

## Estimating the Size and Composition of the Hospital Maintenance Staff

Peter Lufkin  
Whitestone Research

*Abstract: This note describes an approach to estimating the size and composition of the maintenance staff for hospitals. Using data from a recent survey published by the New England Healthcare Engineering Society (1997), a predictive model with variables representing hospital size, staff productivity, and maintenance contract costs was explored, but only hospital size was found to be statistically significant. Based on this finding, a simple predictive equation is defined. The composition of the estimated staff is determined by extrapolation from data published by the International Facility Management Association (1994).*

The maintenance and repair (M&R) requirements of healthcare facilities are more demanding than those of most other facilities. The high intensity of use, long operating hours (24-hours per day for most primary care hospitals) and specialized equipment all lead to a relatively high maintenance workload usually fulfilled by a staff of tradesmen and supervisors.

Credible forecasts of long-term maintenance costs for hospitals require a detailed view of the size and composition of this staff. More specifically, a model of the M&R staff is needed that recognizes the factors that can influence staff size. Once the ability to forecast the staff size is developed, a simple method is needed for defining staff composition. This short note addresses both needs.

### Staffing Surveys

At least three recent surveys have addressed hospital M&R staffing. The surveys are somewhat of a mixed bag in terms of staff definition, type of data collected, and sample size; no clear trend in staffing rates is evident, except that they fall within a broad range of between 12,000 and 63,000 square feet (sqft.) per M&R worker. Staffing rates are typically expressed in terms of square footage per worker--the larger the rate, the smaller the staff.

M&R Staff Definition	Staffing Estimate (sqft. per FTE)	Contract M&R	Average Size (sqft.)	Sample Size	Source
Unclear, probably does not include custodial workers	12,000 to 24,000	na	na	500	Brown, 1993 <sup>1</sup>
"Skilled trades (incl. group supervisors)"; does not include custodial workers	63,000 (mean)	33%	900,000	86	IFMA Benchmark II, 1994 <sup>2</sup>
"Trade/Maintenance & Supervisors"; does not include custodial workers	22,817 (mean)	14%	667,000	50	New England Healthcare Engineering Society 1997 <sup>3</sup>

The variation in staffing rates among the surveys should be a source of discomfort to anyone attempting to generalize about M&R staff size. How do we explain the difference between the NEHES average of 22.8 thousand sqft. per FTE, and the IFMA rate almost three times higher? Some difference is undoubtedly due to staff definition and unmeasured differences, such as quality of construction or maintenance history among the surveyed hospitals<sup>4</sup>. But another part can be due to systematic factors that can be measured. Likely candidates include hospital size, staff productivity, and the amount of work done by contract. These influences may seem intuitive--staff size should move inversely to the percentage of M&R work contracted (perhaps explaining the high rates found in the IFMA survey)--but to date there has been no attempt to quantify these roles.

<sup>1</sup> Donn Brown, *Physical Plant Staffing for Health Care Facilities*. (American Society for Hospital Engineering, 1993).

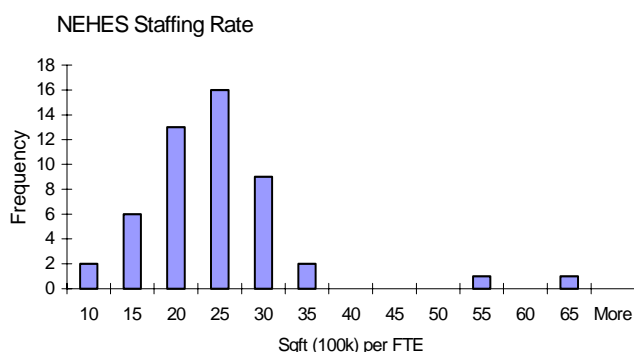
<sup>2</sup> *Benchmarks II, Research Report 13* (International Facility Management Association, 1994).

<sup>3</sup> Robert A. Loranger, *What We Learned from a 50-Hospital Collaborative Facilities Survey* in the Proceedings of Health Facilities 97. (American Society for Healthcare Engineering, 1997).

<sup>4</sup> See "Notes on M&R Cost Benchmarks" (Whitestone, 1996) for a discussion of the use and misuse of cost surveys.

## Determinants of M&R Staff Size

The New England Healthcare Engineering Society (NEHES) survey provides a closer view of M&R staffing. Its primary data and survey instrument were published in a recent conference paper, thus allowing us to directly compute the distribution of staffing rates for the 50-hospital sample.



The NEHES data suggest the influence that selected factors can have on M&R staff size. The simple correlations shown below indicate that there is a negative relationship between staff size and outsourcing (contract percentage), staff productivity (using average M&R salary as a proxy), and facility size (expressed in 100k sqft).<sup>5</sup> Note that we are now expressing staff in a more direct way, as M&R staff per hundred thousand square feet (Maint FTE / 100k sqft).

