A CROSS-SECTIONAL MULTIVARIATE ANALYSIS OF
THE DETERMINANTS OF MAINTENANCE COSTS IN BOSTON'S PUBLIC HOUSING

by

Osafran O. Okundaye
B.sc/B.ed., University of Benin
Benin city, Nigeria
(June, 1979)
M.A., Mass Communications
Southern University, Baton Rouge La.
(December, 1981)

SUBMITTED TO THE DEPARTMENT OF
URBAN STUDIES AND PLANNING
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER IN CITY PLANNING
at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June, 1988

Osafran O. Okundaye, 1988

The author hereby grants to M.I.T permission to reproduce and to
distribute copies of this thesis document in whole or in part.

Signature of Author

Department of Urban Studies and Planning
June, 1988

Certified by

Professor Lisa Peattie
Thesis Supervisor

Accepted by

Professor Donald Schon
Chairman, M.C.P. Committee
A CROSS-SECTIONAL MULTIVARIATE ANALYSIS OF
THE DETERMINANTS OF MAINTENANCE COSTS IN BOSTON'S PUBLIC
HOUSING

by

OSAFRAN OSARENKHIE OKUNDAYE

Submitted to the Department of Urban Studies and Planning on
June 15, 1988 in Partial fulfillment of the requirements for
the degree of Master in City Planning

ABSTRACT

The survival of the nation's public housing stock depends in
part on the availability of funds for routine operations and
capital improvement work. The extent to which such funds are
available largely depends on the prevailing political
climate. This uncertainty establishes the need to minimize
operational costs and also to explore alternative sources of
revenue. Maintenance has been identified as one aspect of
operational costs that could be controlled.

In trying to minimize maintenance costs, it's important to
understand the role, nature and extent of the factors that
exert the most influence on maintenance costs. This is where
this study comes in.

Historically, the variability in maintenance costs has always
been associated with the demographic characteristics of
public housing residents and seldom with building
characteristics. This study goes further, beyond the realm
of tenant demographics, by also testing the relative impact
of building characteristics. In all, 17 variables were
tested, 9 of which were building variables and the others
tenant related.

Using multivariate standardized regression analysis, it was
found, as expected, that tenant variables especially percent
AFDC, percent minors, family size and percent employed, exert
profound influence on maintenance cost. However, fewer
building variables including development type, management
type and building age exert profound influence. Therefore,
there is substantial evidence that tenant variables exert far
higher influence on maintenance costs than building
variables.

Implicit in the findings, without exaggerating the profound
influence of tenant demographics, is the fact that this
study's design, by default, tests the socio-economic status
of residents. Interestingly, the finding that race exerts a
mild influence underscores the notion that socio-economic
status rather than race or ethnicity determines the impact on
maintenance cost.

In spite of the reported profound influence of tenant variables, something that remains unclear is the fact that no one variable stands out with supreme influence partly because it’s often difficult to fully decipher the influence of one from the others; most variables not being mutually exclusive.

Thesis Supervisor: Lisa Peattie Ph.d
Title: Professor Emeritus of Anthropology and Senior Lecturer of Regional Planning

Thesis Committee: Professor J. Mark Davidson Schuster
Professor Langley Carleton Keyes
ACKNOWLEDGEMENT

Few persons made the writing of this thesis possible but a
great many provided help in ensuring that I maintain my
sanity while here at MIT. My profound gratitude goes to
members of my thesis committee for their insightful comments,
criticisms and suggestions.

My in-depth gratitude goes to Professor Peattie, my thesis
advisor; first, for agreeing to take me on at mid semester
long after the thesis filing deadline, and also for her help
in defining the theoretical framework of my study.

Special thanks to Professor Schuster for his help in the
design of my methodology and also for his elaborate editorial
comments and criticisms. If the reader finds the
organization and presentation of my materials direct, clear
and crisp, it's because Mark Schuster carefully went through
the act and style of technical writing with me.

Many thanks to professor Keyes for providing the initial
literature material, background information on public housing
and also for his comments and suggestions.

I also want to acknowledge the support of Professor Aaron
Fleischer, Steve Ervin, Petros Sivitanidis, Han Jun and my
contemporary, Sherman Williams, for fostering my
understanding of statistics in general and the Statistical
Software Tool (SST) in particular.

It is absolutely important to mention here that this
thesis topic was identified and defined in part by Dr
Ebelechukwu Agba, Planning Director at the Boston Housing
Authority (BHA) and an MIT alumnus, while working as an
intern under him.

I cannot do without mentioning the assistance of Susan
Girgenti of the BHA with the collection of literature for
this study. I am also grateful to Dorothy Griffith of the
Fiscal Affairs Dept. at the BHA for her help with the sorting
of maintenance expense data.

Without the assistance of Jaci Hall, former Assistant
Administrator at the BHA and an alumnus of this program, my
indigent status would have remained indefinitely, possibly
jeopardizing my ability to complete this program. The
stipend from my work at the agency provided support for my
family and myself. To this rare breed of homo sapiens, I say
thank you and God bless.

My final thanks goes to all members, especially Mark Kean,
Jose Loria and Walter Oluwole, of the Planning, Design and
Development Department of the BHA for their care, love and
support. My gratitude to Patricia Weems-Carrington, Asst.
Administrator, for allowing the resources of the agency to
be used for this study.
DEDICATION

To my academic advisors, Karen Polenske and Edwin Melendez for making me feel, act and think like somebody in spite of the heavy burden that my indigent status imposed on my school work.

To those whose idea it was to provide food at the DUSP weekly (Thursday) forum. Though once a week, they have fed many mouths especially those, like me, who needed a break in order to make ends meet.

To my parents Samuel and Emily, now made to look poor because of the worthless value of the Nigerian currency in the international market place.

To my siblings, Osaretin and Noro, here in the United States, for whom I have had to make sacrifices often to the detriment of my work here at MIT. Certainly, there are no regrets for doing this because that's what makes our family great and of course in sync with our proud Judeo-Christian heritage.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>LITERATURE REVIEW</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>METHODOLOGY</td>
<td>31</td>
</tr>
<tr>
<td>4</td>
<td>REGRESSION RESULTS</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>CONCLUSIONS</td>
<td>64</td>
</tr>
</tbody>
</table>
Over the years, most of the Public Housing Authorities (PHAs) in the United States have become infamous for their inability to provide efficient and cost effective operations. The problems of the various PHAs are many and the means of resolving these problems seem limited. The general perception of the problems of public housing is that (a) the growing proportion of single parent families and welfare families may be a significant factor in the financial difficulties of the authorities because the incomes of these tenants don't allow more than a minimum rent charge, (b) the large number of uncontrolled children account for a small but significant amount of criminal and other anti-social behavior, and (c) the tenant related problems may be a result of inadequate management rather than the result of any particular tenant characteristics.

Maintenance is a major problem in public housing. While the exact nature and extent of this problem is easily understood, there is considerable disagreement on what factors contribute most to the problem. Many have argued that the problems are inextricably linked to tenant characteristics (1) while others think the problem is more management related.(2) A relatively recent opinion on this issue maintains that maintenance problems in public housing
are strongly related to building characteristics. (3)

Generally, the solutions to the problems of maintenance at a particular point in time are patterned to address the issues raised by the favorite theory of causation in vogue at that time. Those who see the problems as tenant related have advocated some radical measures that would redefine the goals of public housing program as they are known today. The admission of more tenants with higher incomes (above the local median, for example) has been suggested as one way to increase the rental income of public housing authorities with the hope that such additional revenue would make them self supporting. If such a policy is pursued, then the federal government would benefit because it can then discontinue its rent subsidy program. However, cities are likely to bear the brunt of such action because they would have to face the problems of homelessness of the poor and needy for whom the public housing program now caters.

Those who see management as part of the problem, have suggested that the management system should be revamped through training programs, hiring of dedicated professionals and changes in operating procedures. Others have advocated the transfer of management to either private groups or to tenant management boards.

For those who see the problems of maintenance as building related, the solution seems simple: fix building problems before they get worse. The conditions of some urban public
housing projects are sometimes horrible, requiring immediate repairs, but the lack of necessary funds for substantial repairs has caused conditions to worsen. It has often been argued by the proponents of this idea that the design of public housing projects does not reflect the peculiar needs of the user group and, therefore, housing projects are likely to be misused. In addition, it has been claimed that maintenance costs are mostly linked to each project's compliance with building performance criteria and standards. Also, it has been made known that peoples' perceptions of housing environment influence their use and reaction to buildings.

Previous analyses of maintenance cost in public housing have either focused on tenant aspects or on management aspects or both, but seldom have all three sets of variable - tenant, building, and management been included in a single study. My study is designed to examine all three aspects of the problem with the hope that more can be learned about the problem this way. However, my emphasis will still be on tenant demographics and building physical characteristics, largely because of the lack of access to management data.

Therefore, this inquiry is one of the few attempts to examine the extent of the impact of all three areas of influence. Its inclusion of both tenant and building characteristics, -hypothesized as the two most important factors, is also an attempt to see which of the two have the
most impact. The separation of material cost from labor cost is intended to determine the specificity of the impact of tenant and building factors i.e. whether the effects of either or both factors are more highly correlated with one component.

This study uses ordinary least squares regression technique to examine the extent of the correlation between the independent variables -tenant and building characteristics -and the dependent variable, maintenance cost.

For this study, the regression equation is.

\[ \text{Maintenance costs} = xA + yB + zC + vD + uE + \ldots + K \]

(Where A, B, C, D, E etc represent the different independent variables. e.g. percent minors < 18yr, percent AFDC, percent employed, building age, construction type etc. while x, y, z, v, u etc are the coefficients of these variables. The equation constant, is designated by K.)

This study begins with a background note on the origin and current status of the case study agency: the Boston Housing Authority. Chapter 2 reviews the related literature on certain aspects of public housing policies, management and maintenance; with emphasis on studies that tested the impact of tenant demographics on maintenance costs. Here, a series of arguments are made in defense of the use of alternative models, beyond the traditional tenants characteristics, as a basis for the evaluation of the level of maintenance.
Chapter 3 explains my methodology. It includes a discussion of all the variables used in the multivariate regression analysis.

Chapter 4 presents the results of the multivariate regression analyses. This section uses the findings of other studies to corroborate the results of this study’s analysis.

Chapter 5 summarizes the study’s findings, and conclusions.

BACKGROUND NOTE ON CASE STUDY: BOSTON HOUSING AUTHORITY

The Boston Housing Authority (BHA), is one of the oldest and the fourth largest public housing authority in the U.S. Established in 1935, today it has over 72 federal and state aided developments with close to 18,000 units in its portfolio. The BHA is also involved in the leasing of about 5,500 units under the federal and state leased housing rental assistance programs. In addition, in 1987, the BHA took over from the U.S. Department of Housing and Urban Development (HUD) about 14 buildings located in Boston’s South End neighborhood. These buildings are currently being rehabilitated to serve as low cost cooperative housing units for low income families.

The last 10 years have been trouble for the BHA, and the end is not in sight. In 1980, after fending off for a few years a series of tenant initiated class action suits, the State Superior Court mandated that the agency be placed under
receivership. From 1980 to 1984, the BHA was directed by a court appointed receiver, whose duty it was to direct the day to day operation of the agency on principles enunciated in the court order. Although the receivership ended in fall 1984, the court still retains some jurisdiction with an order requiring the Mayor to exercise direct control over the agency.

While the agency has been able to rectify many of the physical problems thanks to federal and state modernization grants, issues of racism pertaining to tenant assignment are still plaguing the agency to this day. In the last few years, HUD has pressured the BHA, to fully integrate its developments in an attempt to avert future lawsuits by tenants and also to achieve the goal of full desegregation. HUD has accused the BHA of deliberately delaying the pace of that exercise and has consequently threatened to cut off federal funds if adequate and urgent steps aren’t taken to implement a desegregation plan.

