

Size Matters: Benchmarking Facility Size, Type of Space, and Maintenance Costs/Rentable Square Foot

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Understanding the role that facility size and space play in making both accurate benchmarking comparisons and in forecasting operating costs of acquired assets is crucial to effectively managing facilities in an increasingly competitive market. While facility-based benchmarking has been embraced by the industry for some time, there exists little research literature on which demographic variables have the greatest impact on facility financial benchmarks. More specifically, the issue of facility size has not been sufficiently addressed in relation to making benchmarking comparisons or in examining economies of scale. An industry benchmarking study (2344 respondents) was developed, conducted, and analyzed for a large Facilities Management organization and this study was undertaken to examine overall trends in facility size and space (Single, campus, or organizational groups) in regard to annual maintenance costs/square foot (SF). The results indicate that single facilities are significantly smaller and have a lower maintenance costs/rentable square foot than their counterparts in larger facility groups. Significant linear relationships were found for all types of space, but the strength of the linear relationship varied from weak to moderate. Results indicate that small economies of scale may exist in groups of managed facilities, however this contradicts the finding of the Kruskal-Wallis test indicating that groups of facilities exhibit higher maintenance costs/rentable square foot (RSF) than their smaller single facility counterparts.

Key Words: Benchmarking, facility size, maintenance costs, type of space

Introduction

The planning for and constructing of facilities represents a very small portion of the life-cycle of a building. Once a building has been constructed, it may operate for 30-50 years or longer giving rise to the largest portion of life-cycle expenses, the Operations & Maintenance phase. It is estimated that 60-70% of the life-cycle costs are encountered during the ownership phase of the lifecycle (Gallaher et al., 2004). In the past 20 years, facilities have begun to incorporate more sophisticated benchmarking techniques as a means of managing the ongoing performance of those buildings and seeking continual improvement (Pitt & Tucker, 2008). One of the paramount principles of benchmarking is making similar comparisons or "apples to apples" comparisons (Camp, 1989). While some demographic variables may seem obvious for making similar facility benchmarking comparisons, such as facility type, industry served, setting, and building age, many variables have not been explored or analyzed in academic research. Facility size is one such variable that common sense may indicate could impact meaningful facility benchmarking comparisons, however, it is only discussed in passing in the literature and there exists very few studies that attempt to quantify the nature of the relationship, the ones that do are contradictory in results. The type of space represented by facilities is another variable related to size that could also have an impact on benchmarking

comparisons. For example, can the operating costs/sf of a single facility be compared to the operating costs/sf of a campus facility? What types of facility space are comparable?

Practitioners may assume that dividing maintenance costs by square footage gives a reliable measure of costs/area that can be used to scale up operating costs during asset acquisitions, but the relationship may be much more complex than is generally assumed. Understanding the role that facility size and space play in making both meaningful benchmarking comparisons and in predicting operating costs of acquired assets is crucial to effectively managing facilities in an increasingly competitive market. This study was conducted to examine the relationship between facility size, operating costs, and types of space for the purposes of identifying appropriate benchmarking space comparisons and examining economies of scale in facility operations and maintenance costs.

Literature Review

Facilities Management (FM) plays a critical role in ensuring efficient operations and achieving cost savings (De Marco & Mangano, 2012). Yet, the benefit of cost savings may be overshadowed by the overall increase in operations and maintenance costs (Cole, 2005). Though maintenance costs have increased overall, they have not done so at the same rate for all organizations. For example, maintenance costs for Cornell University in New York increased significantly more than for facilities owned by the state. In fact, expenditures at Cornell were approximately 70% higher per square foot. Similarly, custodial costs at Cornell also increased, while the costs at state-owned facilities remained the same or even decreased (Cole, 2005).