Correlations						
Variable	MainFTE/100kSqft	Contract%	AvgMaintSal	sqft/100k	TotalMaint\$/Sqft	
MainFTE/100kSqft	1.0000	-0.3418	-0.4059	-0.4049	0.7100	
Contract%	-0.3418	1.0000	0.3817	0.0727	-0.0005	
AvgMaintSal	-0.4059	0.3817	1.0000	0.3809	0.1829	
sqft/100k	-0.4049	0.0727	0.3809	1.0000	-0.2604	
TotalMaint\$/Sqft	0.7100	-0.0005	0.1829	-0.2604	1.0000	

As an aside, the strongest direct correlate we found with respect to staff size was total maintenance costs (sum of labor costs, contracts and supplies). Loosely interpreted, this implies maintenance costs per square foot *rise* with the size of the M&R staff--a controversial finding requiring more study than can be afforded here.

## Estimating Staff Size

To define an equation for estimating M&R staff size, we incorporated the variables noted above. The following model was estimated:

$$\text{Maint FTE}/100\text{ksqft} = 9.20 - 7.55(\text{Contract}\%) - .000048(\text{AvgMaintSal}) - .094715(\text{Sqft}/100\text{k})$$

Details of the estimate (Appendix II) indicate that the overall model is statistically significant, though among the individual determinants only facility size (Sqft/100k) was significant at the 95% probability level. We attribute the lack of significance of the other variables largely to measurement error--productivity and outsourcing clearly affect M&R staffing, though their influence is not evident in the NEHES data.

A simpler equation uses just facility size:

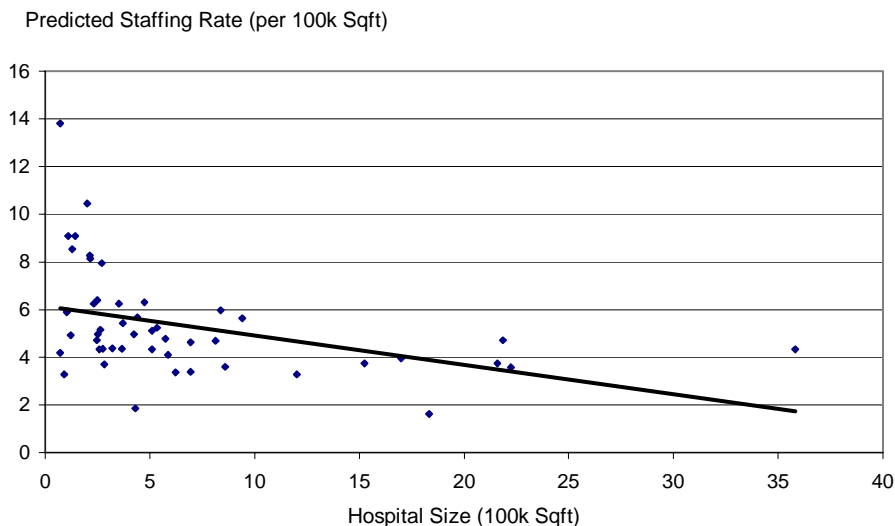
$$\text{Maint FTE}/100\text{ksqft} = 6.117 - .1223(\text{Sqft}/100\text{k})$$

<sup>5</sup> Correlation is a measure of association (or covariance) that has a range of zero to one, with one indicating the strongest association.

Both the overall model and facility size are statistically significant. For the average NEHES hospital (667 thousand sqft.) this equation would yield an M&R staffing rate of 5.3 FTEs, or roughly 35 positions. The data supports estimates of staffing rates from 6 FTEs per 100k sqft. for the smallest hospital (72 thousand sqft.) to 1.7 for the largest facility (3.5 million sqft.) in the NEHES data.

Using this equation to estimate staff size is a considerable improvement over a broader approach--an average derived from general surveys or application of a "benchmark"-- that fails to account for factors specific to hospitals, or recognize the significant economies of size. For example, a common rate derived from university facilities would estimate a staff of 14 for the average size NEHES hospital, much less than the 35 person staff estimated above<sup>6</sup>. The implications of this comparison for estimated M&R budgets should be obvious.

On the other hand, in using this model there are at least three limitations that should be considered. First, the model was estimated using data exclusively from New England hospitals; any staffing requirements unique to this region--e.g. climate, construction styles, labor relationships--are incorporated into the estimated parameters. Second, the estimates were based on a sample of 50 hospitals ranging from 70 thousand to 3.5 million sqft. in size. The use of the model should be limited to facilities falling within this size range. And third, while the model is statistically significant, it only explains about 16 percent of the variation among staffing rates, implying that the accuracy of our forecasts might be improved with more data and more experimentation with model specification.



<sup>6</sup> A staffing rate of 2 FTE per 100k sqft. is used in the Whitestone Maintenance and Repair Cost Reference (1997).