A Citizens Housing and Planning Association study, reported that in 1984, the BHA proposed an income mix policy that was designed to give limited priority to families with incomes between 30 and 50 percent of the area median income. The goal was to achieve a balance between the number of families with incomes below 30 percent and those above that threshold. The plan called for the admission of two families above the mark, for every one family below the mark until
numerical parity was achieved. This plan was envisioned for all developments where income distribution was heavily skewed towards the less than 30 percent mark.

A BHA spokesman, in presenting the agency’s position, wrote that "the BHA proposal is based on the belief that the isolation of people who are unemployed and very poor from the life of the larger community is humanly destructive, and tends to perpetuate poverty... To serve [public housing’s] mandate well, it must seek to overcome these barriers to economic integration, without fundamentally abridging its responsibility to the poor..."

It is important to note that income mixing policy was the cornerstone of the 1974 Housing Act, a legacy of the Nixon presidency, designed to help Public Housing Authorities recoup some of the lost revenues due to the low rents charged the predominantly impecunious families residing in public housing, and as such seen as a link in improving maintenance.

In proposing the policy, the Nixon administration used the same arguments in support of income integration; the PHAs were vehemently against this policy, on the grounds that it was contrary to the stated objectives of their mission and possibly discriminatory against the poor and needy. The interesting twist to this, is that the second time around, [with the government as spectator] it was the BHA tenants organization, the coalition for the homeless and numerous civil liberty groups who argued that the program would
implicitly discriminate against the poor and welfare recipients. The BHA eventually withdrew the proposal.
FOOTNOTES


CHAPTER 2
LITERATURE REVIEW

Maintenance cost, general project upkeep and project viability have all proven to be influenced by a number of factors both human and environmental. Studies assessing the variability of maintenance expenses have featured prominently in many public housing publications, and there has been a wide divergence of opinions on the wide range of issues associated with public housing families, maintenance cost and the future direction of public housing program. The government’s continuing desire to design an acceptable funding formula and the need to fully comprehend the nature and scope of the factors that influence the variability of maintenance expenses have fueled the endless quest for more information on this subject.

So far, it isn’t quite clear which category of factors have the most influence on maintenance cost, but most studies have emphasized human factors for obvious social reasons i.e the attitude that the poor and minorities have negative impact on neighborhood. Thus, environmental and physical issues are neglected in the discussion of this subject.

This chapter reviews a broad range of issues in works that have focused on some aspects of public housing operations; highlighting studies of management issues, particularly those that examined the influences of the characteristics of public
housing residents on maintenance costs.

2.1 MANAGEMENT AND EFFICIENT OPERATION

A 1979 HUD report by Kolodny shows that of the 130 large PHAs whose financial status was reviewed in 1978, 35 were found to have operating reserves below 30% of one year’s operating requirements. (1) Among these were nine of the ten largest PHAs, and three of the ten, including the Boston Housing Authority, had no reserve whatsoever and were perpetually in the red. About a quarter of the medium size agencies were unable to meet the 30% requirements. Given these findings, it may be correct to assume that the most serious maintenance problems are most likely to be delayed; often resulting in huge maintenance bills at a later date.

Therefore, depending on the time horizon in question, the degree of responsiveness to maintenance issues or patterns of maintenance repairs of the various PHAs, may very well be as important an impact as tenants demographics or building characteristics in explaining maintenance expenditures in the short term. For an agency that: (a) lacks the requisite funds to support critical maintenance work over a long period of time, and (b) experiences changing occupancy levels, then the burden of blame is may be just as attributable to the state of fiscal affairs as it is to tenants demographics.

The issue of solvency is management related. Therefore, the role of good management in building maintenance can not
be overstated. Numerous studies have shown the relationship between good management and general agency performance.

Kolodny in the same 1979 HUD study observed that so-called nuisance (i.e. anti-social and anti property) behavior, attributed to "problem families" may in fact be related to management perception and its handling of the affairs of PHAs tenants so described, rather than a deliberate act by tenants. Better performance by tenant management boards in the handling of this issue is a testimony to the fact that these boards have a better grasp of the problems and are perhaps more uniquely qualified to address it.(2)

Sadacca et al in "Management Performance in Public Housing" an Urban Institute study, asserts that high performing PHAs, "on the average, not only have higher levels of resident and staff satisfaction and better maintained buildings, but also have significantly lower total operating expenditures." Management practices identified to be highly related to both high performance and lower operating costs were firmness in enforcing rules and responsiveness to tenants needs, both in the provision of adequate tenant services and in staff-resident interpersonal relations.(3)

The often cited finding that residents are more cooperative with management when rules are promptly and strictly enforced, is also echoed in this study by Sadacca and others.(4) Tenants are reported to be satisfied in environments where, as a rule, neighbors are expected to
cooperate in keeping grounds and buildings litter-free, by handling trash and garbage with utmost care, and lowering noise levels. A management that enforces rules that enhance these kinds of conditions, is most likely to inculcate a high sense of civic responsibility in residents.

Several beneficial consequences may be easily attributed to the quick response by management to maintenance requests. For one thing, a quick response ensures that repairs are quickly made and in turn enables the proper functioning of the unit. In addition, this demonstrates genuine concern both for tenants needs and building conditions. "An interest in keeping up the conditions of buildings appears to be contagious." The reverse is also true: a lack of management response to tenants needs is likely to result in tenants' general nonchalance, culminating in lack of interest in building conditions by the residents and fostering further decay and possibly breeding hostility towards buildings and management personnel.

In light of the apparent benefits of management-tenant interaction, one would expect cooperation between tenants and PHAs to be the cornerstone of present day management policy. Unfortunately, this is not the case. There is still considerable disagreement over what level of tenant participation is acceptable or deemed adequate in order to ensure good management.

John Macey, a noted British public housing consultant,
observed in his 1972 HUD sponsored report, that the word "participation" is interpreted differently by various people. While Macey agrees with the widely held opinion that close consultation and cooperation between tenants and management produce a better environment, he seriously discourages consultation that ensures tenant participation in decision making. He argues that, since management foots the bill and is bestowed with the responsibility to preserve public assets, then it behooves management to exercise full control in decision making. This argument, to say the least, is undoubtedly unresponsive to the plight of tenants simply because it does nothing, other than re-echo the very familiar English saying: "He who pays the Piper, calls the tune".

2.2 TENANT DEMOGRAPHICS, MANAGEMENT, COST AND SERVICES

Although opinions on the extent of the impact of tenant composition on management, maintenance costs and services vary, there is consensus on what it takes to operate a successful public housing project: good management and fiscal prudence. This includes the need to accommodate tenants of diverse backgrounds along with an efficient and competent management operation that is highly responsive to the operational needs of the developments.

The research review in this section concentrates on the relationship between tenant characteristics and maintenance costs. I rely primarily on the Citizen Housing and Planning
Association (CHPA) study(6) for two reasons: first, its separation of costs as "social" costs and actual operating (maintenance) costs and secondly, for its elaborate review of the relevant literature on this subject. Many have argued that the most unnoticeable or rather often forgotten impact of tenant management on public housing is the myriad of social services provided by tenant management boards. These often constitute additional overhead expenses by far higher than those incurred by conventional management.

Prominent research studies pertaining to the relationships between tenant characteristics and operating costs in addition to the CHPA study, are those by Frank de Leeux; 1969 Urban Institute report(7), Peter Rydell; 1970 Rand Corporation report (8), George Sternlieb and Bernard Indik’s 1975 study on New York City housing conditions(9) Robert Sadacca et al; 1975 HUD study on the development of prototype equation for public housing operating expenses.(10) The research review on tenant characteristics and social costs focuses on the work of Oscar Newman in Defensible Space, and Factors Influencing Crime and Instability in Urban Housing Departments, Richard Scobie in Problem Tenants in Public Housing: Who, Where, and Why are They, and other HUD reports on problems of public housing residents.(11)

Frank de Leeux in the 1969 Urban Institute study "Operating Costs in Public Housing: A Financial Crisis" observed the effects of local wages and prices,
characteristics of housing stock and tenant characteristics on operating expenses.\(^{12}\) de Leeux’s interest was in seeing what factor(s) most influence changes in PHA’s operating expenses over time. He examined the operating expenditures of about 23 large PHAs for 3 years covering the period between 1965 and 1968.

The variables de Leeux used for tenant characteristics are

- The average number of minors per household (unit)
- The proportion of units receiving some form of public assistance beside social security
- The proportion of units without employed persons
- The proportion of units without a white head of household

de Leeux used multiple regression methods to analyze his data, and he found that wage and price inflation accounted for about 74% of the changes in operating expenses between 1965 and 1968. This change is thus tied to changes in cost of living and interaction with price levels and other factors. Four percent of the change was due to changes in utility cost, 8.7% due to age of housing stock, 4.2% due to the number of units in the PHAs inventory, and 8.6% due to the number of minors and unemployed per unit. Although, there was a significant positive correlation between costs and tenant characteristics, the aggregate effect was minimal because of the relative stability of tenant population during the study period.

The number of minors per unit and number of unemployed per unit were observed to have an impact on costs, but de Leeux argues that colinearity between these variables made it
difficult to establish the extent of each one's impact e.g. the increase in expenses with increase in the number of minors is undoubtedly related to the fact that more minors per unit may mean more rooms per unit. Similarly, since unemployed include elderly persons who often require special services with attendant maintenance problems, costs increases may be due to services provided for elderly persons.

de Leeux, in examining what components of operating cost are influenced most by each variable, found the number of minors to largely affect administrative expenses, routine and total maintenance costs, while the number of non-wage earners also affected administrative and maintenance costs.

He found that price inflation accounted for a greater percentage of change in operating costs over the 3 year period than the number of non-wage earners and the number of minors per unit which were responsible for far less than 10 percent. However, he warns that on a project basis, the age of the development and the number of minors per unit may be crucial.

Peter Rydell's study is important because it is based on a sample of federal developments. Federal projects were used, as is the case with this study, because of the prevalent practice and policy of equal maintenance, a method that ensures standard control over the type of services rendered. Their use in my study is also in part due to the fact that the BHA developed a database with comprehensive
costs and budgetary information on each of the federal developments.

Rydell's study "Factors Affecting Maintenance and Operating Costs in Federal Public Housing Projects" found that between 1939 and 1967 five factors: price inflation, project age, changes in quantity/efficiency of services, project size and average unit size accounted for about 91% of the annual variation in maintenance and operating costs. For the period 1951-1967, the longest for which figures on price inflation was available, Rydell found that price inflation accounted for a 3% increase in expenses per year, deterioration caused 1.1% increase per year, 10% decrease in the average unit size decreased expenses per unit by 4.3% and a 10% increase in project size decreased expenses by 1.0%.

The CHPA study notes that the results of Rydell's study tell little about the effects of tenant characteristics on expenses. The CHPA study argues that the use of average unit size is a proxy for tenant wear and tear due to minors. Thus, the finding that shows costs increase with unit size, is problematic because of the same problems of colinearity as evident in de Leeux's study. It is impossible to arithmetically separate out the effects of average unit size from those of the number of minors.

Rydell's study is a time series analysis spanning several years, designed to trace costs variations over time as well as across projects, hence the finding that price inflation
accounts for almost 60 percent of total change. My study, on the other hand, is a cross-sectional study designed to examine the effects of tenant characteristics and development characteristics on maintenance expense at a specific point in time but I also want to be able to make time series conclusions: as variable X changes, variable Y won’t change.

Since 91 percent of the annual variations in maintenance and operating costs could be explained by the tested variables, the CHPA study argued that the 9 percent unaccounted for were probably attributed to tenant characteristics which were untested in Rydell’s study.