Many organizational leaders object to the rising costs and, in an attempt to prevent further increases, have recommended delaying preventative maintenance and limiting building repairs. However, this effort to cut costs in the short-term can lead to much greater costs in the long-term (De Marco & Mangano, 2012). The literature acknowledges that facilities maintenance is a significant cost but also a potential generator of profit (e.g., De Marco & Mangano, 2012; Taillander, Sauce, & Bonetto, 2011). However, research is limited regarding the factors contributing to cost. Talley-Seijn (2003) examined the differences in costs for buildings in urban versus suburban areas and in different types of industries.

In particular, research is lacking on the relationship between building size and facilities costs. Most of the literature that mentions costs does so in passing. For example, Suhail (2017) noted that building size affects operations and maintenance costs but did not describe the relationship or present data regarding what the relationship might be. Lai (2008) likewise reported that bigger buildings would have higher operations and maintenance costs. However, the only rationale presented was that bigger buildings would have a greater cooling demand. Houghton, Vittori, and Guenther (2009) examined 13 green-construction health care facilities ranging from 28,000 to 470,000 square feet and found that first-cost premiums are independent of building size. However, the researchers did not specify what the typical relationship is between building size and costs.

Dranove (1998) estimated the magnitude of economies of scale in 14 hospital cost-centers. It was found that smaller hospitals may exhibit large economies of scale during hospital mergers, while larger hospitals do not exhibit economies of scale during the merging process. It was concluded that the small gains on cost-center efficiencies in larger hospital organizations may often be offset by small differences in costs.

As one example, O Mac-Barango and Kakulu (2011) reported that maintenance costs increased as square footage increased for buildings up to 332.5 square feet but that buildings ranging from 333 to 400 square feet (the biggest buildings in the study), the costs started to decrease. As another example, case study involving Rutgers University indicates that when the school demolished small older buildings and focused on larger buildings, it was able to achieve economies of scale and thus reduce maintenance costs (Sightlines, 2016). Gordan and Haasl (1996) presented data suggesting why larger buildings might enable cost savings. These researchers found:

> "It takes approximately.35 property managers to manage 100,000 square feet, or in other words, a typical property manager manages approximately 256,000 square feet. Additional staff (per 100,000 square feet) involved in the operation and maintenance are .84 of a building operator, .33 of a facility manager, .26 of a chief engineer and .16 of an energy manager". (p. 53)

In other words, these employees will not be working at maximum capacity in smaller facilities, thereby preventing economies of scale and cost savings.

Most research and professional reports (e.g., *Facility Executive*, 2016; Utah State Building Board, 2015) present average maintenance costs per square foot, without specifying how the costs might vary based on whether a building is small or large. Rather, the costs might be broken down by facility type, such as offices versus libraries (Utah State Building Board, 2015), or, as previously noted, by location or industry (Talley-Seijn, 2003).Based on the overall body of literature, it appears that the facilities management industry assumes that maintenance costs increase linearly as the square footage increases: forecasting the expected costs is a simple matter of multiplying the average cost per square foot by the anticipated square footage of the building. Presumably, because of this assumption, few researchers have explored whether this relationship exists. The research that has (though only indirectly) explored this presumed relationship has found that the assumption may not be accurate, at least not all the time.

Research Objectives

The purpose of this study is to identify the nature of the relationship between facility costs, type of space, and size for use in benchmarking comparisons and for quantification of economies of scale in facility operations and maintenance.

1. To determine if the type of space being reported on has an effect on the average maintenance costs/Rentable Square Foot (RSF).

    a. H1: The type of space reported in the survey will have a significant effect on maintenance costs/RSF and RSF
    b. H2: The average single facility will have higher maintenance costs/RSF than campus or organizational groups of facilities.

2. To determine if there is a linear relationship between facility size and maintenance costs/RSF.

    a. H3: There is a significant negative linear relationship between facility size and maintenance costs/RSF.

