and basements. This Quality Indicator is primarily a qualitative assessment but several indicators are presented that assess the condition of these spaces.

A poor back-of-house condition has been seen to be spaces that are dirty with leaks and chemicals on floors, clutter, measurement instruments in poor working condition, ad-hoc repairs evident and inadequate securement of these rooms. An average facility would be generally clean but have inappropriate storage practices (i.e. store supplies in MEP rooms), and may have some leaks and instruments not working. An excellent condition score would be back-of-house spaces that are exceptionally clean, no leaks, controls and instrumentation in working order, and MEP areas are not used for storage. Additionally, these spaces would be well lit, have no signs of chemical fouling and have adequate safety measures in place.

4.3.3.2 Condition of public and/or regularly occupied spaces

Public spaces can also be an indicator of FM quality although the signs may be much subtler than the back of house areas. Another qualitative indicator developed for this study is to review and assess the cleanliness of the public spaces within the facility.

Examples of poor FM quality include obvious leak spots on ceiling tiles, remains of unfinished projects, cluttered common areas and signs of poor or inconsistent housekeeping. An average facility would be in generally fair condition with a few areas that could be improved or modernized. An excellent public space would be in good condition, clean, uncluttered, all projects completed and good signage in place.

4.3.3.3 Observed indoor environmental quality (IEQ)

Another observational indicator is indoor environmental quality (IEQ) and this indicator relies on other senses including smell and feel in addition to observations. Per the EPA Indoor Air Quality Guide:

> "*Indoor air quality is not a simple, easily defined concept like a desk or a leaky faucet. It is a constantly changing interaction of complex factors that affect the types, levels and importance of pollutants in indoor environments. These factors include: sources of pollutants or odors; design, maintenance and operation of building ventilation systems; moisture and humidity; and occupant perceptions and susceptibilities. In addition, there are many other factors that affect comfort or perception of indoor air quality*."

Management of IEQ is a function that would rely heavily on the FM department to oversee and support. For example, a poorly maintained HVAC plant can reduce indoor air quality, create humidity issues, and escalate costs.

Poor IEQ would be indicated if comfort complaints exceed 20%[6] of the building occupancy, reactions to thermal comfort issues are ubiquitous (floor heaters, fans, dehumidifiers, etc.), and obvious issues such as odors, noise, and drafts are clearly present. An average facility, however, will have some comfort complaints and may have a few isolated areas with some

[6] ASHRAE Standard 62.2 (Standard for Acceptable Indoor Air Quality). At ideal room conditions, a typical occupancy will have approximately 20% of the occupants complain. That level of comfort complaints is considered normal.

comfort complaints, however these issues will be known and documented. No IEQ management plan is in place or implemented.

An excellent IEQ score would be a facility that has good indoor environments regarding temperature, humidity, odors and noise. Comfort complaints are at or below 20% of the occupancy (perhaps due to increased individual control) and a formal IEQ management plan is in place and dutifully implemented.

4.3.3.4 Level of deferred maintenance

Deferred maintenance is an important metric for determining not only the quality of the FM department but also its effectiveness.

Per Cotts et al. (2010), "*Maintenance deferred means costly breakdowns, possible loss of productivity, and higher repair bills down the road.*" An FM department may have aging and frequently failing equipment and do not have personnel to address the backlog of repairs, upper level management may have cut resources to the FM department, or the FM department does not have effective procedures in place to make repairs.

A poor score for this indicator would be a high amount of deferred maintenance with poor tracking capacity, is growing and currently un-manageable. An average score would have a moderate backlog of deferred maintenance which is measured. It is possible that little progress is made due to staffing, management practices, or frequent new issues.

An excellent score for this activity would include a low backlog of deferred maintenance, the tasks are well managed and kept at a consistent and manageable level with adequate resources in place. A formal maintenance tracking program would be in place.

4.3.3.5 Occupant complaints

Most facilities will experience occupant complaints and needs.[7] The true measure of the FM quality of this indicator is the methods in which the FM department fields and responds to these complaints. Poor IAQ can originate from several sources and per the EPA Indoor Air Quality Guide:

> "*These factors include: sources of pollutants or odors; design, maintenance and operation of building ventilation systems; moisture and humidity; and occupant perceptions and susceptibilities. In addition, there are many other factors that affect comfort or perception of indoor air quality.*"

This Quality Indicator is focused not only on the levels of occupant complaint but looks at the methods and procedures in place to document and remediate complaints.

In a poorly operating environment, complaints may be confined to the local user groups with no official reporting means in place. Many of these issues are only resolved when the problem reaches upper management or becomes critical. The average practice for handling occupant complaints are those addressed in an ad hoc manner (verbally) with no formal tracking or resolution confirmations in place. An excellent complaint management practice would include complaints officially entered into a work order system, triaged for severity, and resolved on a planned basis. Additionally, follow up procedures would be in place to ensure compliance, quality and end user satisfaction.

[7] ASHRAE Standard 62.2 (Standard for Acceptable Indoor Air Quality). At ideal room conditions, a typical occupancy will have approximately 20% of the occupants complain. That level of comfort complaints is considered normal.

4.3.4 Facility Department Data Management Practices

Cotts et al. (2010) provide a five-page list of FM activities supporting the case that the modern facility manager is tasked with numerous administration duties and it is assumed for these Quality Indicators that a well-functioning FM department is skilled in the gathering and management of data. This can take many forms and rises to the level of complexity needed for the facility but for all facilities, some form of data management is essential for optimum operation.

4.3.4.1 In-house data collection methods and procedures

Wong et al. (2013), point out that:

> "*Most organizations expect continuous improvement from their FM service providers to achieve year-on-year cost reductions and enhancements to service quality. Hence, collecting cost and performance related data such as cleaning, security, maintenance, and energy is generally a routine activity*."

Therefore, it is assumed that a good facility manager will have formalized data collection methods in place, and ideally, will use that data to make critical decisions and management reporting.

A poor indicator would be no collection or utilization of data which did occur in most of the subject facilities for this study. The average facility, however, would typically retrieve the data manually and review but only in an extenuating circumstance such as when the accountant observes particularly high utility bills. The excellent FM practice would have an efficient data retrieval system in place, either manual or automatic. The data collected is used for performance measurement, early problem indication, and diagnostics. Automatic fault detection and/or a public dashboard may be in place.

4.3.4.2 Facility Condition Index (FCI) implementation and monitoring

Per Kincaid, (2013), The Facility Condition Index, "*FCI is defined as current maintenance, repair, and replacement deficiencies of the facility divided by current replacement value of the facility. The lower the number, the better*." At its best, the facility condition index is a formal document that identifies the needs of the facility and demonstrates the value of the facility as the various repair, upgrade, and maintenance needs are addressed. The FCI is also a "living" document in that its targets, building valuation, and upgrade needs change regularly.

Although a formal FCI is not mandatory for good FM practice, it does represent a sophisticated approach to building management and is a tool with an abundance of useful data. Maintaining a robust FCI document would be a strong indicator of facility management expertise.

The scale of scoring ranges for no FCI at all to one that is prepared but not updated or utilized. An excellent score would the FCI fully developed, managed and updated on a regular basis.

4.3.4.3 Quality of document storage and retrieval

As Cotts et al. (2010), point out, "*The key to good facility management is documentation*." Here, it is assumed that to successfully manage a facility, important documents should be stored, categorized and readily available. These documents include operating manuals for equipment, current contracts, maintenance guides, as-built and current design drawings and specifications, commissioning reports and reference data.