The study of New York City’s welfare tenants by Sternlieb and Indik provides additional evidence for the correlation between tenant characteristics and building conditions.(15) The authors fell short of establishing any causal link between maintenance cost and any of the independent variables, but the study found that as more welfare tenants were admitted in a building, the conditions worsened, even when certain factors were controlled for such as age and experience of landlords, race of tenants, scale of landlords holdings, rent levels, repairs and maintenance costs, rent increases over time, and profitability. This study used private sector welfare housing and did not examine the relationship between maintenance costs and tenant characteristic directly.

This could easily be interpreted to mean that welfare
tenants cost more to house because of the implied correlation between the number of welfare tenants and building conditions, given that certain likely intervening variables were controlled. The author cautioned that it is also likely that buildings that accept welfare tenants are those whose conditions have deteriorated and whose landlords are simply nonchalant about repairs. Using the performance concept—an idea that evaluates the degree of responsiveness of building design to user needs, it could also be argued that these buildings were not designed to cater for the housing needs of this type of tenants.

In 1974, the Urban Institute developed a performance funding system prototype equation using as variables the number of children per adult, the percent minority, average household income, and the percent of families receiving assistance.(16) The use of these variables was later dropped for fear that they could easily be manipulated by the PHAs in the sense that admission policy could be pursued in a manner favorable to families with characteristics known to be negatively correlated with maintenance costs. But the PHAs were not likely to do this because housing rental subsidy was allocated based on tenant composition.

In 1982, Abt Associates of Cambridge, MA. proposed a revision to the prototype expenses equation by advocating the use of three tenant characteristic variables: percent elderly, average tenant income, and percent minority, along
with a number of neighborhood variables derived from census data e.g. percent below poverty line and percent on welfare.\(^{(17)}\) Its data set was based on a sample of randomly selected public housing projects nationwide. Initially, each of these variable was thought to be positively correlated to expenses, but the introduction of allowable expense level by HUD meant that total expenses would partially be a function of allowable expense level.

As expected, percent elderly was shown to have a negative correlation with expenses while both percent minority and average tenant income were positively correlated. The inclusion of percent minority as a variable was intended to serve as a proxy for other missing variables describing household composition or inner city environments. It is questionable if use of percent minority is adequate to evaluate the influence of these missing variables, particularly the behavior of other minority groups whose lifestyles are incongruent with those of the stereotypical minority.

The Abt Associates proposal also observes that the percent of neighborhood residents on welfare is positively correlated with costs, while the percent below poverty is, surprisingly, negatively correlated with costs. Generally, the lack of adequate data on tenant and building characteristics makes it difficult for the Abt equation to accurately predict costs.\(^{(18)}\)
A discussion of the CHPA study is important for a number of reasons. Most importantly it makes a distinction between social costs and maintenance costs and makes references to available literature to support this viewpoint. Social cost refers to the social burden of tenant characteristics or behavior. There are a handful of studies that have shown the correlation between the so-called social costs i.e. crime, isolation, problem families etc and tenant characteristics.

The work of Oscar Newman in "Defensible Space" stands out as the pioneering attempt to examine the relationship between certain tenant characteristics and social costs in his case the crime rate. The focus of Newman's study was on the link between building design and tenant characteristics. Newman hypothesized that building design was instrumental in determining whether or not some kind of criminal activity occurs. Newman was able to demonstrate, using regression analysis, that the percent of families receiving AFDC was the most important predictor of crime while the second most important predictors were building height, and the percent of families headed by women.

In a different study, "Factors Influencing Crime and Instability in Urban Housing Developments", Newman wanted to show which characteristics of federally assisted family developments attracted the most crime and accounted for community instability and fear of crime. He based his study on a sample consisting of 63 HUD 236 and 221(d)(3) housing
developments in California. Investigating the following independent variables: building size, accessibility, low income/AFDC, teen-adult ratio, cooperative ownership, police service and guard service, he concluded that the percent of low-income/AFDC household was the most important predictor of crime, fear and instability. He advanced the notion that a 10% increase in low-income/AFDC household resulted in 12 more personal crimes per 1000 individuals. Newman argued that the percent of teen-adult ratio was the second most important predictor of crime and burglary in the developments.

The major flaw of Newman’s study was the lack of control for the effects of the neighborhood. It is common knowledge that most public housing developments in large urban areas are often located in decayed, crime infested neighborhoods. He also argued that the increase in percent of low-income/AFDC households in a community, like large buildings, discouraged residents from expanding the territory of their homes (units) beyond the exterior walls and the consequences were serious crimes, burglaries and heightened fear of crime. The relationship between lack of extension beyond the "realm of a unit" and crime is doubtful unless the unit is insecure in the first place, but the lack of interest in such an extension is perhaps related to fear of crime.

A study with a different kind of focus but which used some of the same housing projects as the current study is by Richard Scobie. His work focused on the influence of problem
families in four of Boston's public housing developments. Scobie found that the incidence of problem tenants, which he defined as socially disruptive tenants, was relatively minimal—less than 5 percent, and that 'problems' were only minimally linked to 'problem families' though concentrated in female headed households and, to a lesser degree, in large households. This finding is substantiated by the CHPA study and others. However, Scobie cautions that the small nature of the sample makes generalization of the results difficult.

Another study which examined the issue of tenant demographics and social costs was the 1979 HUD study Problems Affecting Low-Rent Public Housing Projects. This study focused on the general perception of tenant populations in developments that are considered "troubled". This interview study was based on the responses of HUD field staff, project managers, tenant and legal service lawyers, public officials and public housing experts.

The study found that 40 percent of each group of professionals agreed that certain kinds of tenant characteristics and behavior can seriously affect public housing, but only 28 percent of public housing executives agreed with this view. The three important observations made in the study were that (a) the higher proportion of single parent and welfare families may be a significant factor in the financial difficulties of the authorities because the
incomes of these tenants don’t warrant more than a minimum rent charge, (b) the large number of unsupervised children often results in a small but significant amount of criminal and otherwise anti-social behavior, and (c) tenant related problem may be the result of inadequate management rather than the result of any particular tenant characteristic.(22) A major study, which examines the impact of tenant characteristics on social costs and maintenance costs, is that by Citizen Housing and Planning Association (CHPA). The CHPA research presents an elaborate treatment of this issue through the use of mini case studies of developments operated by five large urban PHAs in Boston, New York, Cleveland, San Antonio and Norfolk. The sample selection was based on the similarities in development characteristics, urban socio-economic conditions and availability of historic project level data. Three developments were selected from each PHA, except for New York where the study involved 84 developments. The study on all PHAs but the New York one, involved only cost analysis without statistical test of the correlation between costs and tenant characteristics. The result of the New York case study is very significant in two respect: the size of the sample and the use of multivariate regression analysis.

The findings in the New York case indicated a positive correlation between costs and both the percent minors and the percent of single parent families on welfare with
The high colinearity between these two variables makes it impossible to decipher the effects of percent minors from those of single parent families on welfare with children.

In the mini case studies on other PHAs, it was observed that there was a clear consistent relationship between costs and tenant characteristics. Higher costs were often associated with welfare residents, single parent households and income level. In San Antonio, it was found that lower costs was associated with higher proportion of working families. However, the costs differences between developments under the same PHA were marginal. The New York case shows that large PHAs entertain a lot of fixed costs independent of tenant characteristics. Cost increases between 1973 and 1983 were due mainly to price inflation.

In conclusion, all of the studies irrespective of research methods, showed some indication of close correlation or relationships of tenant demographics with costs but each fell short of suggesting a causal link. This is understandable in view of the interdependence of most of the independent variables.

While one couldn't guarantee that the current study would achieve what others couldn't, it was hoped that the new direction of this study, (examination of the impact of independent variables on each component of maintenance cost) would at least define the nature of the problem and that more
would be learned about the problem through this research effort.
FOOTNOTES


2. Ibid, page 68


4. Ibid, page 45


28
Washington, HUD Report. 1979

12. Frank de Leeux, Operating Costs in Public Housing: A 

13. Peter Rydell, Factors Affecting Maintenance and Operating 
Costs in Federal Public Housing Projects. Washington, 
The Rand Institute. December, 1970

14. Tenancy and Costs in Public Housing –Policies, Attitudes 
February 13, 1985. page 113

15. George Sternlieb and Bernard Indik, The Ecology of 
Welfare: Welfare and the Housing Crisis in New York. New 
York, 1975

16. Robert Sadacca et al. The Development of a Prototype 
Equation For Public Housing Operating Expenses. 

17. Tenancy and Costs in Public Housing –Policies, Attitudes 
February 13, 1985. page 115

18. Ibid, page 116

19. Oscar Newman, Defensible Space. n.d

20. Oscar Newman, Factors Influencing Crime and Instability 
In Urban Housing Developments. Washington, HUD 1968

21. Richard Scobie, Problem Tenants in Public Housing: Who, 
Washington, HUD Report, 1979

February 13, 1985. page 267

24. Ibid, page 256
CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

The main thrust of this inquiry is to estimate the effect that tenant demographics and building physical characteristics have on maintenance costs in public housing developments and to identify which factors exert the most influence on maintenance costs.

Previous studies have either concentrated on the impact of tenant characteristics per se with perhaps only a partial treatment of the building environment or dealt exclusively on one. The emphasis is often on tenant characteristics for the simple reason that many people link the problems of public housing with tenant types. In other words, the choice of variables reflects the predetermined school of thought of the investigator.

Most previous studies (unlike my study), especially those by HUD and the Urban Institute, have used samples drawn from the large public housing authorities across the country rather than focusing on specific authorities. Studies of this type cannot give due attention to peculiar local problems. While it is not possible to make nationwide generalizations based on a local study, the advantages of such a study are numerous. An authority-based study makes it possible to fully examine the influence of other variables,
i.e. building environment, peculiar socio-economic conditions etc., and allows for a thorough understanding of the peculiar problems by putting them in proper historical context.

This study focuses on the Boston Housing Authority. Previous studies of maintenance related issues in the BHA, including the CHPA study, have often involved the use of very small samples, typically three to five developments. The 49 developments selected for this study represent the population of federally assisted public housing developments operated by the BHA.

A new data collection system, funded by the Public Housing Urban Initiative Program in the 1970's, now makes it possible to disaggregate data to the project level. This has made it possible for the first time to observe the influence of many environmentally induced factors and the variability in type and scope of such factors across developments. Moreover, project level data are more reflective of precise line item costs, which are lost sight of when data are aggregated to the authority level.

For the purpose of this study, I have excluded from maintenance costs those costs that are not directly related to the maintenance of the developments. Therefore, administrative expenses, consultant fees and utility costs are not included in the cost component of the study.
3.2 CASES

I chose to restrict my study to the 53 federally assisted housing developments operated by the BHA because of the ready availability and the highly organized nature of the data for these projects. Federal developments also present an additional advantage because of the near even mix of the different development types i.e family/elderly, high rise/low rise, etc. A focus on federal projects is also beneficial because of HUD's policy requiring approved funds to be spent only on the development to which they are allocated. This policy may ensure evenness in the maintenance of buildings, thus reducing the effect of incomparable building conditions, a likely source of error in studies that inadequately control for such situations.

However, there was inadequate data on the three developments that are privately managed by the Tenant Management Corporation (TMC) and on one that is vacant due to its designation for major rehabilitation. This reduced the number of cases to 49 and eliminated 3 cases from the list of 11 privately managed developments; possibly weakening the ability to adequately test the management type variable.

The data are available because of the HUD mandate that the BHA must prepare yearly funding requests based on these variables, which made the collection and documentation of data on all aspects of the operation of federal developments necessary. HUD’s Comprehensive Improvement Assistance
Program (CIAP) required the BHA and other PHAs to prepare a database for capital improvement needs. This led to the commissioning of a series of studies with management and maintenance implications. The product of these efforts was an avalanche of information that could support a wide variety of housing research.

