THE IMPACT OF BUILDING DESIGN ON MAINTENANCE COSTS OF RESIDENTIAL HOUSING ESTATES OWNED BY MOMBASA MUNICIPAL COUNCIL

by

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A thesis submitted in part fulfilment
for the degree of Doctor of
Philosophy in the Department
of Land Development at the
University of Nairobi.

NAIROBI

1985

ABSTRACT

This study constitutes an investigation of the
impact of building design on the subsequent costs of
maintaining buildings in use. It is restricted to
residential buildings owned and maintained by Mombasa
Municipal Council which is one of the oldest urban
authorities in Kenya, and is the second largest urban
authority after Nairobi. The study is solely concerned
with the effect of building morphology (size), construction
materials, and density on maintenance costs. It is assumed
that these factors are within the control of the designer,
so that their manipulation can either increase or decrease
the total amount of money used in both the construction
and maintenance of a building throughout its total life.
Thus the designer's role in this study is seen as that of
sole adviser to building owners as to what would be appro-
priate economically as well as to users.

The study, however recognises that during the use
of a building other factors such as management policy,
finance, building age, mode of use, climate etc. may in
various degrees affect not only the maintenance needs of
a building but also how well the needs can be satisfied.
Management policy and climate are assumed constant in this
study since all the houses belong to one organisation,
and within one climatic region. Other factors may vary
within different housing estates, and therefore may be
measurable.

Given the complexity of the factors that may
influence maintenance costs, it has been found necessary
to employ the technique of multiple linear regression
analysis to measure the degree of association between any
of the factors and maintenance costs. Therefore the
study uses a simple theoretical mathematical model of the
form $Y = f(X_1, X_2 \ldots\ldots X_n)$ as framework within which to
study how the annual maintenance costs vary with building
design and other relevant factors. For the purposes of

this model, 19 independent variables were identified for regression against maintenance cost as the dependent variable.

The study has been organised into seven chapters. The first chapter introduces the problems identified in the study area, the study objectives, as well as the scope and definition of important terms used in the study. It is noted in this chapter that housing estates in Kenya are not only deteriorating fast, but they are also expensive to maintain. Questions were raised, for instance, why some local authorities should spend as much as 58.3% of their rental income on maintenance of their housing estates, when in fact, only 15% is what is allowed for during estate development appraisal. Whether the high costs arise from poor management or bad design, the consequences are disastrous to the whole country whose capacity to build new houses as rapidly as existing ones become unusable, is insufficient.

Chapter Two attempts to set a theoretical framework from some known or assumed principles within which to investigate factors affecting maintenance costs of residential housing estates. The framework leads to the formulation of a null hypothesis that no relationship exists between building design and maintenance costs. A conceptual maintenance cost model in the form of multiple linear regression is developed to test the validity or otherwise of the above hypothesis. The chapter ends with a discussion on how the research was carried out in the field and how the data would be analysed and presented.

The third chapter discusses representative literature selected from various references on the economics of building maintenance, and the influence of design on maintenance costs. It was found in reviewing the literature for this study that there is no cost model that includes maintenance expenditure as a design criterion. It was also found that there is no agreed method of determining how

much money should be set aside for maintenance costs.
The chapter, concludes that there is need to consider
the significance of maintenance costs during building
design. The chapter recommends that in order to determine
maintenance needs of a building, it is necessary to use
the concept of duty of care which relates the building to
a hospital patient. The application of this concept is
further discussed in Chapter Five when maintenance management
process is described.

Chapters Four, Five and Six deal with the case study
area of Mombasa Municipal Council. Chapter Four consists
of general background to the study area of Mombasa and
discusses the factors determining house design in this
hot and humid climatic zone. The chapter finds that
Mombasa is essentially an African town since Africans
comprise 76% of the population. It also notes that one
single important factor in house design is that it should
satisfy people's way of life. It does appear, however,
that the traditional "Swahili-house" is more amenable to
satisfying the needs of the majority of Mombasa's popula-
tion in comparison to conventional house provided by
Mombasa Municipal Council. This house is generally large
in accordance with the generally large African households,
and it also lends itself to easy construction techniques.
It satisfies the climatic criterion of cross ventilation.
It is therefore concluded that its features should be
adopted to the extent possible in the conventional council
house.

Chapter Five examines the incidence of maintenance
failure characteristics. A number of quantitative
aspects of maintenance management process such as frequency
or volume of work orders were investigated, as well as
qualitative aspects such as audit conditions and the use
of photography to give explanations to defects that create
maintenance. It is concluded in this chapter that houses

in Mombasa are poorly maintained, and that there is a backlog in the order of 42% of reported defects unattended. While maintenance management may be the major cause of this backlog, it has been recognised that initial design created fertile grounds for the need for frequency of maintenance. The sixth chapter evaluates the maintenance costs collected in terms of building design features and other relevant factors. It is observed in this chapter that wall decoration and plumbing works are the most expensive elements in Mombasa. This is largely because of paintwork on external surfaces on buildings which calls for frequent redecoration, and the use of steel pipes externally. When the maintenance cost data were subjected to statistical analysis, about seven independent variables out of 19 variables were found significant at a 95% confidence limit. Rental value obtained for each house was the most signficant single factor accounting for more than 86% of the variation in maintenance cost per accommodation unit and more than 68% of the maintenance cost per room. The estates with high rents cost more to maintain in comparsion to low rent estates thus confirming that finance is important in building maintenance. Other significant variables included peri- meter length, room height, number of housing units per estate, number of habitable rooms per hectare, type of roof and type of wall construction. The variables in all accounted for 99.3% of the variation in maintenance costs per unit of accommodation. The plot of standardised residuals was within less than one standard deviation, showing that the model nearly predicts the observations.

The last chapter is a summary of the findings of the study and recommendations for further research into the problems of building maintenance. It is concluded that a relationship exists between building design and maintenance costs in terms of choice of materials, building density and building shape. Recommendations are made

regarding appropriate use of building materials, density and need for compact buildings. Further recommendations include need to externalise design and the need for improved methods for maintenance management. It is, however, recognised that the model developed for Mombasa's Council housing estates may not be universally applicable throughout the country, but that the variables so identified should be tested in other areas to verify their behaviour with respect to maintenance costs. Climatic variations as well as management policies of various housing authorities may need further investigations before general conclusions can be drawn on the operation of maintenance cost models for residential buildings.

P. M. SYAGGA, 1985