A poor FM indicator would be an FM department where much of this data is simply unavailable. The average facility will have most the documentation on site but would generally be scattered throughout the facility. For instance, it was common to see operation manuals taped to the equipment it serves. An excellent document storage system will have all the documents in a single location, contained in an organized manner, up to date, and easily retrievable.

4.3.4.4 Budgeting, cost tracking and analysis

Kadzis (2015) highlights that costs and budgets are important and:

> "…*the C-Suite expects FM to contain the costs of facilities and have an accurate and detailed plan for expenses, including regular maintenance. Ensuring facility managers have a clear budget and capital plan in place for facilities and that costs are managed according to those plans is critical*."

For a professional facility manager, budgeting, cost tracking and analysis would constitute a significant part of their job function.

Facility budgeting may be limited to a re-look at the past years' budget and then applying cost increase factors. Although looking at past costs is useful, budgeting for short and long term strategic planning involves a much more involved process and requires input from across the organizations various departments. Therefore, it is critical that the facility manager participated and contribute to the budgeting process.

A poor score for this Quality Indicator is a scenario where the FM department does not participate in cost gathering and budget analysis and an average score is when the facility manager receives past budget data and estimates new costs for the coming year. An excellent FM function would have the FM department actively tracking costs, preparing budgets and participating in strategic planning for future needs.

4.3.4.5 Ease of utility data retrieval

One observation added by the author of this study, gained from past energy audit activity, and reinforced by the subject properties of this study, is the apparent relationship between the ease at which utility data is obtained and the overall FM quality of the facility. It was commonly encountered that asking for utility data triggered a long process of file searching, waiting for the person who knows where files are stored, and delivery of incorrect data. This was common for facilities that scored low. On other projects, not SMEs, it was found that the higher quality FM departments could produce historic utility use data quickly and in a useable format.

A poor FM Quality Indicator score would be an organization where records are kept by the accounting department in storage files and must be manually retrieved and listed if needed. This process can take several days or longer. An average facility would have records available but not in a readily useable format and the data must be manipulated to be useful.

An excellent example of this activity would be system where a logically compiled record of all utility usage and cost for two or more years is available within one working day. The FM department would track the utility usage to ensure there are no unforeseen issues.

A summary of the FM Quality Indicators is noted below in Table 1:

Table 1. – List of FM Factors and Quality Indicators

Factor	#	Quality Indicator	Data Collection Method
Corporate Organizational Structure in Relation to the FM Function	1	Facility Manager's position within organization	Interview
	2	Are facility related Key Performance Indicators (KPIs) understood and monitored by management?	Observation
	3	Development, implementation, and review of long and/or short term strategic plans for FM functions	Interview
	4	To what extent does the FM manager participate in and contribute to management meetings?	Interview
	5	Are sustainability initiatives and measures embraced and reviewed at the corporate level?	Interview
Facility Management Expertise and Planning	6	Are in-house structured maintenance procedures and tools in place?	Observation
	7	Management of outsourced work and agreements	Interview
	8	Facility staff understanding of system operation and control.	Observation
	9	Active tracking of utility use and cost performance metrics.	Observation
	10	Participation in continuing education or industry events	Interview
Facility Condition	11	Condition of back-of-house areas (i.e. MEP, storage, housekeeping rooms, etc.)	Observation
	12	Condition of public and/or regularly occupied spaces	Observation
	13	Observed indoor environmental quality (IEQ)	Observation
	14	Level of deferred maintenance	Interview
	15	Occupant complaints	Interview
Facility Department Data Management Practices	16	In-house data collection methods	Interview
	17	Facility Condition Index (FCI) implementation and monitoring	Interview
	18	Quality of document storage and retrieval	Observation
	19	Budgeting, cost tracking and analysis	Interview
	20	Ease of utility data retrieval	Observation

CHAPTER 5

METHODOLOGY

To get an accurate picture of how the facility management process works in the typical SME, several organizations that meet the definition of the SME were investigated. For this research, commercial organizations are targeted rather than single-family residential, industrial or manufacturing interests. The reason for this distinction is that it was assumed most industrial and manufacturing businesses, even if small scale, tend to have more formal FM programs in place due to the criticality of the product being manufactured and single-family residential properties are not part of the governing data base of buildings (CBECS). It is the SME in the commercial sector that is the focus of this investigation.

5.1 Research Methodology

The methodology for conducting this research will involve the following primary steps:

1. Identify a suitable candidate organization
2. Conduct a walkthrough of the building
3. Conduct interview using the FM Quality Scorecard
4. Obtain one to two years' energy bills (gas, electric, etc.)
5. Obtain building physical data (i.e. gross area, building type, number of PC's. etc.)
6. Complete FM Quality Scorecard to obtain FM Quality score
7. Derive Energy Star Score from past utility bill history and building type
8. Input scores into reporting spreadsheet
9. Review data

The following sections of this chapter outline the specific steps of the data collection.

5.1.1 Identify a Suitable Candidate Organization

Candidate organizations for this research are required to meet certain pre-qualifications prior to being part of the survey. The organization must first qualify as a Small to Medium Sized Enterprise (SME), defined elsewhere in this report, and meet the eligibility criteria for obtaining an Energy Star score through the Energy Star Portfolio Manager rating system.

Furthermore, the candidate organization must be contacted and informed on the nature of the survey and permission requested to conduct the survey.

It was found during this study that permission to proceed with the survey can be problematic as some SME managers may feel the exercise would portray them in an unfavorable light although the respondents are anonymous in the reporting. A useful strategy for gaining access to the site and the confidence of management, is to offer the organization a free of charge Energy Star Score, summary of the walkthrough observations and analysis of energy performance.

5.1.2 Conduct a Walkthrough of the Building

Possibly the most revealing exercise of this survey is the facility walkthrough. Observing the physical condition of the building can lead to numerous conclusions regarding the quality of the FM function. Furthermore, the walkthrough can be used to score many of the FM Quality indicators. It is recommended that the walkthrough be conducted with an escort who knows the building as conversations during this time can answer several of the survey questions and give the researcher a feel for the level of effort applied to each category.

Many of the qualitative aspects of the scorecard are obtained through the walkthrough. For example, cleanliness of facility, management of documents, indoor environmental quality, and condition of equipment can be observed first hand in this portion of the survey. Refer to

Table 1, for a detailed listing of which Quality Factors were derived through observation and those derived through interview.

5.1.3 Conduct an Interview Using the FM Quality Scorecard

The interview aspect of the survey is best administered as a conversation with the building operator rather than a formal interview where each topic is discussed. By engaging in a conversation, the information flow appears to be more fluid and the tone of the information gathering does not seem like an interrogation.

To obtain data by a conversation (or interview), usually done while conducting the walk through, requires that the researcher have good working knowledge of the FM Quality Scorecard and good conversational aptitude. Refer to Table 1 for a detailed listing of Quality Indicators obtained via interview and those obtained via observation.

It is not recommended that the FM Quality Scorecard be sent directly to the facility manager (or another staff) to be completed in-house or prior to the interview. The potential for conflict of interest is high and the results have a high probability of being biased.

5.1.4 Obtain One to Two Years' of Energy Bills

One to two years of annual utility bills are preferred to obtain an Energy Star Score. These can include electricity, gas, renewable, or any other form of energy used on the site. Furthermore, it is important to ascertain whether any non-standard operational activities have taken place over the period. For example, if construction work was undertaken, or a major lay-off has taken place, a true picture of the actual energy use is unavailable. In this case, it may be necessary to reach back farther to get a period of relatively steady energy use. Weather data is another important factor to document, as unusually warm or cold seasons may affect results.