3.2 DATA COLLECTION

The Management Information Systems (MIS) Unit of the BHA prepares quarterly tenant status reports (TSR) of tenant demographics for all the developments. For my study, the data on tenant demographics were drawn from the September 1987 TSR. The data on maintenance expenses were extracted from the ledgers prepared by the Fiscal Affairs Division for fiscal years 1984, 1985 and 1986. (The BHA’s fiscal year is from April 1 to March 31.)

I had to reorganize and redesign some of the data to suit the purpose of this study. For example, the means for all group data have been estimated from the grouped data rather than trying to get back to actual raw data. In the case of maintenance cost data, attempts were made to eliminate certain line items such as utility costs, administrative costs, consultants fees and major roof repairs costs because of the discrepancies that these items might create.
3.3 SELECTION OF VARIABLES

The guiding principle for variable selection suggests the use of variables that featured prominently in previous studies of this kind, with the addition of others that might explain observations that the conventional models have been unable to explain. Previous studies have used some form of household or family income, number of minors, race and employment as tenant variables. Some of the variables e.g. percent of families receiving AFDC, and percent female head of household were included to see whether the findings of some earlier studies, like Oscar Newman's claims that an increase in the number of low-income/AFDC increases crime and other tenant related problems i.e. vandalism, would be confirmed here. Building specific characteristics were chosen to test the case made in the literature for the application of building performance concepts in the explanation of (a) variability in maintenance costs and (b) the joint influence of building and tenant characteristics.

3.4 DEFINITION OF VARIABLES

Although maintenance cost is the dependent variable in this study, there are several components to it: labor costs, materials costs and external contract costs. These component costs were also used in addition to maintenance cost as dependent variables in some models. This was done to test if there are any specific correlation between each component
cost and the independent variables. These three components of maintenance costs reflect the way disaggregated data on maintenance have been compiled by the BHA since the early 1980's.

The analysis uses two broad groups of independent variables to describe each of the 49 housing projects. The variables and how I have operationalized their measurement are as follows:

Tenant Characteristics
* Family size - mean number of persons per unit.
* Minors - percent of persons 18 yrs. and below.
* Race - percent non white
* Age of head of household - percent of heads 29 yrs. and below.
* Income of head of household - percent of household heads with income below $7999
* Persons gainfully employed - percent of adults employed
* Rent - percent of households paying rents below $101 per month
* AFDC - percent of families receiving AFDC

Building Characteristics
* Age of development - years
* Construction type - brick/concrete masonry unit or wood
* Building engineering systems - steam lines or not
* Management type - public or private
* Vacancy - percent of units vacant
* Number of buildings - number of buildings per development
* Development height - mean height of buildings in a project.
  (Ideally measured as percent of units above certain height in feet or stories but information not available to make this possible).
* Number of units - number of units per development
* Development type - family or elderly development

The following is a more detailed description of how each of the variables listed above is defined and measured.

**Family size**

This is a measure of the number of persons per unit. This variable is calculated by dividing the total persons in each development by the number of occupied units. I expect that an increase in family size would result in an increase in maintenance cost and vice versa i.e a positive relationship because large size families especially those comprising mostly teenagers are most likely to impact more on maintenance expenses.

**Minors**

This variable is measured by the percent of persons 18 yrs and below, excluding those within this age group that are heads of households. Typically, there are no more than 3
heads of households 18 years and below in any one project. The notion underlining the use of this variable is that one expects a priori that an increase in the relative population of minors would lead to an increase in maintenance cost - positive relationship. This assumption is based on the theory that large minor population and uncontrolled minors heavily impact on maintenance cost.

Race

This variable is measured by the percent of persons in each development that identified themselves to be non white in the survey used for the BHA tenant status reports. One is unclear as to what the exact relationship is because arguments could be constructed both ways. An increase in percent non white could result in a decrease in maintenance cost -negative relationship because the existence of certain extraneous factors such as community social cohesion, made possible by active tenant participation, leaves little room for anti-social behavior. Also, an increase in this variable may result in an increase in maintenance cost -positive relationship because certain characteristics of non white tenants heavily impact on maintenance cost. Therefore, this variable is considered as ambiguous.
Age of head of household/family

In the BHA's records the terms household and family are used interchangeably; thus, it's assumed that all persons living in an apartment unit constitute a household or family. I measured this variable as the percent of heads of households or families 29 years of age and below.

The hypothesis underlining its use is that one would expect, a priori, that maintenance would increase with an increase in percent of heads of households below 29 years of age. This assumption is based on the theory that young parents have problem controlling their kids. Therefore, the relationship is positive.

Income of head of household

This variable is the percent of heads of household that earned less than $7999 in the previous year. The underlying hypothesis here is that one expects, a priori, that as the percent of those with incomes below $7999 increases, maintenance cost is going to increase because many argue that low income families are often larger and are most likely to display anti-social behavior and values that impact on maintenance expenses-direct (positive) relationship.

Percent of persons gainfully employed

This variable represents the percent of all persons in each development that are either employed full time or part
time. It's expected, a priori, that the percent of persons gainfully employed will be indirectly (negatively) correlated with maintenance cost because social responsibility comes with employment therefore less anti-social activities such as vandalism is expected. Also, the fact that employed persons spend less time at home means that there is less human activities that would have made more impact on maintenance cost than otherwise.

Rent

A sizable majority of tenants in every development pay more than $101 per month as rent. This amount is used as a cut off point because the BHA data are grouped in that manner. This variable calculates the percent of tenants that pay less than $101 per month in each of the developments. Depending on the allocation formula currently in use by HUD, developments with predominantly low-income tenants may affect maintenance in terms of the percentage of operating expenses that is borne by the BHA.

It's expected, a priori, that this variable has a positive correlation with maintenance cost because low rent paying households are more expensive to house because of their special attributes i.e large size and anti-social behavior. Also, the agency needs extra revenue without which maintenance would suffer.
AFDC

This variable is measured as the percent of all adults with some form of income that are recipients of government aid to families with dependent children. It's expected that increase in the percent of families receiving AFDC would result in an increase in maintenance cost because the characteristics (size, low income and unemployment) of this type of household seriously impact on maintenance cost - positive relationship.

Age of development

The age of each development is measured as the number of years since it was constructed. The notion is that the older the development the higher the expected maintenance costs. Therefore, this variable is expected to be positively correlated with maintenance cost.

Construction type

This dummy variable represents the construction type i.e. brick/concrete/masonry or wood. The value 1 is ascribed to brick while wood gets 0. It's anticipated that lower maintenance expenses will be associated with brick type construction because it's more durable. Therefore, an indirect (negative) correlation is expected here.
Building engineering systems

This dummy variable represents the kind of development wide heating systems by indicating whether or not steam lines are used in the projects. The presence of a project-wide steam system gets 1 and its absence gets a 0. It's expected a priori that this variable should be positively correlated to maintenance cost because operation and maintenance of steam lines is more expensive.

Management type

This is a dummy variable that represents the management system: public or private. The value 1 is ascribed to publicly (BHA) managed developments while 0 is given to those managed by private agencies. The intention here is to test for causal relationship between management type and maintenance costs. The general notion is to test if privately managed developments are more efficient and cost effective. It has been argued that a change from public to private (a decrease in the dummy variable) would result in a decrease in maintenance expenses because privately managed development are cheaper to operate and maintain. Therefore, a positive relationship is expected.

Vacancy

This variable is the percentage of units currently vacant. The a priori expectation for this variable is ambiguous
because arguments could be constructed both ways. It could be argued that high vacancy rate results in high maintenance cost because of either the exposure of vacant units to vandalism or preparation costs prior to occupancy or both. To the contrary, high vacancy rate may result in low maintenance cost because vacant units cost little or nothing to maintain.

**Number of buildings**

The variable is the number of buildings in the development. This variable might prove crucial for a number of reasons. The fact that very large developments are, by and large, a community in their own right, might help explain some other factors that aren’t readily apparent. For example, large developments require community type services such as security equipment and devices, recreational facilities, etc which create additional operational and maintenance overhead. Therefore, I expect maintenance cost to increase with increase in the number of buildings - positive relationship.

**Development/building height**

Ideally, the best measure for this variable would be the percent of units above a certain height in feet or stories or, alternatively, the percent of units serviced by elevators. This approach measures the number of units whose
maintenance cost are affected by their vertical location in the development. However, it wasn’t possible to get this kind of information from available data. Therefore, I measured the height of buildings in feet. For developments with variations in height between buildings, the mean height per project is used. I expect that maintenance costs will be positively related to height because the general assumption is that taller buildings are more expensive to operate and maintain.

Development type

This dummy variable ascribes a value of 1 to elderly developments and 0 to family developments. A majority of the developments in the 'sample' are family developments. Family developments are often the oldest, biggest and probably the most problematic. It has been argued that a change from elderly to family (a decrease in the dummy variable) would result in an increase in maintenance expenses because elderly projects are cheaper to operate and maintain. The a priori expectation is that maintenance cost will be indirectly (negatively) related to this variable.

Number of units

This variable is simply the number of units in the development. The expected relationship for this variable is ambiguous. It could be argued that this variable will be
negatively correlated to maintenance cost per unit because of the likely impact of economies of scale in maintenance operations but alternatively it could be argued that the number of units is directly correlated with maintenance cost because savings due to economies of scale often do not apply to exterior repairs such as brick repointing and site work.

3.5 LINEAR REGRESSION MODELS

Although this study is a cross-sectional study using data at a specific point in time, the value for the dependent variable (the maintenance costs) is calculated as the average cost per unit in constant dollars for each project spanning a 3 year period. It is important to do this to avoid the problems of autocorrelation, a situation in which the variable is correlated with itself. For instance, the amount expended on maintenance this year depends on maintenance expenses in the previous years.

Maintenance cost is arguably a function of many different variables. My paramount concern in this analysis is to measure the extent to which maintenance cost responds to these tenant and building variables. Using multiple regression analysis, the simultaneous responsiveness of maintenance costs to these variables can be tested. Moreover the responsiveness of labor cost and material cost to each type of variable will also be identified and assessed.

The literature review suggests that percent AFDC, percent
employed, mean family size, percent minors and percent heads of households prove to be the most important variables in explaining the variability in maintenance costs. In other words, I expect that tenant variables will be more important than building characteristics.

Theoretical framework for these models is predicated on the assumption that the set of 17 selected independent variables (listed in sec. 3.4) explains the variability in maintenance expenses of the 49 cases. As a first step, all the independent variables are organized into three all inclusive models with total maintenance cost, material/contract cost and labor cost as the dependent variables. The next step involves the testing of several reduced models for each type of dependent variable. This is done to remove colinearity and to see whether a simpler model still has significant explanatory ability. Some of the smaller models are organized to specifically test the impact of tenant and building variables.

The correlation between each independent variable and the dependent variable is easily assessed with the use of correlation matrices. Three sets of correlation matrices will be constructed for total maintenance cost, material/contract cost and labor cost. Also, a cross correlation matrix is used to assess the level of colinearity among all the independent variables. These matrices will give the first indication of the direction and level of the
The reliability of any regression model can be judged by the value of its $R^2$ statistic. The relative strength and direction of the relationship between each independent variable and the dependent variable can be assessed by the value and sign of its standardized regression coefficient, so I report these in addition to the unstandardized regression coefficients that one is more accustomed to seeing.
CHAPTER 4
REGRESSION RESULTS

4.1 ANALYSIS OF THE LINK BETWEEN TENANT AND BUILDING CHARACTERISTICS AND MAINTENANCE EXPENSES

As a first step in understanding the relationships between maintenance costs and all the independent variables -tenant demographics and building characteristics- consider the correlation matrix depicting the link between maintenance costs and each of the independent variables in table 4.1.