Methodology

Data Collection

A benchmarking survey was developed, implemented, and analyzed for the purpose of updating a large Facilities Management organization's Operations and Maintenance Benchmarking Report. This survey had been previously administered in 2009 by the FM organization, and attempted again in 2012 with an insufficient sample size. The researchers were asked to administer and update the survey with guidance from research literature and Subject Matter Experts. The data from the previous survey administrations was not available to the researchers, only the questions. The researchers solicited feedback for updating the content of the survey from the organization and twelve Subject Matter Experts (SMEs) over a period of five months from August 2016 through January 2017. The survey was deployed electronically and administered through the Qualtrics survey service over a period of four months from February 2017 through May 2017. Email invitations were sent to all active members of the FM organization and 2344 responses were received from 24,084 email invitations, representing an approximate response rate of 10% of email invitations. The responses represented 35 industries within facilities management, 37 facility uses, 4 facility settings, and a facility age range of 167 years. Respondents were incentivized to participate by offering them a free copy of the benchmarking report. The data was then quality checked for inconsistencies, extreme outliers, and inconsistent or illogical answers. Respondents were called for follow up verification if any of these problems were found in their responses. If respondents could not be reached to verify outliers in their responses, the data was excluded from the study. After the data cleansing and quality management, the survey was analyzed for the purpose of producing and publishing the FM organizations technical benchmarking report.

Survey Content

The survey consisted of 134 questions and included information on demographics, facility practices, facility costs, and a variety of questions on organizational culture and miscellaneous practices (See Figure1: Survey Content & Flow). Though the respondents were asked to provide data on their largest and most active single facility, they were given the option to report on a space within a facility, a single facility, a campus facility (multiple buildings in one place), or organizational (multiple facilities in multiple places). Respondents were given these options to ensure ease of participation based upon feedback from members of the FM organization. SMEs indicated that single facility data is not always available, and it may be easier for facility managers to report costs and size on a larger, more wholistic scale, such as from a campus or organizational perspective.

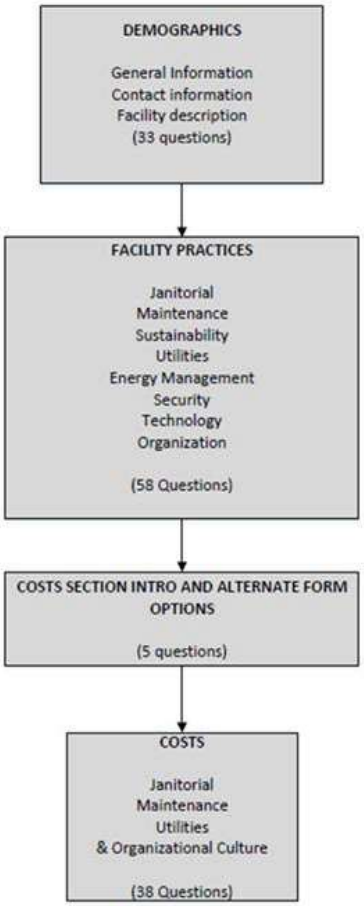

Figure 1: Survey Content & Flow

Study Variables

Independent

This study utilizes two independent variables, type of facility space (Single facility, Campus Facilities, and Organizational Facilities (multiple buildings in multiple places), and Facility Size in Rentable Square Feet (RSF). Rentable Square Feet is defined as building exterior gross area minus exterior walls, major vertical penetrations, interior parking space and void areas (ASTM 1836-01).

Dependent

This study utilizes one dependent variable, maintenance costs/RSF. This variable was calculated by dividing the total reported maintenance costs by the reported rentable square feet. RSF is also used as a co-variable in this study for the purpose of statistically verifying that the types of space have differing ranked distributions in maintenance costs/RSF.