Ensure that the energy use data includes usage and cost. For the purposes of this research, only the total cost and total usage are needed and there is no need to break out additional fees, surcharges, or demand charges associated with energy bills.

5.1.5 Obtain Building Physical Data

To successfully obtain an Energy Star score, certain building physical attributes are needed and these can usually be obtained during the walkthrough by looking at existing design drawings of from knowledge of the operations staff. Sometimes, however, the data can be challenging to obtain and the researcher may need to employ creative means to obtain this data, such as contacting the original architect or contractor, or manually taking on-site measurements.

The primary data needed to obtain the Energy Star Score includes:

1. Building name and address
2. Calendar year of analysis
3. Property Type
4. Gross floor area (in square feet)
5. Number of buildings (one)
6. Energy type (electricity, gas, etc.)
7. Energy rates

5.1.6 Complete FM Quality Scorecard to Obtain FM Quality Score

The FM Quality Scorecard consists of a spreadsheet with the Factors and Quality Indicators listed under a Likert scale where values on a 1-5 scale are indicated. On a second tab of the spreadsheet, the scores for each Quality Indicator are input by the researcher and the final FM Quality Score on a 1-100 point scale is automatically calculated and displayed.

To have a resulting score of 1-100 with a total of twenty quality indicators, a proportional scale factor is applied (in the spreadsheet) to arrive at the final score. A score of 50 would represent an average facility management operation and higher scores represent increasingly better quality organizations.

5.1.7 Derive Energy Star Score

The format for obtaining the Energy Star Score is through the Energy Star Target Finder tool which allows for basic energy and building data to be input and which then develops an Energy Star score of the existing building. This tool is relatively simple to use but the researcher must be careful to use correct areas and building types to obtain the score.

5.1.8 Input Scores into the Reporting Spreadsheet

Once the Energy Star and FM Quality scores are determined the final step is to transfer this information to the reporting section of the scorecard. This is a separate spreadsheet tab that lists all subject properties, their Energy Star and FM Quality Scores. This spreadsheet automatically populates a graph where Energy Star Score is the Ordinate (*y*-axis) and FM Quality is the Abscissa (*x*-axis). A linear trend line is generated as the data sets become populated.

5.1.9 Data Analysis

Once the information is compiled, the researcher will then analyze the data for trends and associations and prepare a final report of the findings. From the results of this study, it was found that the facilities that follow the expected outcomes, i.e. poor energy use is associated with poor facility management, are not particularly remarkable and meet expectations.

However, it will be outliers that merit attention and analysis. For example, in this study, one subject property had an excellent Energy Star score but a poor FM Quality score. The reasons for this were analyzed and discussed in this study. Perhaps it is the outliers that will give meaningful data and insights.

The research activity flow chart is graphically represented in Figure 1, below:

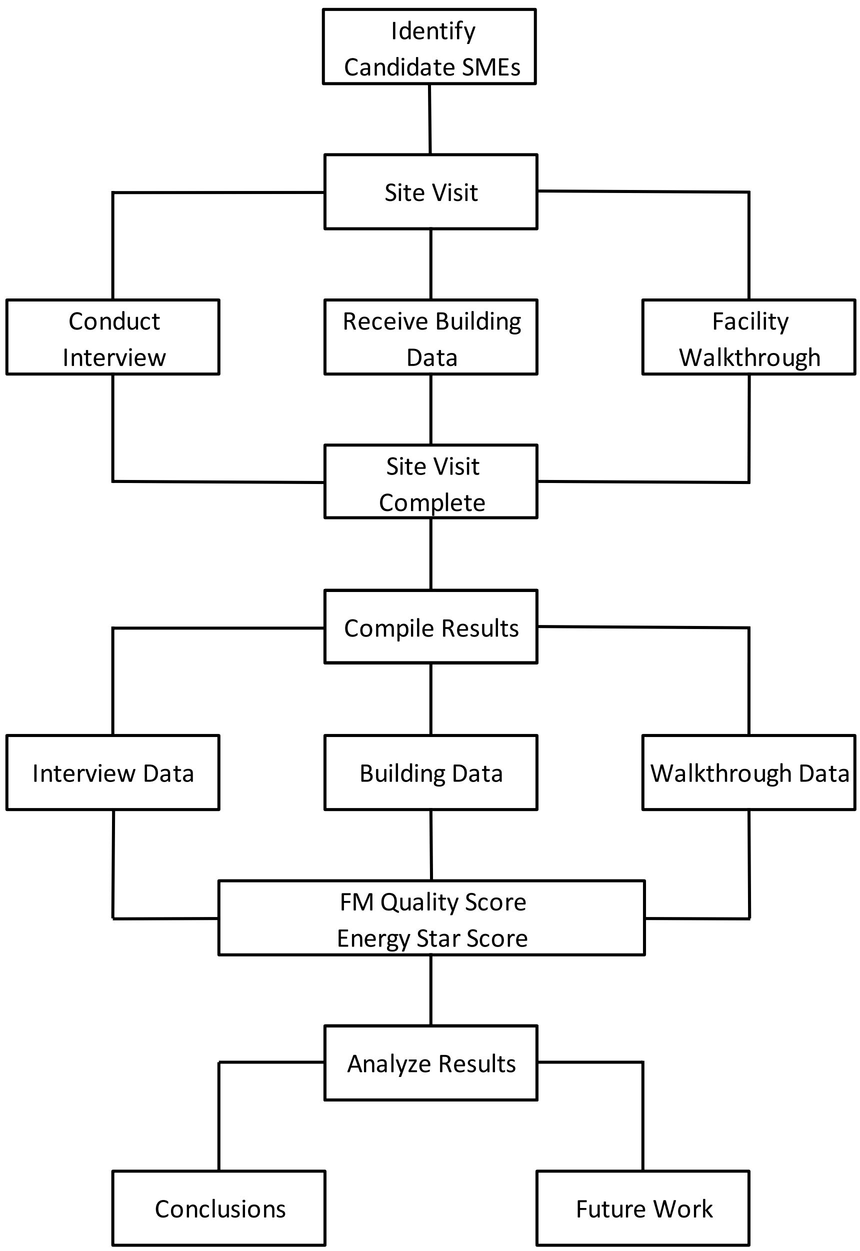

Figure 1. Research Process Flow Diagram

CHAPTER 6

RESULTS, DISCUSSION AND FUTURE RESEARCH

This research, focused exclusively on the small to medium enterprise (SME), indicates a possibility that there is an association between annual energy performance and the quality to which the facility management function is performed within the facility. However, more research and data are required to unequivocally substantiate the association.

6.1 Results

The population of subject buildings for this study was a total of 11 facilities and included offices (3), places of worship (4), multifamily apartments (2), a small regional hospital, and a k-12 school. Eight of the facilities exhibited low scores (less than 50 on a 1-100 scale) for both Energy Star and FM quality. Two of the facilities had high scores for both Energy Star and FM quality scores. One facility had a good Energy Star score but a low FM quality score and a possible reason for this outlier is addressed in the discussions section of this chapter.

The characteristics of the subject buildings are also worth noting. The period from which the buildings were constructed ranged from the late 1950's to 2008. The sizes of the buildings (floor area) ranged from approximately 5,000 ft^2 to 400,000 ft^2. The size of the building does not appear to be a major factor in FM Quality but age may have an influence as the five worst scoring buildings are from the decades of 1950, 1960 and 1970. One building from 1970, however, had a near average score for FM Quality yet had the lowest Energy Star Score. This building was large (eighteen floors and over 200,000 ft^2) and the base building HVAC equipment retained was original vintage, was approximately 45 years of age and with a ventilation system that supplied 100% outdoor air with no energy recovery. This property was overdue for a system upgrade and it appears the poor Energy Star score is due to obsolete system design and no upgrades for 45 years.