Looking at the correlation matrix of total maintenance cost with all the independent variables, one would expect, a priori, that the correlation coefficients for most of the independent variables will be high enough as to explain the observed variations in maintenance cost across developments, i.e. their influence will be very obvious. In light of what's known from previous works, it's also expected that tenant variables will have higher values.

Generally, the observed values are sufficiently high to establish significant levels of correlation between the independent variables and maintenance cost. The correlation coefficients (r) of tenant variables are clearly higher than those of building variables, indicating that maintenance costs across projects are more responsive to changes in tenant variables.

The signs for most variables turned out as expected but to my surprise, there are three variables whose signs are the
Table 4.1: Correlation Matrices--Total Maintenance Cost With Independent Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Maint. Cost</th>
<th>Expected Sign</th>
<th>Variable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Family Size</td>
<td>+.70</td>
<td>Positive</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent Non white</td>
<td>+.45</td>
<td>Ambiguous</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent AFDC</td>
<td>+.85</td>
<td>Positive</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent Employed</td>
<td>+.74</td>
<td>Negative</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent Rent Below $101.00</td>
<td>+.20</td>
<td>Positive</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent income Below $17999</td>
<td>+.33</td>
<td>Positive</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent Head of Household Below 29yr.</td>
<td>+.71</td>
<td>Positive</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent of Minors Below 18yr.</td>
<td>+.81</td>
<td>Positive</td>
<td>Tenant</td>
</tr>
<tr>
<td>Percent Vacancy</td>
<td>+.22</td>
<td>Ambiguous</td>
<td>Building</td>
</tr>
<tr>
<td>Construction Type</td>
<td>+.13</td>
<td>Negative</td>
<td>Building</td>
</tr>
<tr>
<td>Building Age</td>
<td>+.59</td>
<td>Positive</td>
<td>Building</td>
</tr>
<tr>
<td>Management Type</td>
<td>-.12</td>
<td>Positive</td>
<td>Building</td>
</tr>
<tr>
<td>Number of Buildings</td>
<td>+.47</td>
<td>Positive</td>
<td>Building</td>
</tr>
<tr>
<td>Building Systems</td>
<td>+.53</td>
<td>Positive</td>
<td>Building</td>
</tr>
<tr>
<td>Development Type</td>
<td>-.78</td>
<td>Negative</td>
<td>Building</td>
</tr>
<tr>
<td>Building Height</td>
<td>-.21</td>
<td>Positive</td>
<td>Building</td>
</tr>
<tr>
<td>Number of units</td>
<td>+.40</td>
<td>Ambiguous</td>
<td>Building</td>
</tr>
</tbody>
</table>
opposite of what was expected when looked at in this simple bivariate sense. I expected that the percent employed and construction type would both have negative signs but both turned out to be positive. The variable management type was expected to be positive but it turned out to be negative.

Table 4.1 gives the first indication of what signs to expect but the direction of the relationships as shown may only be true in the a bivariate sense. Thus, signs might change a number of times between models either to confirm or disclaim the a priori expectations, as a variety of other variables are controlled for in the various models. The variables with the highest correlation coefficients are percent AFDC (.85), percent minors (.81), development type (-.78), percent employed (.74), percent heads of households (.71), and Mean family size (.70). All these variables except development type are tenant variables.

4.2 MULTIVARIATE MODEL--TENANT VARIABLES

Most of the popular literature on this subject subscribe to the notion that tenant variables exert the most influence on maintenance costs in public housing developments. Most studies have identified percent minors, percent AFDC, percent employed, age of heads of households, female heads of households and percent income among others as the most prominent influence. My obvious response was to test first the exact influence of tenant variables including some of the
### Table 4.2: Multivariate Regression Model--Total Maintenance Cost With Tenant Variables

#### Raw Variables and Raw coefficients

Total Maint. Cost = $144.0 + ($0.06 \times \% \text{Non white}) + ($3.64 \times \% \text{AFDC}) + (-0.60 \times \% \text{Rent}) + ($0.00 \times \% \text{Income})

#### Standardized Variables and Standardized Regression Coefficients

Total Maint. Cost = 0.00 + (0.15 \times \% \text{Non white}) + (1.22 \times \% \text{AFDC}) + (-0.02 \times \% \text{Rent}) + (0.09 \times \% \text{Income})

\[
\begin{align*}
R^2 &= 0.73
\end{align*}
\]
ones listed above, on maintenance cost.

Table 4.2 reports the regression results using only tenant variables. The standardized regression coefficients for almost all the variables except percent AFDC are unexpectedly low though \( R^2 \) statistic is very high. Particularly surprising, are values for percent non white and percent income. Although the signs for both are as expected, the low standardized regression coefficients indicate low to mild influences on maintenance cost. A 1.0 standard deviation change in each of the variables percent non white and percent income results in a .15 and .09 standard deviation change respectively in maintenance cost. The relative influences of each of these variables can be compared to that of percent AFDC, whose influence as expected is far more profound. A 1.0 standard deviation change in percent AFDC results in a whopping 1.22 standard deviation change in maintenance cost.

The relative influence of percent non white is particularly worth noting. Most studies have shown this variable to exert profound influence on maintenance cost; whereas here, its impact is mild (.15) though in another model its effect is modest (.43). Also, the value and sign of the regression coefficients of percent rent are contrary to expectations. It was expected, a priori, that percent rent would be positively correlated, and also make pronounced influence on maintenance cost but it turned out that the relationship was indirect and minor. The low coefficient
(-.02), may simply show that rent has a minimal influence on maintenance cost independent of the other variables. This shouldn’t be too surprising because the BHA receives rent subsidies from the federal government to augment the low rents paid by many tenants.

4.3 MULTIVARIATE MODEL--BUILDING VARIABLES

The influence of building characteristics on maintenance cost has often been down played in favor of tenant demographics. Although there is ample evidence that tenant variables exert overwhelming influence on maintenance cost, it’s been established that some building variables also have profound influence on maintenance cost.

Table 4.3 reports the regression results of the best regression model using only building characteristics as independent variables. The signs and values of some of the standardized regression coefficients are definitely surprising. The a priori expectation for vacancy rate was ambiguous because a reasonable theory could be constructed both ways. Although the sign for vacancy rate was shown to be positive in the correlation matrix (table 4.1) it becomes negative when controlling for other variables in table 4.3; the low regression coefficient of -.07 almost makes the sign irrelevant since its influence on maintenance cost is barely noticeable. The coefficients of the variables construction type and building systems are relatively higher than those of
Table 4.3: Multivariate Regression Model—Total Maintenance Cost With Building Variables

Raw Variables and Raw Coefficients

Maint. Cost = $211.8 + ( -$.30 x % Vacancy) + ( $22.7 x Const. Type) + ( -$19.1 x Mgmt Type) + ( $21.4 x Bldg Syst.)
+ ( -$96.0 x Development Type)

Standardized Variables and Standardized Regression Coefficients

Total Maint. Cost = 0.00 + ( -0.07 x % Vacancy) + ( .16 x Const. Type) + ( -0.01 x Mgmt Type) + ( .21 x Bldg Syst.)
+ ( -1.1 x Development Type)

$R = .65$
vacancy rate and management type but the positive sign of construction type is contrary to what was expected.

The sign and value of the variable development type are important because the sign agrees with the correlation matrix and the a priori expectation. A 1.0 standard deviation change (increase) in development type results in a decrease of 1.13 standard deviation maintenance cost, while a 1.0 standard deviation change in each of percent vacancy and management type result in .07 and .01 changes in maintenance cost. In this model development type has the most influence on maintenance cost.

One important objective of this study is to compare the relative impact of tenant variables and building variables in order to establish which variable type exert the most influence on maintenance cost. Tables 4.2 and 4.3 summarize the best regression results indicating the relative impact of tenant and building variables respectively. The R² statistic for the tenant model is higher than the building models. The R² statistic for the tenant models ranged from .59 in the worst model to .73 in the best model (table 4.2), while those for the building models ranged from .28 in the worst model to .65 in the best model (table 4.3). Although, the R² statistic is high in most models, the coefficients for most of the variables, as previously shown, are surprisingly low i.e. indicative of very mild influence. Comparing the relative impact of each variable in each of the tenant and
building model, it's apparent that tenant variables exert more influence.

4.4 MULTIVARIATE MODEL--ALL INDEPENDENT VARIABLES

Having tested tenant and building variables separately, now let's see what happens when all variables are combined in a single model. Table 4.4 reports the regression results of a model using all 17 independent variables. Here, the values for the coefficients for most of the variables are particularly unimpressive. Of course, this is expected in part because of the increase in the number of variables—as the number of variables goes up, standardized regression coefficients will go down.

Using a cut-off point of ±.30 for the coefficients, 9 variables fall below this level, while 8 variables fall above. The interesting thing is that of the 8 variables that are above the point, five are building variables while three are tenant variables. One would expect the pattern to be the other way around given the prominence of tenant variables in the models tested so far. However, two of the tenant variables—percent minors (1.0) and percent AFDC (.96) still have the two highest coefficients.

Generally, the signs for the coefficients came out as expected except for a few such as percent employed, development type and construction type which are positive but expected to be negative. Also, percent income and percent
Table 4.4: Multivariate Regression Model--Total Maintenance Cost With All Independent Variables

<table>
<thead>
<tr>
<th>Raw Variables With Raw Coefficients</th>
<th>Standardized Variables and Standardized Regression Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Maint. Cost = $29.5 + (14.8 x Family Size) + (0.02 x % Non White) + (2.91 x % AFDC) + (0.97 x % Employed) + (1.46 x % Rent) + (-0.29 x % Vacancy) + (43.9 x Const. Type) + (2.39 x Bldg Age) + (8.80 x Mgmt Type) + (1.86 x # of Bldg) + (5.26 x Bldg Syst.) + (14.1 x Dev. Type) + (0.08 x Bldg Ht.) + (-0.00 x % Income) + (-0.10 x # of Units) + (-0.80 x % Heads of Household &lt;29yr.) + (0.35 x % Minors below 18yr.)</td>
<td>Total Maint. Cost = 0.0 + (0.23 x Family size) + (0.03 x % Non White) + (0.96 x %AFDC) + (0.13 x % Employed) + (0.16 x % Rent) + (-0.12 x % Vacancy) + (0.38 x Constr.Type) + (0.52 x Bldg Age) + (0.005 x Mgmt Type) + (0.48 x # of Bldgs) + (0.11 x Bldg Sys.) + (0.87 x Dev. Type) + (0.14 x Bldg Ht.) + (-0.01 x % Income) + (-0.56 x # of Units) + (-0.51 x % Heads of Household &lt;29yr.) + (1.0 x # of Minors &lt;18yr.)</td>
</tr>
</tbody>
</table>

2

\( R = .80 \)
heads of households turned out negative but was expected to be positive. The negative signs of development type and construction type may suggest that maintenance operations in elderly and brick/masonry developments are expensive. The likely explanation for this may be any or all of the following features associated with both types of projects. There are about five elderly projects which house a few families with minors and this attracts additional costs. Also, almost all elderly projects are elevator accessed high rises often equipped with special handicap accessories. Whereas all elevator work is contracted out by the BHA, it is more costly and tends to distort the total maintenance expenses. Although exterior surface work such as brick repointing is infrequent, the costs for such repairs are huge.

The signs and values of the coefficients are difficult to predict in this model because (a) signs are likely to change between models depending on the number of variables in use and (b) the ordinary least squares (OLS) regression estimation method is unable to fully measure the combined effect of all the variables in the model when problems of multicolinearity exist. In light of this, one cannot conclude that building variables exert more influence on maintenance cost than tenant variables in this model.

