Green Buildings and FM - A Case Study on How FM Influences the Environmental Performance of Office Buildings

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Abstract

Over the past decade it has become well-known that the built environment is a major contributor to climate change. It is further known that the majority of carbon dioxide emissions caused by buildings are created during the operating phase of existing buildings. In other words, the way a building is managed and maintained has a major impact on the environmental performance of the building. Notwithstanding, research and discussion have to date mainly focused on green design and the construction of new buildings. Particularly in Europe, the role of facility management (FM) in the green building market has not been adequately addressed. Facility services typically include, but are not limited to, maintenance of air conditioning, electric power, plumbing and lighting systems; and cleaning. Several of these services may have a significant impact on the environmental performance of a building. The aim of this study is to identify and understand the role of FM in the environmental performance of existing office buildings. The study is conducted using case study methodology. The green building indicator system used as a reference is the United States Green Building Council's LEED for Existing Buildings: Operations and Maintenance Rating System (hereinafter "LEED EB"). The rating system is specifically tailored for existing, operational buildings and was chosen due to its wide international recognition. The case facility represents a rather typical Finnish office building dating from the 1980's, where all major facility services are provided by a single FM provider. In the study, facility service processes of the FM provider are compared and analyzed against the chosen green building indicator. The study reveals the surprisingly central role the FM service processes play in the environmental performance of an office building. The FM service processes have both direct and indirect influence on environmental indicators and performance metrics. Based on the study, FM providers readily hold a great portion of the data required for green management.

Keywords: green building, LEED, facility management (FM), operating phase, office building

1. Introduction

Over the past decade it has become well-known that the built environment is a major contributor to climate change. The built environment (i.e., residential and commercial buildings) accounts for roughly 40% of both the total energy consumption and the carbon dioxide emissions in Europe (COD/2008/0223) and the U.S. (USGBC, 2010a). Furthermore, research (Rosenblum et al, 2000) has shown that, even when compared with the industrial sector, the service industry (including the use of commercial buildings) accounts for a surprisingly large portion of all environmental impacts in areas such as energy consumption. Consequently, reducing the environmental impacts of commercial buildings represents significant potential.

An estimated 80% (Junnila and Hovarth, 2003; Junnila et al, 2006) of climate change impacts caused by commercial buildings are created during the operating phase of existing buildings. Moreover, existing commercial buildings will continue to represent the majority of the building stock far into the future. Notwithstanding, research and discussion associated with environmental performance of commercial buildings has to date mainly focused on building technologies and the construction of new buildings. Particularly in Europe, less attention has been paid to the role of FM in the green building market. However, based on previous research, FM could potentially support user organizations in their effort to become more environmentally sound (Hodges, 2005; Roper and Beard, 2006; Nousiainen and Junnila, 2008). Furthermore, as Hodges (2005) suggests, facility managers are unique in bearing knowledge of historical, current, and future operations, i.e., the entire life-cycle of a building. Appropriate FM practices can, consequently, improve an organization's sustainability. This study suggests that the focus of green building research be shifted from new buildings to the operation and maintenance of existing buildings. The lack of new developments, resulting from the current economic downturn, could accelerate the shift.

The purpose of this research is to identify and understand the role of FM service processes in the environmental performance of office buildings. More specifically, this study aims to determine which areas of environmental performance would be most efficiently managed through FM. It is hypothesized that FM service processes play a central role in an office building's environmental performance. The working hypothesis has been that FM organizations can significantly support client organizations in their efforts to minimize their total environmental impact. FM organizations can for instance provide information and knowledge of the building operation systems and, particularly in long-term service agreements, produce reference data from previous years as along with information on potential trends.

Following this introduction, Section 2 briefly defines the concepts of facility management and green building. Section 3 describes the research approach and methodology, while Section 4 presents and analyses the major findings. Finally, the Section 5 discusses the findings further, draws conclusions, and provides recommendations for the application of the results and future research.