Additionally, from the data developed in this study, building usage type does not appear to have an influence on FM Quality. The facility types with multiple representation, namely, offices, houses of worship, and apartments scored both high and low for FM Quality. This observation may support the assumption that organization culture, management practices, and budgets would affect FM Quality more so than the type of facility.

Another observation is that seven of the total (eleven) either had in place, or could justify a full-time facility manager position. These buildings tended to be larger sizes (over 100,000 ft^2) with extensive needs for HVAC, grounds keeping, cleaning, and security, and had relatively high occupancy such that a full-time facility manger is justified. In fact, two of the facilities, relative to the expected median operating cost of similar buildings through Energy Star analysis, were spending an extra \$100,000 and \$65,000 per year respectively on energy waste alone. Four of the facilities did not have the need to justify a full-time facility manager. The top performing building, a LEED Platinum office, did, in fact, have a full-time facility manager. However, four of the five worst FM Quality facilities did have a full-time facility manager on staff.

Table 2, below, provides a summary of the Energy Star and FM Quality scores as well as a summary of the building types, areas, and ages. The table is ordered by FM Quality rank from highest to lowest score.

Table 2. Summary of Results and Data of Observed Facilities

FM Quality Study: Facilities Observed (Ranked by FM Quality Score)						
Facility #	**Type**	**Area (ft^2)**	**Circa**	**Energy Star Score**	**FM Quality Score**	**FM Quality Rank**
10	Office	24,000	2000s	98	85	1
9	Worship	142,300	1980s	55	69	2
7	Hospital	195,000	1980s	32	44	3
8	Apartment	201,500	1970s	5	43	4
6	Worship	33,000	2008	18	40	5
4	Office	10,000	2000s	89	35	6
1	k-12 School	125,000	1960s	23	31	7
5	Worship	56,600	1960s	11	24	8
3	Worship	120,000	1950s	5	20	9
11	Office	5,000	1970s	34	19	10
2	Apartment	400,000	1970's	2	18	11

The graphical representation of this research is shown in Figure 2, below. Using a linear regression model, the graphical trend line for the results indicates a positive slope, as expected, with most of the facilities underperforming in both energy use and FM quality. There were no facilities in this study that had a poor Energy Star score and an above average facility management quality score.

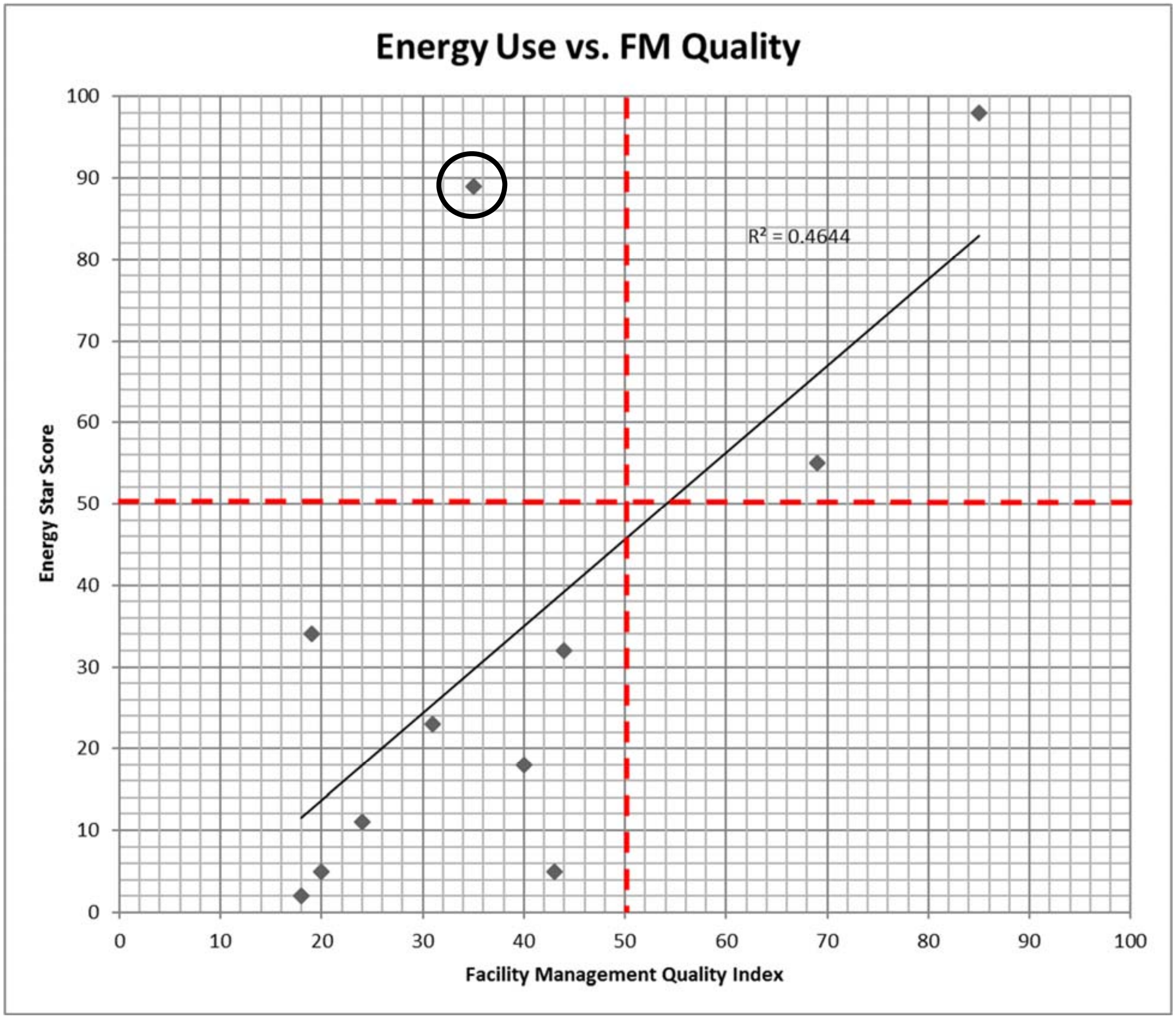

Figure 2. Energy Star Score vs. Facility Management Quality Score (Including Outlier - circled)

The results of this study included one "outlier" facility which had an excellent Energy Star score but a poor FM Quality score. The outlier is further discussed in section 6.2.1 of this study. For analysis, an additional graphical representation of the results is shown including a linear regression trend line that excludes the outlier facility to determine what effects this single entry had on the overall results and this graph is shown in Figure 3, below. As can be seen, the slope of the line remained positive with very little deviation from the original graph with the outlier removed.

For the eleven subject properties, including the outlier, the R^2 value was 0.464 and with the outlier removed, the R^2 value increased to 0.732. Since the R^2 value is an indication of how close the data is fitted to the regression line, and since the data for this project essentially has a single outlier, the small variation in line placement further validates that the outlier is more of an anomaly rather than a trend.