Problems of multicolinearity exist when the independent variables are highly correlated with one another. The
variation in all the regressors could be classified into two types: variation unique to each regressor and variation common to regressors. In calculating the coefficient of each regressor, the OLS method uses the variation unique to each regressor and ignores the variations common to all regressors. When regressors are highly correlated (multicolinearity), most of the variations are common to all the variables leaving little variation unique to each. Thus, the OLS method is unable to measure the combined variations of all the regressors. The outcome is that the coefficients do not show the true variation of each regressor in this model.

The problems of multicolinearity underscore the need to isolate regressors that are highly correlated by dropping them from a reduced model that estimates the variation unique to each regressor. One way to overcome the problems of multicolinearity is to identify variables that are highly correlated through the use of cross correlation matrix. The analysis below explains how this was achieved.

4.5 ANALYSIS OF THE CROSS CORRELATION BETWEEN ALL INDEPENDENT VARIABLES

The ability of the OLS estimation method to adequately estimate the coefficients of the independent variables could be considerably enhanced by minimizing the problems of multicolinearity. By so doing, an attempt is made to eliminate the need to measure the independent variables'
Table 4.5: Cross Correlation Matrix—All Independent Variables

<table>
<thead>
<tr>
<th>Tenant Variables</th>
<th>Percent</th>
<th>Percent</th>
<th>Percent</th>
<th>Percent</th>
<th>Percent Heads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family Size</td>
<td>.76 % AFDC</td>
<td>.77 Family Size</td>
<td>.89 Dev. Type</td>
<td>.66 Bldg Age</td>
<td>.79 % Minor</td>
</tr>
<tr>
<td>% Minors &lt;18yr.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% AFDC</td>
<td>.79 % Employed</td>
<td>.94 % AFDC</td>
<td>.81 % Heads</td>
<td>.66 # of Bldg</td>
<td>.81 % AFDC</td>
</tr>
<tr>
<td>% Employed</td>
<td>-.76 Dev. Type</td>
<td>.85 % Employed</td>
<td>.94 % Minor</td>
<td>.93 Dev. Type</td>
<td>.76 % Employed</td>
</tr>
<tr>
<td>% Income</td>
<td>.74 % Income</td>
<td>.62 Bldg Age</td>
<td>.81 % Employed</td>
<td>.63 % Income</td>
<td>.65 Bldg Age</td>
</tr>
<tr>
<td>% Minors</td>
<td>-.79 Dev. Type</td>
<td>.79 % Heads</td>
<td>.76 % Heads</td>
<td>.85 % Minors</td>
<td>.96 Dev. Type</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent Heads of Households</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Building Variables</th>
<th>Number of Units</th>
<th>Number of Buildings</th>
<th>Building Systems</th>
<th>Development Type</th>
<th>Building Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Units</td>
<td>.71 % Heads</td>
<td>.67 Dev. Type</td>
<td>.60 # of Units</td>
<td>.79 # of Units</td>
<td>.70 # of Bldg</td>
</tr>
<tr>
<td>% Heads</td>
<td>.60 Bldg Syst.</td>
<td>.77 % Heads</td>
<td>.65 % Heads</td>
<td>.96 % Heads</td>
<td>.81 Bldg Syst.</td>
</tr>
<tr>
<td># of Bldgs</td>
<td>.85 # of Units</td>
<td>.85 # of Units</td>
<td>.80 Bldg Age</td>
<td>.67 # of Bldgs</td>
<td>-.67 Dev. Type</td>
</tr>
<tr>
<td>Bldg Age</td>
<td>.80 Bldg Age</td>
<td>.66 % Employed</td>
<td>.76 Family Size</td>
<td>.80 # of Units</td>
<td>.80 Bldg Type</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Height</th>
<th>Percent</th>
<th>Construction Type</th>
<th>Management Type</th>
<th>Management Type</th>
<th>Management Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacancy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Height</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
common variations, which the OLS method can't adequately estimate, because there is absence of serious problems of colinearity.

Table 4.5 reports the cross correlations among the independent variables and one another. It's important to note that the problems of multicollinearity can only be minimized and not eliminated because there will always be some degree of correlation between each independent variable. Therefore, to avoid reporting all variables as being correlated, a cut-off point of +-.60 is established; meaning that any two variables with a correlation coefficient of .60 and above are considered highly correlated.

Looking at table 4.5, the variable percent heads of households with 8 highly cross correlations tops the list. It's closely followed by building age with 7 cross correlations while percent employed, development type and percent minors have 6 cross correlations each. The variables family size has 5, while percent AFDC, number of buildings and number of units have 4 cross correlation each. The variable percent income with 2 cross correlation has the least.

It's important to observe that 6 variables show no cross correlation with any other variable and these are percent non white, percent rent, percent vacancy, construction type, management type and building height. The OLS estimation method gives the best estimates of the coefficients of these
six variables because they have no cross correlation by the set standard. The only way to get the best estimate of the coefficients of the regressors that are cross correlated with others using the OLS method is to eliminate from the regression model all but one of those variables that are cross correlated with one another.

Another point of interest is the sign of the correlation coefficients. The variables development type is shown to be negatively cross correlated to six other variables which include percent heads of households (-.96), percent employed (-.93), percent AFDC (-.89) and others. While there isn't any specific a priori expectations for the cross correlations between variables, the negative relationships between each of the six variables and development type is likely because of the characteristics of the BHA developments. The dummy variable development type describes family (0) and elderly (1) developments. Family developments almost exclusively house heads of families below 29 years, those employed and AFDC families. Therefore, it's conceivable that a "decrease" in this variable is associated with an "increase" in number of units, number of building and family size; so its no wonder that these three variables are negatively cross correlated with development type.
4.6 MULTIVARIATE MODEL--INDEPENDENT VARIABLES (REDUCED MODEL)

So far, the influence of tenant and building variable in reduced models have been reported separately but the extent of the influence of each type of variable within the same reduced model has not been examined. Having examined the extent of cross correlation between all the independent variables, it's now possible to successfully attempt an estimation of the influence of each variable without having to fear for the problems of multicolinearity.

Table 4.6 reports the regression results of a reduced model consisting only of independent variables with minimal correlation with other variables in the model. Because a majority of the variables are cross correlated as evident in table 4.5, it's never possible to have more than eight variables in any one reduced model without repeating use of some variables. Variable selection for all the reduced models tested was simply done by picking one variable from any one group of cross correlated variables by ensuring that no two variables with correlation of +/- .60 and above are included in the same model.

Having addressed the issue of multicolinearity in the reduced models, several reduced models were tested and their R² statistic ranged from .28 in the worst model to .77 in the best model (table 4.6).

Looking at the standardized regression coefficients in table 4.6, three things become apparent. First, it's
Table 4.6: Multivariate Regression Model--Total Maintenance Cost With All Independent Variables -Reduced Model

Raw Variables and Raw Coefficients

Total Maint.
Cost = $66.8 + ($0.17 x % Non white) + ($3.22 x % AFDC) + ($1.02 x % Rent) + (-$0.70 x % Vacancy)
+ ($24.8 x Const. Type) + ($19.37 x Mgmt Type) + ($22.8 x Bldg Syst.) + ($0.004 x % Income)

Standardized Variables and Standardized Regression Coefficients

Total Maint.
Cost = 0.00 + (0.21 x % Non white) + (1.09 x % AFDC) + (0.03 x % Rent) + (-0.15 x % Vacancy)
+ (0.18 x Const. Type) + (0.02 x Mgmt Type) + (0.23 x Bldg Syst.) + (0.18 x % Income)

\[ R = 0.77 \]
observed that percent AFDC exerts the most influence on maintenance cost. Secondly, the variables percent rent and management type could be said to have no influence on maintenance cost and thirdly, the influences of other variables are undoubtedly mild.

In terms of signs, the a priori expectation for percent non white and percent vacancy was ambiguous because arguments for the relationship between each variable and maintenance cost could be constructed either way. However, the positive sign for the variable construction type comes as a surprise because a negative relationship was expected. While the reasons for the positive relationship aren't quite clear, it seems that the relationship must be positive, rather than negative as expected, because it consistently showed a positive relationship in all the reduced models tested.

Perhaps the most interesting observation from the model is the sign and magnitude of the coefficient for percent non white. In all the reduced models tested, the sign was consistently positive indicating that race directly influences maintenance costs but the consistently low values in all models also indicate that though the influence is direct it's minimal.

The variable percent vacancy, though listed as ambiguous, is shown in this model and in all others to be consistently negatively correlated to maintenance cost, indicating that an increase in vacancy results in a decrease in maintenance
cost. In constructing one of the contrasting arguments for this variable’s expected relationship, the likelihood of huge unit preparation cost either due to damages caused by previous tenants or acts of vandalism by residents or both was thought of as a strong reason for increased maintenance cost. The negative sign, regardless of the low value of the coefficient, suggests that additional cost due to vandalism is not the case.

It’s equally important to explore a little further the observations on rent and income because of the current debate on what the future local and federal policies on both issues should be. Here, the influence of rent though positive as expected, is almost nil indicating that this variable exerts no real impact on maintenance cost. In all the models tested, percent rent either exhibited a negative but very mild influence or positive with almost no influence.

Regardless of sign, the low values of its coefficients in all the other reduced models suggest that rents charged in BHA developments do not influence maintenance costs. The most logical explanation for this is the non reliance by the agency on rental revenue for supporting operating expenses. However, my rent variable is not a direct measure of rental income. The BHA has in the last several years relied on federal grants and rent subsidies for the support of its services. The low values for the coefficient of income in table 4.6 and in other models simply show that income has
little or no influence on maintenance costs.

Across models, family size, minors, AFDC families, heads of households, employed, building age and development type consistently exhibited profound influence on maintenance cost. There are compelling reasons to believe that tenant variables either separately as in tenant models (table 4.3) or jointly as in combined models (tables 4.4 and 4.6) exert the most influence on maintenance cost.

**SUMMARY**

Through the use of correlation matrices it was first shown that the majority of the independent variables are highly correlated to maintenance cost. Later, it was observed that most of the variables were highly correlated to one another, thereby creating very severe problems of multicolinearity. Often, the signs and values of the coefficients in the regression models differed from those observed in the correlation matrix. However, such changes in signs and values of the coefficients from bivariate to multivariate models are normal because the introduction of additional variables into models often influences the values and signs of the variables.

It's apparent from the results of the correlation matrix (table 4.1) and those subsequently reported in other regression models, that the majority of the independent variables used in this study do exert some influence on
maintenance cost. Arguably, tenant variables particularly AFDC families, employed, minors, and family size, have been shown to exert profound impact on maintenance cost. Surprisingly, the influences of race, rent and income often turned out to be minimal, indicating that they are irrelevant determinants of maintenance cost in the BHA (though they may be important predictors in other PHA's).

4.7 CORRELATION BETWEEN LABOR COST AND MATERIAL COST WITH INDEPENDENT VARIABLES

Another dimension of this study was to tests whether there were any specific correlations between all the independent variables and the different components of maintenance cost i.e. labor cost and material/contract cost. These regression models used either labor cost or material cost as the dependent variable.

Through a set of correlation matrices, the observed patterns of correlation suggested that tenant variables and building variables are more highly correlated to material cost and labor cost respectively -see appendix #1. Although this pattern was expected to change in the multivariate models, it remained, though sometimes inconsistently, in the reduced models which tested tenant and building variables separately. Interestingly, there was far higher correlation between material cost and tenant variables than with total maintenance cost. Also it was observed that labor cost was more correlated to building variables than to the
corresponding tenant variables. (see appendix #2 - #8).

The reasons for this seemingly high correlations between labor cost and building characteristics vis-a-vis material cost and tenant demographics are not clear. It would be premature at this stage to advance reasons for this observed trend; suffice it to say that in as much as the pattern is sometimes inconsistent, then the evidence for such a pattern is at best inconclusive and should be simply considered as something of statistical curiosity.