2. FM and Green Buildings Overview

2.1 Facility Management

Facility management (FM) can be described as the integration of an organization's non-core services, primarily related to the maintenance and care of buildings. The aim of facility management is to support the organization in their core business. The potential scope of facility management is very broad and can vary greatly. The European Committee for Standardization (CEN 2007) divides the scope of facilities management in two categories based on client demand: Space & Infrastructure and People & Organization. The former includes client demands for space, working environment, utilities, hygiene and cleanliness. The latter category comprises client demands for a safe environment, a hospitable working environment, information and communication (ICT) services, and logistics, i.e. transport and storage of goods. The categories are not intended as exhaustive and other client specific demands and related services potentially exist as well.

Several of the aforementioned services may have a significant impact on the environmental performance of a building. Consequently, as previous research (Nousiainen and Junnila, 2008) has demonstrated, end-user companies already expect facility managers to be able to provide environment and energy related services. End-user companies wish to receive comprehensive reporting and recommendations on improving their environmental performance. Energy system commissioning and green cleaning policies are examples of such improvements.

2.2 Green Buildings

Green buildings are buildings or structures that have less impact on the environment than conventional buildings. The environmental aspects to be considered in estimating the impact include, at a minimum, energy and resource use, waste generation, pollution, and indoor air quality (US EPA, 1995). The green building practice ideally considers all of the environmental aspects listed above, and therefore does not equal building energy-efficiency, as sometimes falsely perceived. Furthermore, green building is a practice that extends throughout the entire life-cycle of a building, not just the design and construction phase.

It is worth noting that the term sustainable building is sometimes used synonymous to green building. However, generally only the environmental dimension of the triple bottom line of sustainable development (environmental, social, and economical) is considered when evaluating green buildings. This paper refrains from using the term "sustainable" to avoid confusion.

Many green building indicator systems are available globally, the most well-known being the British BREEAM and the U.S. based LEED. Others include HK-BEAM (Hong Kong), DGNB (Germany), Green Star (Australia), as well as CASBEE (Japan). While all mentioned indicator systems have similar scopes, the criteria differ, making benchmarking difficult (Reed at al., 2009). However, Lee and Brunett (2007) found that LEED, BREEAM, and HK-BEAM do not show significant differences when estimating building energy efficiency.

3. Research Approach and Methodology

The study was conducted using case study methodology. A single-case design is used in order to retrieve detailed empirical data on the studied phenomenon (Yin 1994). As the study hypothesizes that an FM organization can play a significant role in the environmental performance of an office building, it was of importance to find a plausible critical case for the testing of the hypothesis. The three different elements of this case study and their respective selection criteria are described in the following chapters.

3.1 Case Facility

The subject of this case study is a 16,300 square meter office facility housing the Finnish headquarters of the information technology corporation Hewlett-Packard (HP), employing ca. 800 staff. The building was first developed in 1984. An extension was built and major renovation carried out in 1991. The building parameters are presented in Table 1 below.

Table 1: Building Parameters

Building Parameters	***Value***
Location	*Espoo, Southern Finland (Northern Europe)*
Current service life	*24 years (1984)*
Gross floor area	*16,300 m^2 (~175,451 ft^2)*
Gross Volume	*70,000 m^3(¨2,471 000 ft^3)*
Structure	*3-storey with basement*
Employees	*800*
Operating energy (2008):	
Heat	*124 kWh/m^2/year*
Electricity	*146 kWh/m^2/year*

The HP facility is considered to represent a rather typical Finnish commercial facility. According to Statistics Finland (2010), a significant portion (22%) of existing commercial buildings in Finland date from the 1980's. Additionally, the facility is located in the Helsinki Metropolitan Area in Southern Finland, with the highest density of commercial buildings in the country (KTI Property Information Ltd, 2010).