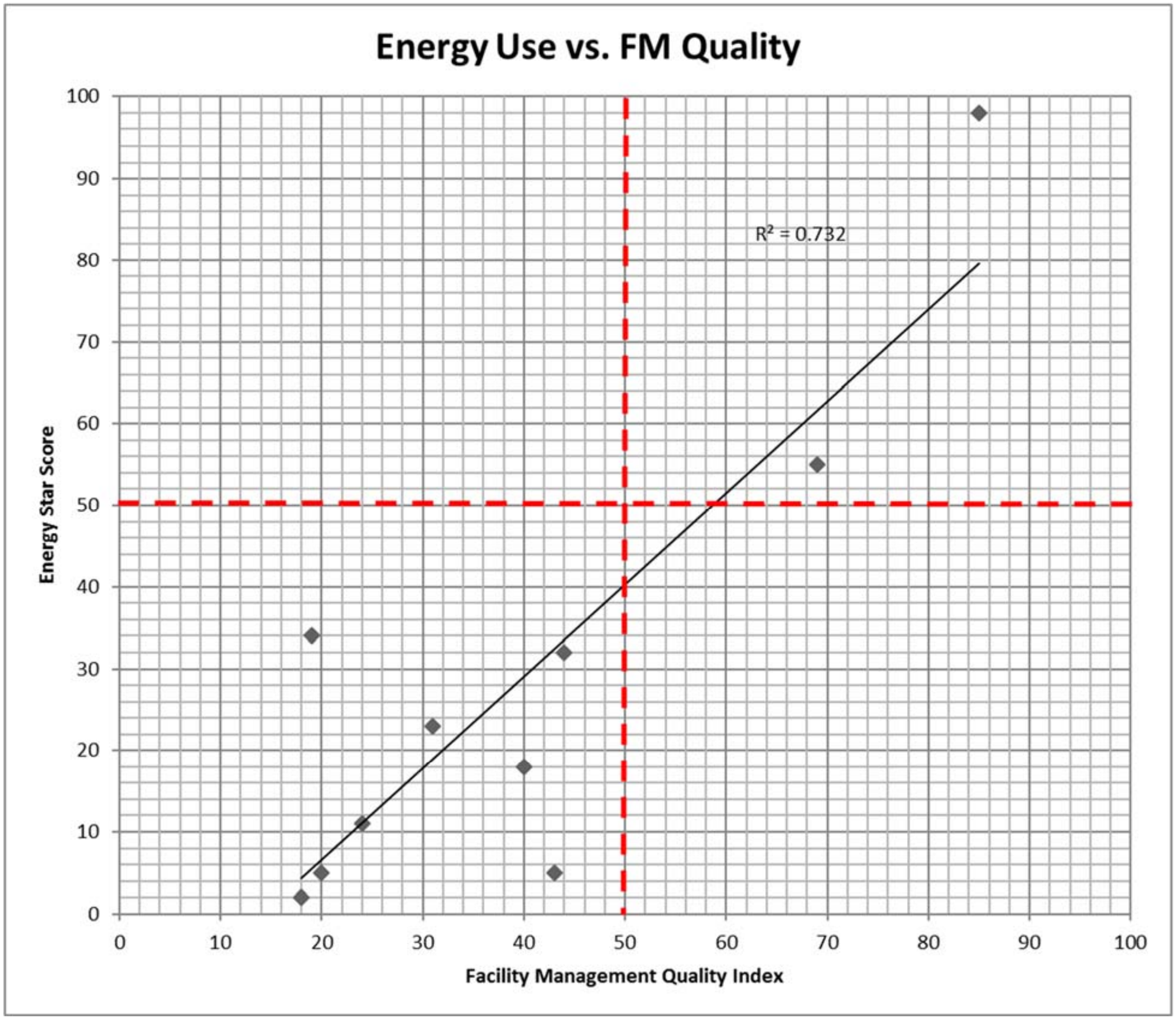

Figure 3. Energy Star Score vs. Facility Management Quality Score (Excluding Outlier)

It is important to note that the Energy Star score is an indicator of relative building performance and not an absolute determinant of building performance. Its greatest value lies in two fundamental aspects of the rating system. The first is that the Energy Star score evaluates energy use of a building compared to other similar buildings in similar climate zones. Anomalies may exist such as, for example, an office building with an internal data center that could affect the overall score. However, the score does give an appropriate indication of building performance for analysis purposes.

The second useful aspect of the Energy Star score is for the operators to maintain a constant and updated metric of how the subject building performs over time. The effects of energy related improvements can be tracked historically and a running record of building performance maintained. In this use of the analysis tool, the operators are simply tracking the actual performance of the building in isolation and are not comparing performance to a database of similar buildings. This is an example of using Energy Star as a management tool and applies to those building that do not qualify for an Energy Star score.

6.2 Discussion

Although the hypothesis that poor management of a building will lead to increased energy use seems obvious - and the results of this research corroborate that hypothesis - the number of buildings investigated in this study (the population) would need to be higher to arrive at that conclusion with certainty.

The findings from this limited study, however, do corroborate much of the existing literature review in that many SMEs have limited resources for FM activity, have mangers that are handling multiple business operation issues, and typically allocate a custodial level employee to oversee and manage complex building systems, and therefore, the FM function suffers.

Furthermore, there is a mindset present within the management suite that the FM function is, in fact, a custodial effort. Also, the concept that high-level experience, strategic planning, budgeting, and project management skills are required to manage a building, and that a well-managed facility enhances the organizations mission does not appear to be fully understood as supported by literature review of SMEs.

The marginalization of the FM function by upper level management appears to influence FM performance and, for most subject buildings, poor energy performance was due to poor management practices within the organizations and, in only one case, could poor energy performance be attributed to other circumstances even though average to good FM Quality was in place.

The question arises, then, of under what circumstances would a facility have good FM quality (and management support) yet also have higher than anticipated energy use? This question became a topic of discussion in the preparation of this study. Although this topic is a good candidate for future research, some of the discussion points were addressed within the scope of this study. Refer to Section 6.2.2 of this chapter for a discussion on possible conditions where building energy use is high yet FM Quality is good.

One of the most common observations in the poor FM Quality buildings was the disabling of system automatic control combined with the failure of supporting control devices. It was common for HVAC systems to be placed on manual settings (not automatic) due to failures in ancillary equipment such as automatic dampers, temperature sensors, or timeclocks. Furthermore, it was common in all subject buildings that the operators and managers of the building had no reference point to determine if energy costs were low, normal, or high.

Another observation from this study is the perception of FM taken by the C-Suite managers of the organizations. In discussions and observations, the business managers relegated FM to a custodial level operator and may not have understood that building systems are not "hands-off" but in fact are complicated and require constant attention and care. Furthermore, there was not an understanding that the FM function is a practice that enhances the productivity of the organization, maintains building value, lowers operating costs, and allows the organization to focus more resources and time towards the core mission.