The proof for the existence of such a pattern is also weakened by the very nature of the data in terms of the way data on material cost were reported by the housing authority. The material cost component also included other expense line items that were considered as contract cost by the agency. Typically, contract cost represented cost of repair work contracted out to outside contractors and these include items such as elevator repairs. It’s important to note that contract cost has labor cost included. It’s the hope that other data errors weren’t created through the inadvertent use of inapplicable figures.
CHAPTER 5
CONCLUSIONS

What conclusions can one draw from the foregoing analyses of the relationships between maintenance cost and the independent variables? The most logical starting point for such discussion is to review my a priori expectations.

The reported influence of tenant variables in most previous studies made it more than likely that these variables would establish profound influence on maintenance cost in my inquiry; as expected, they did. The first indication of their influence was in the correlation matrix in table 4.1 in which it was shown that the correlation coefficients of tenant variables were significantly higher than those of the corresponding building variables. In spite of high correlations, the signs for some variables such as percent employed and construction type were different from what was expected. Unless observed signs are consistently different from expected, it's usual to see signs change from models to models depending on which other variables are being controlled for.

Tenant variables have also shown to be the most important prognostic determinant of maintenance cost in the multivariate models. Though this trend was expected, what is surprising is that fewer variables especially those identified in previous studies, exert the strong influence on
maintenance cost. One such variable, percent AFDC, exercises more influence than percent non white, percent rent or percent income.

Regardless of signs, the low values of these variables show that they do not explain the variations in maintenance cost in developments used in the study. This observation is important in light of the current debate in which many have advocated a change in tenant demographics in order to admit tenants with higher incomes. Also, it's interesting to note that race isn't as much of an influence as some studies have indicated in the past. This position is especially true in this study because in the several models tested, the influence of race could be considered as consistently mild.

At the outset I was unclear as to what the likely link between maintenance cost and certain variables, namely race, vacancy and number of units, would be. Except for race that had a modest influence in a model, all others seldom had any influence. Again, it shows that vacancy rate and number of units do not influence maintenance cost. Thus, indicating that vandalism is not rampant and that economies of scale do not reduce overall maintenance cost.

Another interesting aspect of this inquiry was the comparison of the relative influences of tenant and building variables. To achieve this, it was necessary to test exclusive models for each type of variable. In doing this, the tenant models did not only have higher standardized
regression coefficients but also higher $R^2$ statistic. The superior influence of tenant variables was further proven in both the full and reduced inclusive regression models. In all instances, the same tenant variables—AFDC families, family size, employed and minors—exhibited the most profound impact. However, certain building variables particularly building age, development type and management type, stood out as the most important and compelling building factors.

The limitations imposed by multicolinearity and the ordinary least squares (OLS) estimation method make it almost impossible to compare one group of variables with another, but one can compare one variable with another. The latter type of comparison is not particularly useful because most variables especially the tenant related aren’t mutually exclusive. The former type of comparison is problematic because problems of multicolinearity can only be minimized but never completely eliminated indicating that the exact extent of the influence of some variables particularly the tenant related cannot be fully deciphered.

Reflecting back, de Leeux made the argument in his study (see chapter 2), that it’s difficult to differentiate between the impact of the number of minors per unit, number of unemployed per unit and some other variables. For instance, an increase in expenses with increase in minors per unit is related to the fact that more minors may mean more rooms per unit. Also, the fact that elderly persons, who often require
special services with attendant maintenance problems areclassified as unemployed makes it more difficult to measurethe exact level of influence of this factor.

It's obvious from the foregoing that the task ofdelineating the influence of any one variable is problematicbecause some untestable or ignored extraneous factors canjointly explain the influence. In this study, it's obvious that the influence of AFDC families overlaps with minors, hence it's difficult to establish which of the two command the most influence.

It's important to know that beyond the evidence concerningmy a priori expectations - particularly the expected influence of tenant variables that this study's design, by default, tests the influence of socio-economic indicators. Even building variables that ordinarily should not, also turned out to be correlated with socio-economic status. For example, AFDC families, minors, family size, building age and building systems do in fact describe poor large families receiving some form of state support and often housed by the agency in older and larger developments using steam heating systems.

Implicit in the findings of this study, beside restating the expected influence of tenant variables, is that tenant socio-economic status rather than race is true determinant of maintenance cost. Therefore, the mild influence of race in this study is understood in light of emerging evidence from
other studies including one on Boston's high school drop outs in which it was shown that the key determinant of drop out rate is poverty not race or ethnicity. The fact that poverty is prevalent in minority groups makes it look as though race is a principal determinant for just about any ill fated project involving minorities.

In the final analysis, tenant variables especially percent AFDC, percent minors, family size and percent employed, have all been shown to exert profound influence on maintenance cost. On the other hand, fewer building variables including development type, management type and building age exert profound influence. In spite of the reported profound influence of tenant variables, two things remain unclear (a) no one variable stands out with supreme influence and (b) the influence of certain variables become profound only in association with other variables.

Diaiso, Robert et al. *Perception of the Housing Environment: A Comparison of Racial and Density Preferences.* Pittsburgh, Graduate School of Public and International Affairs, University of Pittsburgh. 1971


APPENDIX #1: Correlation Matrices--Material Cost And Labor Cost With Independent Variables

<table>
<thead>
<tr>
<th></th>
<th>Mean Family Size</th>
<th>Percent Non White</th>
<th>Percent AFDC</th>
<th>Percent Employed</th>
<th>Percent Rent Below $101.00</th>
<th>Percent Vacancy</th>
<th>Construction Type</th>
<th>Building Management Type</th>
<th>Number of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Cost</td>
<td>+.75</td>
<td>+.52</td>
<td>+.73</td>
<td>+.61</td>
<td>-.05</td>
<td>+.15</td>
<td>-.10</td>
<td>+.15</td>
<td>+.55</td>
</tr>
<tr>
<td>Labor Cost</td>
<td>+.32</td>
<td>+.18</td>
<td>+.58</td>
<td>+.53</td>
<td>+.36</td>
<td>+.19</td>
<td>+.30</td>
<td>+.76</td>
<td>+.36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Building Developmt Systems Type</th>
<th>% of Income &lt;$7999</th>
<th>Number of Units</th>
<th>% Heads Household &lt; 29yr.</th>
<th>% of Minors &lt; 18yr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Cost</td>
<td>+.17</td>
<td>-.68</td>
<td>-.03</td>
<td>+.46</td>
<td>-.08</td>
</tr>
<tr>
<td>Labor Cost</td>
<td>+.65</td>
<td>-.53</td>
<td>-.30</td>
<td>-.05</td>
<td>+.53</td>
</tr>
</tbody>
</table>
APPENDIX #2: Multivariate Regression Model--Material Cost With All Independent Variables

Raw Variables and Raw Coefficients

Material Cost = $82.2 + (-$7.60 x Family Size) + ($0.03 x % Non White) + ($0.98 x % AFDC) + ($2.43 x % Employed)
+ ($0.15 x % Rent) + ($0.34 x % Vacancy) + ($13.0 x Const. Type) + ($0.59 x Bldg Age)
+ ($-13.7 x Mgmt Type) + ($0.64 x # of Bldgs.) + ($10.6 x Bldg Syst.) + ($128.0 x Dev. Type)
+ ($0.15 x Bldg. Ht) + ($0.00 x Income) + ($-0.002 x # of Units) + ($-3.21 x % Heads of Households)
+ ($3.48 x % Minors <18 yrs.)

Standardized Variables and Standized Regression Coefficients

Material Cost = 0.00 + (-.28 x Family Size) + (.03 x % Non white) + (.42 x % AFDC) + (1.08 x % Employed) + (.02 x % Rent)
+ (-.13 x % Vacancy) + (.15 x Const. Type) + (-.24 x Bldg Age) + (-.16 x Mgmt Type) + (.22 x # of Bldgs)
+ (.16 x Bldg Syst.) + (1.95 x Dev. Type) + (.19 x Bldg Ht) + (.01 x % Income) + (-.02 # of Units)
+ (.96 x % Heads of Household <29yr.) + (2.28 x # of Minors <18yr.)

\[ R = .86 \]
APPENDIX #3: Multivariate Regression Model--Material Cost With Independent Variables -Reduced Model

Raw Variables and Raw Coefficients

Material Cost = $55.3 + ($1.17 x % Non white) + ($1.27 x % AFDC) + (-$1.18 x % Rent) + ($1.11 x % Vacancy) + (-$.40 x Const. Type) + (-$28.35 x Mgmt Type) + ($1.89 x Bldg Syst.) + ($0.11 x % Income)

Standardized Variables and Standardized Regression Coefficients

Material Cost = 0.00 + (.21 x % Non white) + (.55 x % AFDC) + (-.20 x % Rent) + (.04 x % Vacancy) + (-.004 x Const. Type) + (-.33 x Mgmt Type) + (.02 x Bldg Syst.) + (.11 x % Income)

R = .78
APPENDIX #4: Multivariate Model--Material Cost With Tenant Variables

Raw Variables and Raw Coefficients

Material Cost = $18.3 + ($ .22 x % Non white) + ($1.38 x % AFDC) + (-$1.14 x % Rent) + ($0.00 x % Income)

Standardized Variables and Standardized Regression Coefficients

Material Cost = 0.00 + (.28 x % Non white) + (.60 x % AFDC) x (-.24 x % Rent) + (.20 x % Income)

\[
R^2 = .70
\]
APPENDIX #5: Multivariate Regression Model--Material Cost With Building Variables

Raw Variables and Raw Coefficients

Material
Cost = $111.0 + ( $.02 x % Vacancy) + ( $.69 x Const. Type) + ( -$35.7 x Mgmt Type) + ( $1.70 x Bldg Syst.)

+ ( -$36.9 x Development Type)

Standardized Variables and Standardized Regression Coefficients

Material
Cost = 0.00 + ( .00 x % Vacancy) + ( .00 x Const. Type) + ( -.42 x Mgmt Type) + ( .02 x Bldg Syst.)

+ ( -.56 x Development Type)

\[ R = .63 \]
APPENDIX #6: Multivariate Regression Model--Labor Cost With Independent Variables (Reduced Model)

Raw Variables and Raw Coefficients

Labor Cost = $13.8 + ($14.5 x Family size) + ($0.04 x % Non white) + ($1.29 x % Rent) + (-$0.82 x % Vacancy) + ($25.7 x Const. Type) + ($52.8 x Mgmt Type) + ($2.63 x % Heads of Household <29yr.)

Standardized Variables and Standardized Regression Coefficients

Labor Cost = 4.00 + (0.33 x Family Size) + (0.03 x % Non white) + (0.14 x % Rent) + (-0.20 x % Vacancy) + (0.19 x Const. Type) + (0.39 x Mgmt Type) + (0.49 x % Heads of Household <29yr.)