3.2 FM Organization

The partner FM organization in the research is ISS Palvelut Ltd (hereinafter referred to as "ISS"), which is part of the global ISS Group. ISS Group is one of the world's largest commercial providers of facility services. ISS operate in 53 countries and the service repertoire is individual for every country. For the purpose of the research, it was perceived important that

the studied FM organization provides a so called Total FM (TFM) service. Atkin and Brooks (2009) define TFM as follows:

"Total facilities management is where a single entity takes responsibility for all facets of facilities management".

ISS use the term Integrated Facility Services (IFSs) as equivalent to TFM. ISS's main services comprise cleaning, property, catering, and security services, with a number of supporting services; all provided using the IFS solution. ISS consider a service solution including three or more different services IFS.

Since September 2008, ISS has provided all major facility services for the HP facility using the IFS solution. Altogether 20 ISS staff, including a service manager work on site. The provided services comprise cleaning services, waste management, catering services, indoor and outdoor property services (i.e., air conditioning maintenance, housing automation, plumbing and lighting systems), in-house mail delivery services, reception of goods, office services, pest services as well as energy control services.

3.3 Green Building Indicator

The green building indicator system chosen as a reference in this study is the United States Green Building Council's LEED for Existing Buildings: Operations and Maintenance Rating System (LEED EB). USGBC's LEED was chosen due to its wide international recognition and popularity: 19,926 registered projects and 5,166 certified projects worldwide in July 2010 (USGBC 2010b). Majority of the LEED projects are located in the US, but LEED is also gaining interest in Europe, including Finland. At the time of this study, there were 4 certified and 14 registered LEED projects in Finland. LEED EB is a rating system specifically tailored for existing, operational buildings. In addition, the facility subject to the case study was in the process of adopting the LEED EB rating system.

LEED rating systems have been criticized, e.g., for the systems' poor consideration of building materials (Marsh, 2008; Bowyer, 2007) and energy-efficiency (Gifford, 2008). However, the LEED EB rating system does have a broad approach to different environmental aspects, which is essential in estimating the environmental impact of a building. The rating system comprises altogether seven (7) categories with which the environmental performance of operational buildings is measured. Of the seven categories, six are applicable internationally. The six internationally applicable categories have been outlined by the USGBC (2010c), as follows:

- ***Sustainable Sites (SS).*** *Discourages development on previously undeveloped land; minimizes a building's impact on ecosystems and waterways; encourages regionally appropriate landscaping; rewards smart transportation choices; controls storm water runoff; and reduces erosion, light pollution, heat island effect and construction-related pollution.*

- ***Water Efficiency (WE).*** *Encourages smarter use of water, inside and out. Typically achieved through more efficient appliances, fixtures and fittings inside and water-wise landscaping outside.*

- ***Energy and Atmosphere (EA).*** *Encourages a wide variety of energy strategies: commissioning; energy use monitoring; efficient design and construction; efficient appliances, systems and lighting; the use of renewable and clean sources of energy, generated on-site or off-site; and other innovative strategies.*

- ***Materials and Resources (MR).*** *Encourages the selection of sustainably grown, harvested, produced and transported products and materials. Promotes the reduction of waste as well as reuse and recycling, and takes into account the reduction of waste at a product's source.*

- ***Indoor Environmental Quality (IEQ).*** *Promotes strategies that can improve indoor air as well as providing access to natural daylight and views and improving acoustics.*

- ***Innovation in Operations (IO).*** *Provides bonus points for new and innovative technologies and strategies beyond other LEED credit requirements or for considerations not addressed in LEED. Rewards projects for including a LEED Accredited Professional on the team.*

The above categories comprise altogether 52 credits from which a maximum of 106 points can be obtained. The basic level certification requires the minimum of 40 points, silver level 50 points, gold level 60 points and the highest level, platinum, 80 points.

The research was conducted by analyzing existing ISS service processes and comparing them against the LEED EB criteria.