Across the subject properties for this study, the two highest scoring Quality Indicators were the condition of the public spaces and the perceived indoor environmental quality (IEQ). The lowest scoring Quality Indicator was the Facility Condition Index and this is most likely because this may be an FM activity more associated with larger organizations. Setting this possible outlier aside, the next two lowest scoring items were active tracking of utility data and participation in continuing education activities, although active tracking of facility KPIs was a close third. Figure 4, below, summarizes the average Quality Indicator responses for all buildings (refer to Table 1 for a listing of each numbered Quality Indicator):

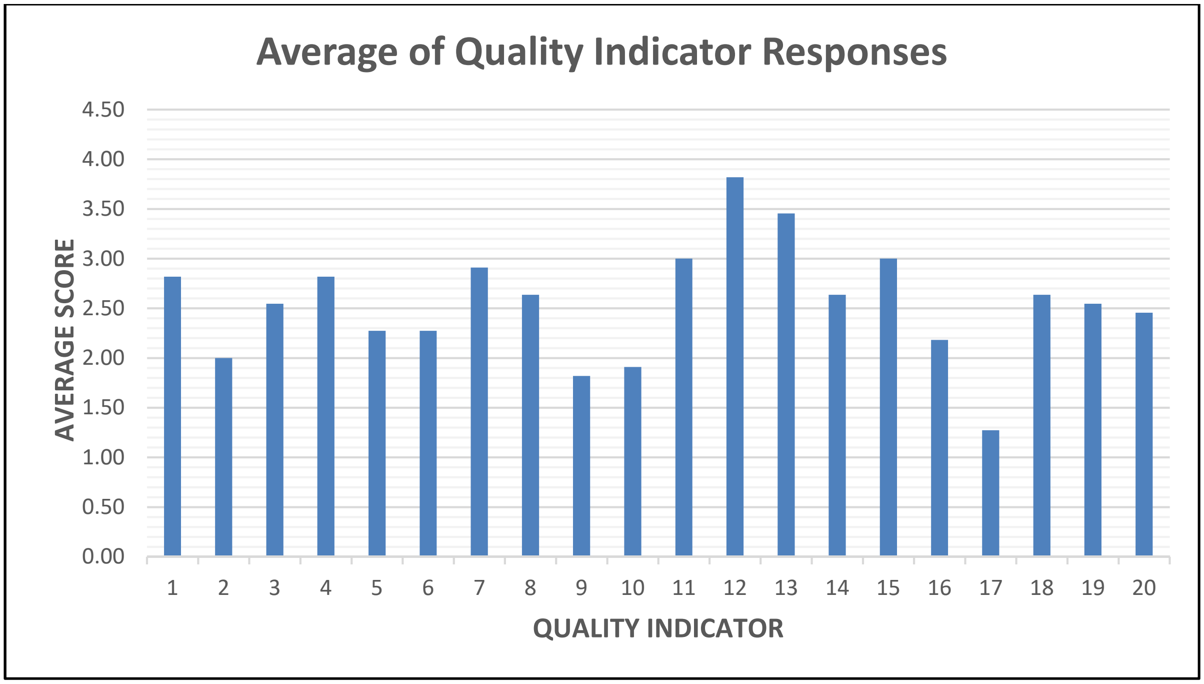

Figure 4 – Average of Quality Indicator Responses – All Buildings

6.2.1 Outliers

One of the subject facilities, an office building, had an Energy Star score of 89 (very good) yet had a poor facility management score of 35. This is a result inconsistent with expected results yet the circumstances of this facility merit further elaboration.

The one-story building underwent a major renovation and was occupied in 2008 and is approximately 10,000 square feet in area. Upon completion of the renovation, this building achieved LEED Platinum status, the highest rating available. The building includes many high performance green building features including daylighting design, ground source heat pump HVAC system, energy recovery ventilator, a 5-kW solar power array, a solar thermal water heating system, and a rain harvest system for toilet flushing. Additional passive energy design features such as window shading, reflective roof, and strategic tree placement are also in place.

The business manager, tasked with many additional operations tasks, is also responsible for the facility management function of the building. Many of the attributes that define a high level of quality of FM are not present in the current operation practices. However, it is suspected that the relatively young age of the building, initial system commissioning, and subsequent improved performance of systems, have allowed for high performance operation to proceed in lieu of high level FM attention. One presumption is that new buildings with new systems (that underwent the commissioning activity) will perform well for a period, and perhaps get a short-term pass on high quality FM intervention. To further support this assumption, it was noted that over an eight-year period (2008 to 2016), the Energy Star Score dropped from an initial score of 97 to the current score of 89. Although still an excellent score, there is a decline in performance over this time frame.

However, at the buildings current age, systems are approaching their middle age where maintenance needs are increasing, failures are more frequent, and many of the systems, especially lighting, are practically obsolete. The current lighting system uses fluorescent fixtures and has mostly manual lighting control. A lighting system upgrade would most likely include LED based fixtures with automatic lighting control. It is assumed that continued poor maintenance activities will further deteriorate the system performance.

6.2.2 Conditions that Lead to Poor Energy Scores although Excellent FM Quality Exists

One question that was raised during this research related to possible causes for a building to have high energy use while also having excellent FM practices. How could it be that a building has excellent FM Quality but still has poor energy performance? This question was posed to an open forum of high performance green building professionals (ASHRAE Standard 189.1 committee) and a summary of the results are indicated in Appendix C.

Of the ten top comments provided, only four are conditions outside the control of the facility management function. These include occupant behavior, occupancy that is higher than design, degradation of controls, and incorrect system design (although degradation of controls could be assigned to the facility manager scope). The other six items on the list, which can lead to higher energy use, are essentially baseline conditions that are not anomalies.

For example, a building with high process equipment loads, or the effects of climate change, can increase energy use in a building but would also constitute a normal, or baseline, operation criterion.

This is an important question because the identification of those conditions that affect energy use yet lies outside of the facility manager's control would be useful characteristics to identify and understand when analyzing building performance against operational practices.

6.3 Limitations

A fundamental limitation with this study is the minimal number of facilities that were analyzed. Acquiring subject properties proved to be much more difficult than originally intended.

For this study, in addition to the eleven subject properties evaluated, there were approximately eighteen other facilities contacted for potential survey. These facilities were all SMEs and met the qualifications for an Energy Star score. There are a variety of reasons that gaining access to facilities was difficult.

It was difficult to find the right person internal to the SME to champion the study. Ideally, the best person to discuss the study and gain acceptance is an upper level manager who would be able to authorize the activity and provide resources to help with the study. Placing a "cold call" to an organization proved difficult to gain access to this key decision maker. Almost universally, the caller was directed to the facility manager who most often felt there was not a need to review facility management practices. Developing a practiced means for contacting the key stakeholders is critical to gaining access to an organizations inner workings.

Building managers perceive the facility study will be unflattering to their performance. In addition to the facility manager feeling under the microscope, it was found that the upper level managers responsible for FM also felt that the study would pull back a curtain and reveal unsatisfactory management practices. This dynamic was effectively a showstopper and resulted in the many organizations to cease conversation on the topic.

The suspicion that this research activity is a "sales" call was also encountered. Regardless of claims that the study was a research project and that the data was anonymous, it was somewhat common that the busy executives quickly eliminated the prospect of a site visit entirely. This reaction is consistent with the literature review of SMEs in that the upper level managers are highly loaded with multiple tasks and are reluctant to entertain new avenues.

On a few occasions, managers that were not interested in facility performance or energy costs were encountered. In these instances, the managers viewed the FM function as a custodial activity and could see no reason or benefit for elevating the work to a professional level. In these instances, it appeared that the FM costs were the cost of doing business and there was no need for improving its quality.

The organizational culture is resistant to change. Not only did this aspect become evident in the initial contact, but it also became evident once the study was completed. In one instance, the upper level management of the facility that spent $100,000 more per year on energy than the typical building type (per Energy Star) exhibited no interest in making the necessary changes within the organization to reduce these costs. The perception appeared to one of reluctance to change and unpalatable disruption of the status quo. Additionally, the existing facility managers were long time employees and adaptive change within the organization was simply too much of a perceived burden.

Managers that were simply too busy to participate in the process was another theme encountered in getting organizations to agree to the survey. This was another example that reflected data from the literature review where SME managers wear many hats and are constantly moving from major issue to major issue.