Analysis

The statistical analysis was conducted in IBM SPSS Statistics 25.0. Since there are three levels of the independent variable, type of space (Single facility, Campus facility, Organizational group), an omnibus statistical test had to be used followed by post-hoc analyses. The dependent variables of maintenance costs/RSF and RSF violated the assumption of normality necessary for an ANOVA (See Figure 2: both distributions were approximately similar), so a Kruskal-Wallis H test with Mann-Whitney U post hoc tests was conducted as a non-parametric alternative. A Bonferroni correction method was also utilized to avoid Type I Errors associated with multiple comparison tests. A Spearman's' Rho rank correlation was also used to assess the strength of the linear relationship between maintenance costs/RSF and RSF. All statistical testing in this study uses rank-based comparisons.

Results

Descriptive Statistics

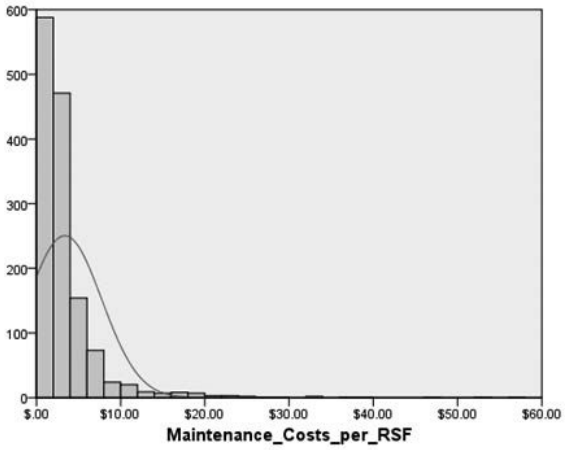

Figure 2: Distribution of Maintenance Costs/RSF w/normal curve superimposed

Table 1

Type of Facility Space, Maintenance Costs/RSF, and RSF

Type of Space	N	Mean Maintenance Costs/RSF	St. Dev.	Mean RSF	St. Dev.
A single facility	887	$3.03	$3.50	213,754	311,306
A campus facility group	191	$4.40	$4.79	654,991	788,327

Multiple facilities & locations (organizational)	147	$4.57	$5.47	589,845	817,411

Inferential Statistics

A Kruskal-Wallis H test was conducted to determine if the type of space reported on had an effect on maintenance costs/RSF, H (2,1225) = 24.872, p = .000, α=.05 (See Table 2). Mann-Whitney U post hoc tests were performed to identify which type of space were significantly different from one another. The alpha level of significance was adjusted using the Bonferroni correction. Single facilities were found to have significantly lower maintenance costs/RSF than campus facility or organizational facility groups. There was not statistical evidence for significant maintenance costs/RSF differences between campus groups and organizational facility groups.

Table 2

Effect of Type of Space on Maintenance Costs/RSF

Kruskal-Wallis H statistic	**df**	**Significance**
24.872	2	.000
Types of Space	**Mean Rank**	**N**
A single facility	582.53	887
A campus facility group	710.08	191
Multiple facilities & locations (organizational)	670.70	147
Mann-Whitney U post hoc tests: Bonferroni Correction α = .05/3 = .017		
Comparison	**U statistic**	**Significance**
Single facilities – campus facilities	66,779.50	.000
Single facilities – multiple buildings/locations	56,099.50	.007
Campus facilities – multiple buildings/locations	13,426.00	.492

A Kruskal-Wallis H test was also conducted to determine if the types of space reported on were significantly different in size, H (2,1318) = 155.304, p = .000, α=.05 (See Table 3). Mann-Whitney U post hoc tests were performed to identify which type of space were significantly different from one another. The alpha level of significance was adjusted using the Bonferroni correction. Single facilities were found to be significantly smaller than campus facilities or organizational facility groups. Campus groups and organizational facility groups were also found to be statistically different in overall size, with campus groups in this survey representing larger RSF than organizational or single facility perspectives.