3.4 LEED EB Process

Despite the age (first developed in 1984) of the facility, no major structural or technical refurbishments were needed to achieve the green building certificate. The facility has been appropriately maintained, and many environmental aspects had already been taken into consideration. Most recently, remote real-time energy monitoring of the building was included in the facility services. However, some modifications were required to achieve desired results in the certification process. Most of the required changes involved adjusting various set point values and operating schedules in the building automation system. The most significant actions performed comprised the installation of a water pressure reduction valve to the main water line in order to control the fixture water flows, and replacing one chiller system with a system including a free-cooling exchanger.

The needed process or documentation changes were implemented prior to the beginning of the performance period of the LEED EB certification system. The performance period started 1

December 2009 and ended 31 March 2010, covering 4 months. The FM practitioners and researchers cooperated actively throughout the certification and research processes. The following Section presents the main findings of the case study.

4. Findings

As a result of a preliminary analysis by the FM, the case facility decided to attempt a Gold level certification. The required score for the Gold level is 60 points. In this case, 66 of the 106 available points were deemed feasible to attain without major upgrades or alterations. The pursued points fall quite evenly between the different LEED categories, as can be seen from Table 3.

The study focused on the role of FM services in the achievement of the green building points. Based on thorough analysis of the certification process, the following categories were developed, indicating the influence, or "impact potential" of the FM provider on the pursued points.

1. ***Fully attainable with FM's internal policies and processes.*** *FM readily holds the information or documentation required to meet the criteria, or FM has full control over the processes included in the criteria. Meeting the criteria is independent of the site charasteristics and occupant. Credit Example: Green Cleaning Program.*

2. ***FM has operational impact and can influence the points achieved.*** *FM plays a central role in meeting the criteria via operating the systems, equipment or processes in question and can produce the required documentation. However, meeting the criteria also depends on the site characteristics and occupant. Credit Example: Optimize Energy Efficiency Performance.*

3. ***FM has operational impact, but cannot influence the points achieved.*** *FM has no impact on whether the systems, equipment or processes in question are in place, but can implement the required changes and produce the necessary documentation. Meeting the criteria depends on the site characteristics and occupant. Credit Example: Protect and Restore Site Habitat*

4. ***FM can act as an expert advisor.*** *FM can perform tasks, such as occupant surveys, required by the green building system, or advice on the best practices. Meeting the criteria depends on the site characteristics and occupant. Credit Example: Alternative Commuting Transportation.*

LEED EB entails nine prerequisites that must always be met in order to achieve certification. The prerequisites are grouped according to the respective impact potential of the FM provider in Table 2.

Table 2: Impact Potential of FM - LEED EB Prerequisites

Impact Potential	*Prerequisite*
Fully attainable with FM's internal policies and processes	*-EA P1 Energy Efficiency Best Management Practices - Planning, Documentation, and Opportunity Assessment* *- EA P3 Fundamental Refrigerant Management* *- MR P2 Solid Waste Management Policy* *- IEQ P3 Green Cleaning Policy*
FM has operational impact and can influence the points achieved	*- WE P1 Minimum Indoor Plumbing Fixture and Fitting Efficiency* *- EA P2 Minimum Energy Efficiency Performance* *- IEQ P1 Minimum Indoor Air Quality Performance*
FM has operational impact, but cannot influence the points achieved	*-*
FM can act as an expert advisor	*- IEQ P2 Environmental Tobacco Smoke (ETS) Control* *- MR P1 Sustainable Purchasing Policy*

SS = Sustainable Sites, WE = Water Efficiency, EA = Energy and Atmosphere, MR = Materials and Resources, IEQ = Indoor Environmental Quality, IO = Innovation in Operations

Most notably, four out of nine prerequisites are fully attainable through the FM provider. Furthermore, another three can be influenced by the FM, even though dependant on the subject facility. Only two out of the nine prerequisites could not be influenced by the FM. However, with these two prerequisites, the FM was still able to advice on best practice.