Possibly the most dominant reason for a facility to refuse participation in the survey was a fear that the results would shed an unfavorable light on the very person responsible for maintaining the facility. In fact, one respondent said he did not care what the report said as long as it did not him look bad. A subset of this issue is the frequency that upper level managers refer the surveyor to the actual facility manger (if present). This instance almost universally created a scenario where defenses were high and all efforts were made to report that all is well in hand and no outside interference is necessary. Generally, this exercise was an interesting introduction to an organizations culture, political realm, and personalities.

An additional limitation could be that this study was conducted in a single climate zone (climate zone 3A) and was not representative of building performance across additional zones. For example, a building in the Dakotas would have different management needs than a building in Georgia. However, Energy Star scores are based on climate zone and reflect the specific performance values of those regions. It is possible, however, that the FM Quality factors may change with changing clime zones.

Additionally, the FM Quality Scorecard is based on the accumulation of practices derived from primarily academic sources but with some industry professional input. The contents of the factors used in the scorecard may benefit from a larger scholarly and industry review and some of the quality indicators may be modified accordingly.

6.4 Future Research

There is a wide range of possibilities for future research within this subject area. Most of that research centers around fine tuning the basic concepts of the FM Quality score and enhanced analysis methods applied to the evaluation of outcomes.

With a larger sample of research facilities, a more robust statistical analysis can take place. For this study, the quality factors, 20 total, were all given the same weighting regarding score value. Upon development of a sophisticated factor analysis study, it may possible to isolate and discover the most important factors that affect FM quality. It is also anticipated that future studies will include a wider range of building types and climate zones.

Another interesting potential area of research would be an investigation into the association between Indoor Air Quality (IAQ) and FM Quality.

In closing, future research may also include studies and development of business management strategies and guidelines for incorporating high quality FM practices into the structure of a typical SME. Smaller buildings and small businesses represent most building and business types in the United States and opportunities for improvement and cost savings appear to be substantial.

APPENDIX A

Compilation of energy use data from subject SMEs

Table 3. FM Quality Scorecard – Corporate Organizational Structure in Relation to the FM Function

FACTORS	#	FM QUALITY INDICATORS	Poor (1-2)	Average (3)	Excellent (4-5)
Corporate Organizational Structure in Relation to the FM Function	1	Facility Manager's position within organization	FM is a custodial position; under-resourced, may have additional (non-FM) responsibilities. Has little technical or management skills.	FM responsibility lies with a mid management person with numerous additional responsibilities.	The Facility Manager is a dedicated mid to upper-level position with dedicated staff, formal procedures, uses KPIs, and has refined technical and management skills.
	2	Are facility related Key Performance Indicators (KPIs), in place, understood and monitored by management?	Never used / nonexistent.	Some KPIs available, typically derived from standard data sources (i.e. expense/utility statements) and undergo cursory review.	KPIs are actively collected, regularly reviewed, and discussed at management meetings.
	3	Long and/or short term strategic plans for facility equipment and operation are in place (development, implementation, and review).	Nonexistent. Management typically reacts only to emergency failures.	Plans considered but no formal development or strategies in place. May have some plans for capital expenses that are imminent.	Strategic plans in place and regularly monitored and updated. Long term budget items (i.e. 5-10 years out) known.
	4	To what extent does the FM manager participate in and contribute at management meetings?	Not invited / does not attend.	Is present at most meetings but with a mostly cursory role. Input is mostly historical report of recent activities.	Is provided agenda time for FM updates and presentations; provides KPI reports, and participates in decision making.
	5	Are sustainability initiatives and measures embraced and reviewed at the corporate level?	Sustainability is not part of the upper level management focus or scope. Indifference.	Limited sustainability measures considered and/or attempted, typically instigated by an isolated internal group. Cursory or weak support from management and/or FM deptartment	Sustainability measures include several active initiatives, with reporting, tracking, and continuous improvement. Fully supported and enforced at the top.

Table 4. FM Quality Scorecard – Facility Management Expertise and Planning

FACTORS	#	FM QUALITY INDICATORS	Poor (1-2)	Average (3)	Excellent (4-5)
Facility Management Expertise and Planning	1	Are in-house structured maintenance procedures and tools in place (i.e. CAFM, PM, CMMS, COBiE, BIM, etc.)?	None.	One or more systems installed but rarely used and/or not fully utilized.	Maintenance activity is well planned and administered using computerized management tools. Good data records of past performance.
	2	Management of outsourced work and agreements	Relies exclusively on outsourced providers. The providers are mostly engaged when a problem needs repair. Little or no preventative maintenance activity. Outsource providers prepare contract and develop scope of work.	Most or all FM activity is outsourced with loosely defined preventative maintenance. May have some in-house technicians. Outsource providers prepare contract and develop scope of work.	FM department develops contracts for outsourced work. Performance of outsourced vendors is tracked using performance indicators. FM dept. has technical expertise in-house.
	3	FM staff understanding of system operation and control.	Adjustments, calibrations and controls settings require outsourced vendors. In-house staff unable to program automatic control systems or perform system diagnostics.	Basic ability to set thermostats and turn equipment on and off and re-set parameters. May know how to navigate an automatic control system. Requires outsourced vendor for all other functions.	In-house personnel are trained to operate equipment and troubleshoot problems. Staff is familiar with automatic control system operation and resets. Many repairs and adjustments can be performed in-house. May use outsourced vendors for specialty functions.
	4	Active tracking of utility use and cost performance metrics.	None. Accounting department typically pays the bills with no oversight or review from the FM department.	Utility bills are made available to the FM department with little or no formal tracking or critical review.	Utility bills are input and tracked monthly using a spreadsheet, dedicated software program, or web-based tool such as Energy Star Portfolio Manager. Data is regularly reviewed.
	5	Participation in continuing education or industry events	No FM training for in-house staff.	Attend some events, trainings, or on-line courses.	Active membership in industry groups (i.e. IFMA, BOMA, etc.). Attends structured training courses and documents hours for CEUs.

Table 5. FM Quality Scorecard – Facility Condition

FACTORS	#	FM QUALITY INDICATORS	Poor (1-2)	Average (3)	Excellent (4-5)
Facility Condition	1	Condition of back-of-house areas (i.e. MEP, storage, housekeeping rooms, etc.)	Dirty; leaks and oily patches present, floor not swept, storage room clutter, instruments and actuators not in working order, ad-hoc repairs. Rooms unlocked. Unsafe. Neglected.	Generally clean, often used for storage, may be older but gives the impression that the room gets regular attention. Some instrument and equipment performance issues. Most likely no regular calibrations.	Clean, no leaks, controls and instrumentation in working order, and areas are not used for storage. Well lit. No signs of chemical fouling. Safety measures in place.
	2	Condition of public and/or regularly occupied spaces (lobby, offices, classrooms, corridors, rest rooms, etc.)	Leak spots on ceiling tiles, unfinished / deferred projects, cluttered common areas. Poor housekeeping.	Fair Condition; spaces look clean and neat	Good condition, projects are completely finished with little disruption; good signage.
	3	Observed indoor environmental quality (IEQ)	Comfort complaints exceed 20% of occupancy. Obvious thermal comfort issues (i.e. floor heaters, fans, dehumidifiers, etc.), odors, noise and drafts observable and ubiquitous.	Some comfort complaints (~20%), may have some isolated areas with IAQ related issues, which would be on a repair list. No IEQ plan in place or not utilized.	Excellent IEQ with good temperature, humidity conditions, noise, and no odors. Formal IEQ management plan in place. Minimal complaints. No odors.
	4	Level of deferred maintenance	High - Deferred maintenance work may (2) or may not (1) be tracked but the list continues to grow and is currently un-manageable.	Medium - Deferred maintenance is measured but quantity of tasks is high with very little progress due to staffing, management practices, or frequent new issues.	Low - backlog of deferred maintenance is well managed and kept at a consistent and manageable level with adequate resources in place. Formal PM system in place.
	5	Occupant complaints	Complaints are typically confined to the local user groups with no official means to report. Are only resolved when the problem reaches upper management or becomes critical.	Complaints are handled on an ad hoc basis (typically verbally) with no formal tracking and/or resolution system in place.	Complaints are officially entered into a work order system, triaged for severity, and resolved on a planned basis. Follow up procedures in place to ensure compliance and quality.