### Composition of the M&R Staff

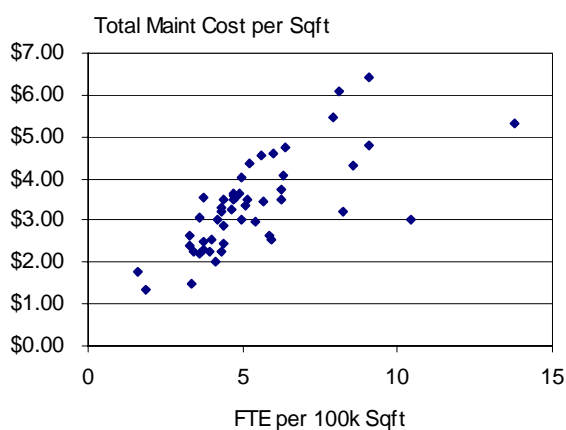
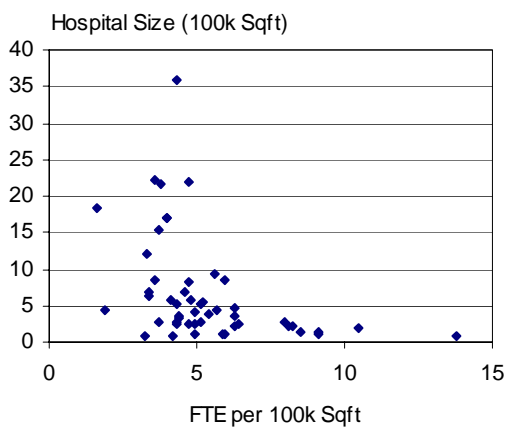
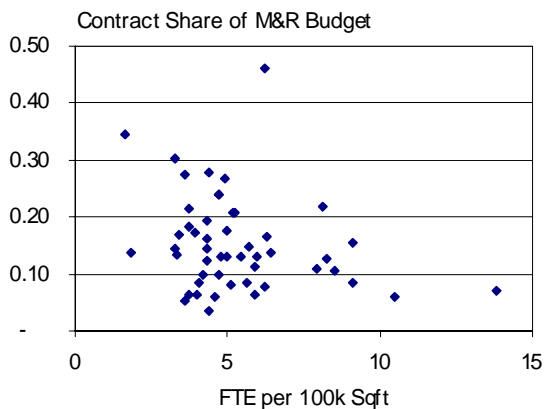
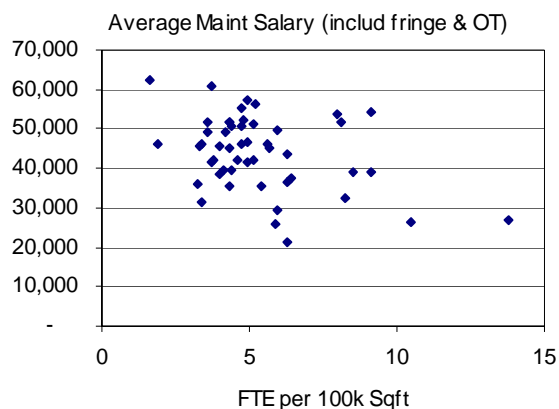
The composition of the estimated staff can be determined using the average distribution across trades shown in the IFMA report. We apply this distribution to the estimated staff for the average size hospital from the NEHES data.

Composition Of Hospital M&R Staff for the Average (667,000 sqft.) NEHES Hospital		
Trade	Percent	FTE
Group Supervisor	.085	3
HVAC Mechanic	.176	6
Electrician	.092	3
Painter & Carpenter	.108	4
Landscape	.032	1
Plumbers	.061	2
Locksmith	.025	1
Transport	.037	1
Generalist	.267	10
Other trades	.116	4
Sum	1.000	35

### Summary

Data from a recent survey by the New England Healthcare Engineering Society was used to construct a model for estimating hospital maintenance staff size. A simple model predicting staffing on the basis of hospital size was selected after other predictive factors, such as the percentage of work done by contract and the average staff salary, were found to be statistically insignificant. We argue that using this model provides improved estimates over more general approaches, which fail to recognize the unique requirements of hospital facilities. The composition of the estimated staff is determined by extrapolation from data published by the International Facility Management Association.

**Appendix I: Scatterplots**



Source: NEHES, 1997

## Appendix II: Model Estimates

Response: MinFTE/ 100kSqft

**Summary of Fit**

RSquare	0.28913
RSquare Adj	0.240662
Root Mean Square Error	1.943496
Mean of Response	5.287986
Observations (or Sum Wgts)	48

**Parameter Estimates**

Term	Estimate	Std Error	t Ratio	Prob> t
Intercept	9.2027496	1.489776	6.18	<.0001
Contract %	-7.547147	4.243153	-1.78	0.0822
AvgMintSal	-0.000048	0.000037	-1.29	0.2022
sqft / 100k	-0.094715	0.041664	-2.27	0.0279

**Whole-Model Test**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	67.59640	22.5321	5.9653
Error	44	166.19576	3.7772	Prob>F
C Total	47	233.79215		0.0017

Response: MinFTE/ 100kSqft

**Summary of Fit**

RSquare	0.16394
RSquare Adj	0.145765
Root Mean Square Error	2.061364
Mean of Response	5.287986
Observations (or Sum Wgts)	48

**Parameter Estimates**

Term	Estimate	Std Error	t Ratio	Prob> t
Intercept	6.1170019	0.405856	15.07	<.0001
sqft / 100k	-0.122273	0.040712	-3.00	0.0043

**Whole-Model Test**

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	38.32789	38.3279	9.0200
Error	46	195.46426	4.2492	Prob>F
C Total	47	233.79215		0.0043