Table 3

Effect of Type of Space on Rentable Square Feet (RSF)

Kruskal-Wallis H	**df**	**Significance**
155.304	2	.000
Types of Space	**Mean Rank**	**N**
A single facility	574.87	915
A campus facility group	895.99	231
Multiple facilities & locations (organizational)	792.12	172
Mann-Whitney U post hoc tests: Bonferroni Correction α = .05/3 = .017		

Comparison	U statistic	Significance
Single facilities – campus facilities	53,863.00	.000
Single facilities – multiple buildings/locations	53,069.00	.000
Campus facilities – multiple buildings/locations	17,056.00	.015

In order to determine if there is a linear relationship between facility size (RSF) and maintenance costs/RSF, a number of correlation analyses were conducted. Correlation analyses quantify the strength of the linear relationship between two variables, where a correlation of 0 represents no relationship and a correlation of 1 represents a perfect linear relationship. A Spearman's Rho rank correlation was used due to the non-parametric nature of the dependent variable, maintenance costs/RSF (See Table 4). An analysis of overall space was compared to analyses of the relationships within each type of space. Although all space categories indicated significant linear relationships, the strength of that relationship varied from weak to moderate.

Table 4

Facility size (RSF) and maintenance costs/RSF correlations by type of space

Type of Space	Spearman's Rho rank (correlation)	P-Value	Sample Size (N)
All types of space	-.068	.013	1378
Single Facilities	-.119	.000	870
Campus Facilities	-.278	.000	187
Organizational (Multiple facilities & locations)	-.402	.000	172

Discussion

Research Objective 1

There was sufficient evidence to reject the null hypothesis for H1. The type of space reported on had a significant effect on maintenance costs/RSF and RSF. The Whitney U post-hoc tests revealed that single facilities, campus facilities, and organizational groups are all significantly different in terms of size and that single facilities have significantly lower maintenance costs/RSF than the other two groups. The null hypothesis was rejected for H2; however, the outcome was in the opposite direction as was anticipated. The smallest group in terms of average area, single facilities, reported lower maintenance costs/RSF than the two groups representing larger facility organizations. The presence of an economy of scale would suggest that the smaller facilities should have higher maintenance costs/RSF than their large-scale counterparts, but the opposite was found.

Research Objective 2

There was sufficient evidence to reject the null hypothesis for H3. Significant linear relationships were found for all types of space. The results of the correlation analysis, which indicate a stronger negative linear relationship between maintenance costs/RSF and Rentable Square Feet in facility campuses and organizational groups than in single facilities, suggests larger organizations demonstrate a weak-to-moderate economy of scale. These groups of buildings being operated by the same facilities group show a stronger tendency for maintenance costs/RSF to decrease as the size of the assets increase. This is consistent with the literature as it suggests that economies of scale might be more easily achieved by larger facilities and organizations. Size alone, however, is at best a moderate contributor to this relationship, meaning that other variables not addressed in this study are accounting for further differences in maintenance costs/RSF.

Conclusion and Future Research

Consistent with previous research, the results of this study are somewhat contradictory. It is curious that campus and organizational facility spaces report significantly higher maintenance costs/RSF than single facilities despite being significantly larger, as well as a stronger linear relationship between facility size and costs/RSF. If campus and organizational facilities are significantly larger than the average single facility reported, then an economy of scale should suggest that they have lower reported maintenance costs/sf, but the results contradict this. The lack of a perfect linear relationship between maintenance costs/RSF and RSF suggests that variables other than size are contributing to maintenance costs, though size itself is a significant but misunderstood factor.

Future research will further explore the relationship between facility size and maintenance costs/square foot by conducting a more detailed analysis that explores the average building size represented by the campus groups and organizational perspectives rather than the total area represented by the asset group. Examination of whether these trends continue into the average building sizes of the facility groups will help to further clarify the nature of the relationship between facility size and maintenance costs. Additional research should also focus on identifying the predictive variables for maintenance costs, and further testing of the size and cost relationship for specific industries or facility types, such as office buildings that may also play a role in determining maintenance costs/sf.

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