Table 6. FM Quality Scorecard – Facility Department Data Management Practices

FACTORS	#	FM QUALITY INDICATORS	Poor (1-2)	Average (3)	Excellent (4-5)
Facility Department Data Management Practices	1	In-house data collection methods and procedures	No collection of performance data.	Data is manually retrieved and reviewed only when a problem has occurred (i.e. accountant observes unusually high water bill).	Efficient data retrieval system in place. Manual or automatic. Data is used for performance measurement, early problem indication, and diagnostics. Automatic fault detection and/or dashboard.
	2	Facility Condition Index (FCI) implementation and monitoring (formal or informal)	None	FCI loosely prepared and informal. Rarely referenced. Management suspects poor operation.	FCI developed, managed, and updated regularly and is used as a key performance indicator.
	3	Quality of document storage and retrieval (drawings, specifications, equipment manuals, product data, training resources, system manuals, etc.)	Difficult or impossible to locate, or non-existent.	Documents are typically available but not filed, and may be kept in distributed locations throughout the building (i.e. at someone's desk or stored at the actual piece of equipment).	Documents, including as-built drawings, specifications, system manuals, product and equipment manuals are contained in an organized manner, up-to-date, and easily retrievable. Training videos, procedures and O&M manuals are permanently stored.
	4	Budgeting, cost tracking and analysis	Facility cost data gathering and budgeting analysis is not part of the FM function.	Accountant provides past cost data for development of next years budgets. FM staff may participate in the budgeting process.	The FM department actively tracks costs, prepares budgets and participates in strategic planning for future needs.
	5	Ease of utility data retrieval	Records are kept by accounting department and are typiclally in storage files. Must be manually retrieved and listed if needed.	Records are available but are not in a readily useable form and must be manipulated to be useful. Only become important when there is a problem. Not regularly tracked.	A logically compiled record of all utility usage and cost for two or more years is available within one working day.

APPENDIX B

Energy Star Portfolio Manager: List of Eligible Buildings

Table 7. Property Types Eligible for 1-100 Energy Star Score

Property Types Eligible for 1-100 Energy Star Score	
1	Bank Branch
2	Barracks
3	Courthouse
4	Data Center
5	Distribution Center
6	Financial Office
7	**Hospital (general medical and surgical)**
8	Hotels
9	**K-12 School**
10	Medical Office
11	**Multifamily Housing**
12	Non-refrigerated Warehouse
13	**Office**
14	Refrigerated Warehouse
15	Residence Hall / Dormitory
16	Retail Store
17	Senior Care Facility
18	Supermarket / Grocery Store
19	Wastewater Treatment Plant
20	Wholesale Club / Supercenter
21	**Worship Facility**

Although approximately 80 property types are eligible to be part of the Energy Star Portfolio Manager program, only the property types listed above are eligible to achieve an Energy Star score. This is due to the population of data sets available.

Property types represented in this study are in bold font.

APPENDIX C

Summary of Quality Indicator Scores for all Facilities

Table 8. Summary of Quality Indicator Scores for all Facilities

Quality Indicator	Summary of Quality Indicator Scores for all Facilities — Facility Number											Average Quality Indicator Score
	1	2	3	4	5	6	7	8	9	10	11	
1	3	2	2	3	2	4	4	3	3	4	1	2.82
2	2	1	1	1	2	1	2	2	4	5	1	2.00
3	2	1	3	2	2	3	3	3	3	4	2	2.55
4	4	2	1	3	2	4	2	3	4	4	2	2.82
5	1	1	1	4	1	2	1	3	5	5	1	2.27
6	2	1	3	1	1	1	4	3	4	4	1	2.27
7	3	3	2	3	2	2	4	3	3	4	3	2.91
8	2	2	1	1	3	2	4	4	4	5	1	2.64
9	1	1	1	1	1	1	2	1	5	5	1	1.82
10	1	1	1	1	1	3	2	3	3	4	1	1.91
11	4	2	3	3	2	3	2	3	4	4	3	3.00
12	4	3	3	5	3	4	5	3	4	5	3	3.82
13	4	2	3	5	3	3	4	3	4	5	2	3.45
14	2	2	2	3	3	3	3	2	3	4	2	2.64
15	3	3	2	4	3	3	3	3	3	4	2	3.00
16	1	1	1	2	2	2	2	3	4	5	1	2.18
17	2	1	1	1	1	1	1	1	2	2	1	1.27
18	1	1	2	2	2	3	3	4	4	5	2	2.64
19	2	2	1	1	2	4	2	2	4	5	3	2.55
20	1	2	2	2	1	3	2	2	5	5	2	2.45

Note: Refer to Table 1, page 54, for a listing of each Quality Indicator.

APPENDIX D

Conditions that can Lead to High Energy use in a Building even though Excellent Facility Management Practices are in Place.

Table 9. High Energy Use Conditions with Good Quality FM

#	ISSUE	COMMENT	FM SCOPE
1	Occupant behavior and office culture	Leaving lights and computers on, vampire loads, adjusting thermostats to manual, use of desk heaters and fans, etc. Occupants are not aware of the energy implications of their actions.	No
2	Over occupancy	Some buildings get more crowded than design, so equipment is running more often at full load (no savings from part-load efficiencies, variable speed drives / controls, etc.) and sensors save less energy, since more spaces are more occupied more of the time.	No
3	Control degradation	Controls that don't perform as well later in their life (e.g., a dimmer that starts out dimming to 10%, but over time only dims to 30%). The gradual "fade" may not be noticed.	No
4	Incorrect system design	Incorrectly designed HVAC plant, poor lighting control, and inefficient off-hours control are examples of weak system designs that can lead to poor performance although they are correctly operating and maintained. This condition may not be evident to the operators.	No
5	Poor building envelope	Windows, insulation, air barriers, and other poorly functioning building envelope elements allow uncontrolled moisture, heat, and outside air (infiltration) into a space. This is a condition that can be repaired. (FM quality issue)	Yes
6	Process applications	Specific equipment and processes that are both high energy and fundamental to the operation of the facility such as manufacturing equipment, data storage, hospital procedures, etc. (Baseline issue).	Yes
7	Old equipment	Although old equipment would have lower efficiency ratings, and may have some performance loss through age, it is still possible for old equipment to be maintained at a good level of quality. Age factors must be applied to achieve a reasonable assessment of the expected baseline level. (Baseline issue).	Yes
8	Climate change	Increasingly non-standard atmospheric and weather conditions (heat, cold, duration) that differ from a previously established bin data files. (Baseline issue).	Yes
9	Anomalous conditions	Temporary control over-rides, emergency conditions, catastrophic failures, etc., can lead to high energy use. However, these would be identified, tracked, of limited duration, and monitored in a quality FM environment.	Yes
10	Long operating hours	Although longer than typical operating hours do increase energy use per unit area, the longer hours alone are not in and of themselves an inefficiency condition. (Baseline issue).	Yes

Note: Items 1 through 4 are considered factors outside the control of the FM Department. Items 5 through 10 are considered factors that fall under the purview of the FM Department.

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