R = 0.69
APPENDIX #7: Multivariate Regression Model—Labor Cost With Tenant Variables

Raw Variables and Raw Coefficients

Labor Cost = $105.3 + ($0.96 \times \text{Family Size}) + (-0.04 \times \% \text{Non white}) + (0.33 \times \% \text{Rent})

+ ($3.82 \times \% \text{Heads of Household <29yr.})

Standardized Variables and Standardized Regression Coefficients

Labor Cost = 0.00 + (0.02 \times \text{Family Size}) + (-0.03 \times \% \text{Non white}) + (0.03 \times \% \text{Rent})

+ (0.72 \times \% \text{Heads of Household <29yr.})

\[ R = 0.54 \]
APPENDIX #8: Multivariate Regression Model--Labor Cost With Building Variables

Raw Variables and Raw Coefficients

\[
\text{Labor Cost} = 101.0 + ( -0.32 \times \% \text{Vacancy}) + ( 21.6 \times \text{Const. Type}) + ( 55.1 \times \text{Mgmt Type}) + ( 19.7 \times \text{Bldg Syst.}) + ( -59.5 \times \text{Development Type})
\]

Standardized Variables and Standardized Regression Coefficients

\[
\text{Labor Cost} = 0.00 + ( -0.07 \times \% \text{Vacancy}) + ( 0.16 \times \text{Const. Type}) + ( 0.41 \times \text{Mgmt Type}) + ( 0.19 \times \text{Bldg Syst.}) + ( -0.57 \times \text{Development Type})
\]

\[ R = .61 \]
APPENDIX #8A: Multivariate Regression Model--Labor Cost With All Independent Variables

Standardized Variables and Standardized Regression Coefficients

Labor Cost = 0.00 + ( .51 x Family Size) + ( .00 x % Non white) + ( .53 x % AFDC) + ( -.94 x % Employed)
+ ( .14 x % Rent) + ( .01 x % Vacancy) + ( .22 x Const. Type) + ( .76 x Bldg Age)
+ ( .16 x Mgmt Type) + ( .26 x # of Bldgs) + ( -.05 x Bldg Syst.) + ( -1.08 x Dev. Type)
+ ( -.05 x Bldg Ht.) + ( -.02 x % Income) + ( -.54 x # of Units) + ( .45 x % Heads of Household <29yr.)
+ ( -1.28 x % Minors Below 18yrs.)

\[ R = .79 \]
<table>
<thead>
<tr>
<th>CITY</th>
<th>CURRENT EXP.</th>
<th>MATERIALS EXP.</th>
<th>CONTRACT EXP.</th>
<th>MAINT. &amp; CTR. EXP.</th>
<th>TL MAINT. EXP.</th>
<th>LABOR EXP.</th>
<th>A CONT. EXP.</th>
<th>MAINT. EXP.</th>
<th>3RD AVG.</th>
<th>3RD AVG.</th>
<th>3RD AVG. TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1  CHARLESTOWN</td>
<td>12797</td>
<td>22464</td>
<td>44230</td>
<td>30216</td>
<td>9231</td>
<td>54710</td>
<td>27937</td>
<td>21213</td>
<td>6373</td>
<td>276262</td>
<td>152</td>
</tr>
<tr>
<td>2-2  MISSION HILL</td>
<td>58923</td>
<td>17593</td>
<td>28560</td>
<td>30560</td>
<td>9231</td>
<td>54710</td>
<td>27937</td>
<td>21213</td>
<td>6373</td>
<td>276262</td>
<td>152</td>
</tr>
<tr>
<td>2-3  LOOMIE T.</td>
<td>172015</td>
<td>59461</td>
<td>15256</td>
<td>30560</td>
<td>9231</td>
<td>54710</td>
<td>27937</td>
<td>21213</td>
<td>6373</td>
<td>276262</td>
<td>152</td>
</tr>
<tr>
<td>2-4  ORCHARD PARK</td>
<td>44575</td>
<td>15561</td>
<td>74412</td>
<td>9670</td>
<td>6799</td>
<td>25110</td>
<td>195032</td>
<td>150353</td>
<td>400</td>
<td>110483</td>
<td>150</td>
</tr>
<tr>
<td>2-5  CATHEDRAL/SOUTH END</td>
<td>25047</td>
<td>77054</td>
<td>53512</td>
<td>15327</td>
<td>24559</td>
<td>9723</td>
<td>35200</td>
<td>130346</td>
<td>888</td>
<td>130346</td>
<td>130</td>
</tr>
<tr>
<td>2-6  HEATH ST.</td>
<td>195129</td>
<td>59461</td>
<td>22007</td>
<td>13906</td>
<td>76400</td>
<td>23327</td>
<td>16423</td>
<td>95841</td>
<td>5751</td>
<td>95841</td>
<td>5751</td>
</tr>
<tr>
<td>2-7  EAST BOSTON</td>
<td>321893</td>
<td>79688</td>
<td>24351</td>
<td>7551</td>
<td>2199</td>
<td>16550</td>
<td>124775</td>
<td>93937</td>
<td>4658</td>
<td>124775</td>
<td>93937</td>
</tr>
<tr>
<td>2-8  FRANKLIN HILL</td>
<td>81269</td>
<td>86981</td>
<td>19447</td>
<td>10988</td>
<td>3145</td>
<td>11026</td>
<td>30299</td>
<td>82933</td>
<td>1690</td>
<td>30299</td>
<td>82933</td>
</tr>
<tr>
<td>2-9  WHITTIER ST.</td>
<td>150402</td>
<td>32455</td>
<td>31096</td>
<td>76606</td>
<td>23227</td>
<td>46324</td>
<td>89641</td>
<td>57153</td>
<td>2128</td>
<td>89641</td>
<td>57153</td>
</tr>
<tr>
<td>2-10 WEST BOSTON-BECON</td>
<td>220613</td>
<td>67178</td>
<td>43554</td>
<td>15023</td>
<td>9536</td>
<td>10865</td>
<td>88043</td>
<td>57616</td>
<td>1390</td>
<td>88043</td>
<td>57616</td>
</tr>
<tr>
<td>2-11 WEST BOSTON-RENTAL</td>
<td>225766</td>
<td>80479</td>
<td>59135</td>
<td>38656</td>
<td>72631</td>
<td>34965</td>
<td>82542</td>
<td>57153</td>
<td>2128</td>
<td>82542</td>
<td>57153</td>
</tr>
<tr>
<td>2-12 WEST BOSTON-RENTAL</td>
<td>511529</td>
<td>59461</td>
<td>23070</td>
<td>76606</td>
<td>23227</td>
<td>46324</td>
<td>89641</td>
<td>57153</td>
<td>2128</td>
<td>89641</td>
<td>57153</td>
</tr>
<tr>
<td>2-13 MARY ELEEN MORGAN</td>
<td>544625</td>
<td>170822</td>
<td>13495</td>
<td>5313</td>
<td>16791</td>
<td>56733</td>
<td>226055</td>
<td>172420</td>
<td>4934</td>
<td>226055</td>
<td>172420</td>
</tr>
<tr>
<td>2-14 OLD COLONY</td>
<td>511952</td>
<td>156806</td>
<td>89321</td>
<td>23489</td>
<td>30655</td>
<td>9335</td>
<td>192509</td>
<td>153700</td>
<td>481</td>
<td>192509</td>
<td>153700</td>
</tr>
<tr>
<td>2-15 WWAS ST.</td>
<td>91</td>
<td>26</td>
<td>85</td>
<td>27</td>
<td>89</td>
<td>254</td>
<td>286</td>
<td>117</td>
<td>310</td>
<td>117</td>
<td>310</td>
</tr>
<tr>
<td>2-16 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>2-17 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>2-18 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>2-19 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>2-20 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>2-21 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>2-22 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>2-23 WWAS ST.</td>
<td>2190</td>
<td>667</td>
<td>6764</td>
<td>1042</td>
<td>7111</td>
<td>2165</td>
<td>4107</td>
<td>2718</td>
<td>3276</td>
<td>2718</td>
<td>3276</td>
</tr>
<tr>
<td>DEVS</td>
<td>MORTGAGE DEPRECIATION</td>
<td>MORTGAGE EXP.</td>
<td>CONTRACT EXP.</td>
<td>NATURE &amp; CTE EXP.</td>
<td>MAINT. EXP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----------------------</td>
<td>---------------</td>
<td>---------------</td>
<td>------------------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>CHARLESTON</td>
<td>179355</td>
<td>55816</td>
<td>45204</td>
<td>16055</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-30</td>
<td>2-31</td>
<td>2-32</td>
<td>2-33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-34</td>
<td>2-35</td>
<td>2-36</td>
<td>2-37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-38</td>
<td>2-39</td>
<td>2-40</td>
<td>2-41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-42</td>
<td>2-43</td>
<td>2-44</td>
<td>2-45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-46</td>
<td>2-47</td>
<td>2-48</td>
<td>2-49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-50</td>
<td>2-51</td>
<td>2-52</td>
<td>2-53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-54</td>
<td>2-55</td>
<td>2-56</td>
<td>2-57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-58</td>
<td>2-59</td>
<td>2-60</td>
<td>2-61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-62</td>
<td>2-63</td>
<td>2-64</td>
<td>2-65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-66</td>
<td>2-67</td>
<td>2-68</td>
<td>2-69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-70</td>
<td>2-71</td>
<td>2-72</td>
<td>2-73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-74</td>
<td>2-75</td>
<td>2-76</td>
<td>2-77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-78</td>
<td>2-79</td>
<td>2-80</td>
<td>2-81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-82</td>
<td>2-83</td>
<td>2-84</td>
<td>2-85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-86</td>
<td>2-87</td>
<td>2-88</td>
<td>2-89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-90</td>
<td>2-91</td>
<td>2-92</td>
<td>2-93</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-94</td>
<td>2-95</td>
<td>2-96</td>
<td>2-97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-98</td>
<td>2-99</td>
<td>2-100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**APPENDIX #19**

**MAINTENANCE EXPENSES FISCAL YEAR 1985**

<table>
<thead>
<tr>
<th>DEVS</th>
<th>MORTGAGE DEPRECIATION</th>
<th>MORTGAGE EXP.</th>
<th>CONTRACT EXP.</th>
<th>NATURE &amp; CTE EXP.</th>
<th>MAINT. EXP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>CHARLESTON</td>
<td>179355</td>
<td>55816</td>
<td>45204</td>
<td>16055</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-30</td>
<td>2-31</td>
<td>2-32</td>
<td>2-33</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-34</td>
<td>2-35</td>
<td>2-36</td>
<td>2-37</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-38</td>
<td>2-39</td>
<td>2-40</td>
<td>2-41</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-42</td>
<td>2-43</td>
<td>2-44</td>
<td>2-45</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-46</td>
<td>2-47</td>
<td>2-48</td>
<td>2-49</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-50</td>
<td>2-51</td>
<td>2-52</td>
<td>2-53</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-54</td>
<td>2-55</td>
<td>2-56</td>
<td>2-57</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-58</td>
<td>2-59</td>
<td>2-60</td>
<td>2-61</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-62</td>
<td>2-63</td>
<td>2-64</td>
<td>2-65</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-66</td>
<td>2-67</td>
<td>2-68</td>
<td>2-69</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-70</td>
<td>2-71</td>
<td>2-72</td>
<td>2-73</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-74</td>
<td>2-75</td>
<td>2-76</td>
<td>2-77</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-78</td>
<td>2-79</td>
<td>2-80</td>
<td>2-81</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-82</td>
<td>2-83</td>
<td>2-84</td>
<td>2-85</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-86</td>
<td>2-87</td>
<td>2-88</td>
<td>2-89</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-90</td>
<td>2-91</td>
<td>2-92</td>
<td>2-93</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-94</td>
<td>2-95</td>
<td>2-96</td>
<td>2-97</td>
</tr>
<tr>
<td>2-1</td>
<td>BOSTON</td>
<td>2-98</td>
<td>2-99</td>
<td>2-100</td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX II

#### BOSTON HOUSING AUTHORITY

**MAINTENANCE EXPENSES FISCAL YEAR 1984**

#### DEV. 1 FAMILIES DEVELOPMENTS LABOR EXPENSES

<table>
<thead>
<tr>
<th>MATERIALS EXP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NET.</td>
</tr>
<tr>
<td>MUNA</td>
</tr>
</tbody>
</table>

#### DEV. 2 ELDERLY DEVELOPMENTS LABOR EXPENSES

<table>
<thead>
<tr>
<th>MATERIALS EXP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NET.</td>
</tr>
<tr>
<td>MUNA</td>
</tr>
</tbody>
</table>