Once the prerequisites have been met, the credits to be pursued can be chosen freely, as long as the certification minimum of 40 points is achieved. The 66 points pursued by the case facility are presented in Table 3, divided by both the LEED EB category (horizontally) and the impact potential of the FM provider (vertically).

Table 3: Impact Potential of FM – LEED EB Points

LEED Category / *Impact Potential*	*SS*	*WE*	*EA*	*MR*	*IEQ*	*IO*	*POINT TOTAL*	*of point total*
Fully attainable with FM's internal policies and processes	*2*	*-*	*6*	*1*	*5*	*1*	*15*	*23%*
FM has operational impact and can influence the points received	*-*	*10*	*13*	*3*	*9*	*4*	*39*	*59%*
FM has operational impact, but cannot influence the points achieved	*3*	*-*	*1*	*-*	*-*	*-*	*4*	*6%*
FM can operate as an expert advisor	*7*	*-*	*-*	*1*	*-*	*-*	*8*	*12%*
POINT TOTAL	*12*	*10*	*20*	*5*	*14*	*5*	*66*	
of point total	*18%*	*15%*	*30%*	*8%*	*21%*	*8%*		*100%*

SS = Sustainable Sites, WE = Water Efficiency, EA = Energy and Atmosphere, MR = Materials and Resources, IEQ = Indoor Environmental Quality, IO = Innovation in Operations

The results show that the FM had either direct or indirect (operational) impact on 82% of the points achieved by the case facility. The vast majority of the points achieved were either readily available due to the FM's existing internal policies and practices (23%, 15 points) or indirectly influenced by operations conducted by the FM (59%, 39 points). Moreover, the categories with less FM impact potential represent the minority of the achieved points with the shares of 6% (4 points), and 12% (8 points), respectively.

5. Discussion

The built environment plays a major role in fighting climate change and delivering a sustainable economy as the built environment accounts for roughly 40 % of both the total energy consumption and the carbon dioxide emissions globally. Furthermore, it is estimated that approximately 80% of carbon emissions caused by buildings are created during the operating phase of existing buildings, making the topic of this research both relevant and current. The initial hypothesis was that that FM plays a significant role in supporting end-user organizations in their efforts to minimize their total environmental impact.

The study shows, that using LEED EB as indicator for green performance an office building dating from the 1980's, the FM organization had either direct or indirect (operational) influence on 82% of the LEED points achieved by the building. The vast majority of the points earned by the subject facility were either readily available due to the FM organization's existing internal policies and practices (23%, 15 points) or substantially but indirectly influenced by operations conducted by the FM organization (59%, 39 points). The latter category is of course dependent on both the characteristics of the existing building, and the willingness of the end-user to adopt the points.

It should be noted; however, that only one service provider was assessed against a single green building indicator system. Moreover, the case study represents a situation where all FM services are provided by one service provider using an integrated facility service (IFS) solution. Since the case study is conducted in Finland, the results may not be applicable for other countries. It is therefore not possible to make wide generalizations based on the results. However, the study exemplifies the impact potential of an active FM organization in a reliable manner.

As previous research (Nousiainen and Junnila, 2008) has demonstrated, end-user companies expect facility managers to be able to provide environment and energy related services. This research has shown that, at least in the case of a leading Finnish FM organization, these services partially already exist, as part of the FM organization's internal policies. Additionally, the study has demonstrated that for a FM organization providing a wide range of services it is possible to contribute to several of the green building criteria. It can be argued that FM organizations are well equipped to guide the end-user through a green building certification process, since the required information is already in-house and readily available. What is needed is an active, even proactive, approach to the building occupant's potential green building initiatives.

Future research on the role of FM could focus on other countries, such as the U.S., where the number of LEED certified buildings is immensely greater than anywhere else in the world. Furthermore, similar studies using different green building indicators (BREEAM, HK-BEAM), energy efficiency or carbon footprint calculation as the measure of environmental performance would be of interest.

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