

Development of building automation systems from user's point
of view

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KEYWORDS

Building automation
Building maintenance

ABSTRACT

The obstructions of the energy efficient use of the building automation systems can be divided to unpractised staff, defects on programs and in computers.

The study deals with the buildings furnished with different types of apparatuses, building automation systems and organizations.

The profitability of the building automation systems in different environments is studied with profitability analyses method which take also the users' requirements into consideration. These requirements can vary according to situation of selection.

The result of this study will give information to the owner for the building automation selection and instructions for the designers.

Amélioration des systèmes automatiques du bâtiment à partir des besoins des usagers

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MOTS-CLES

Automatisation du bâtiment
Entretien des bâtiments

SOMMAIRE

La recherche a pour objet de déterminer les principaux obstacles à l'utilisation efficace des systèmes automatiques du bâtiment. Les insuffisances des systèmes peuvent être réparties entre programmes, appareillages et personnel.

La recherche porte sur des bâtiments, systèmes automatiques et organisations diversement équipés.

La rentabilité des appareillages automatiques utilisés dans des environnements différents est étudiée à l'aide d'une analyse comparative des coûts prenant en considération non seulement les coûts, mais aussi les besoins des usagers qui varient en fonction de la situation de choix.

La recherche a pour résultat de donner des instructions de choix et de planning.

INTRODUCTION

Building Automation in Finland

Approximately 2 % (per cent) of buildings in Finland are connected to central control and monitoring systems. The systems in operation are relatively large monitoring approximately 500 points. The initial cost of these systems covers approximately 1 % of the building's total construction costs. The number of control and monitoring systems installed annually is about 20.

Maintenance costs in real estate and potential for reduction of costs

Nearly half of the maintenance costs of tenement blocks consisted of costs associated with heating, electricity and water supply. The remaining costs comprised labour and materials expenses. As far as office blocks are concerned, it was found that the main factor contributing to maintenance costs was labour, which accounted for approximately 60 % of the total costs. Hence labour, heating, electricity and water costs constitute the main areas where reduction of costs may be possible.

The average saving of labour in building sites with automation has roughly been as follows:

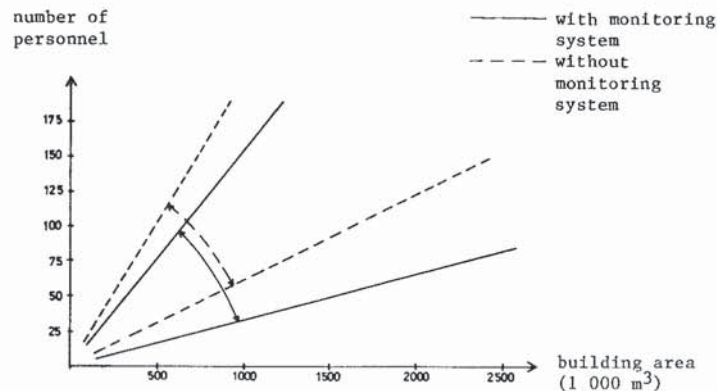


Figure 1. Maintenance personnel and automation.

In terms of energy conservation it appears that investment in centralized control and monitoring systems is more profitable than investment in energy saving measures offered by construction engineering, but less profitable than investment in independent control and adjustment devices.

Table I. Co-efficients of cost-reduction of different factors.

	Co-efficient	Residential buildings	Business or office buildings
Ventilation	k_1	1,00 - 0,87	0,99 - 0,66
Heating	k_2	0,98 - 0,82	0,98 - 0,85
Lighting	k_3	1,00 - 0,99	1,00 - 0,93
Other electrical devices	k_4	1,00 - 0,97	1,00 - 0,95
Labour	k_5	0,98 - 0,88	0,97 - 0,88
Other factors	k_6	0,98 - 0,90	0,98 - 0,90
Total co-efficient	k	0,94 - 0,54	0,92 - 0,39

Problems identified

It has not always been possible to realize the savings, or the savings have remained smaller than estimated, for the following reasons:

- a) The maintenance organization and its management has been deficient and the degree of knowledge and motivation among the personnel has been low. In addition, problems were found in the planning and efficiency of labour. Furthermore, the decisionmaking authority has often been divided.
- b) The planning of the building's HVAC-systems has not taken into account any future monitoring-systems. In addition, these are often oversized. Another frequent problem is caused by air-leaks in the constructions. This increases energy consumption if an automatic monitoring system is installed in the building.
- c) The potential of the control and monitoring system is not always realised, or, the system chosen is not the most suitable for the building. Furthermore, problems are found in the reliability of this system. The training requirements recognised by the operational personnel of the monitoring systems were found to be the following:

ADP (automatic data processing)	
- training	56 % of the interviewees
Maintenance training	33 % "
HVAC-training	11 % "

THE SELECTION AND PLANNING OF A CONTROL AND MONITORING SYSTEM ON THE BASIS OF USER REQUIREMENTS

Planning proceeds as follows:

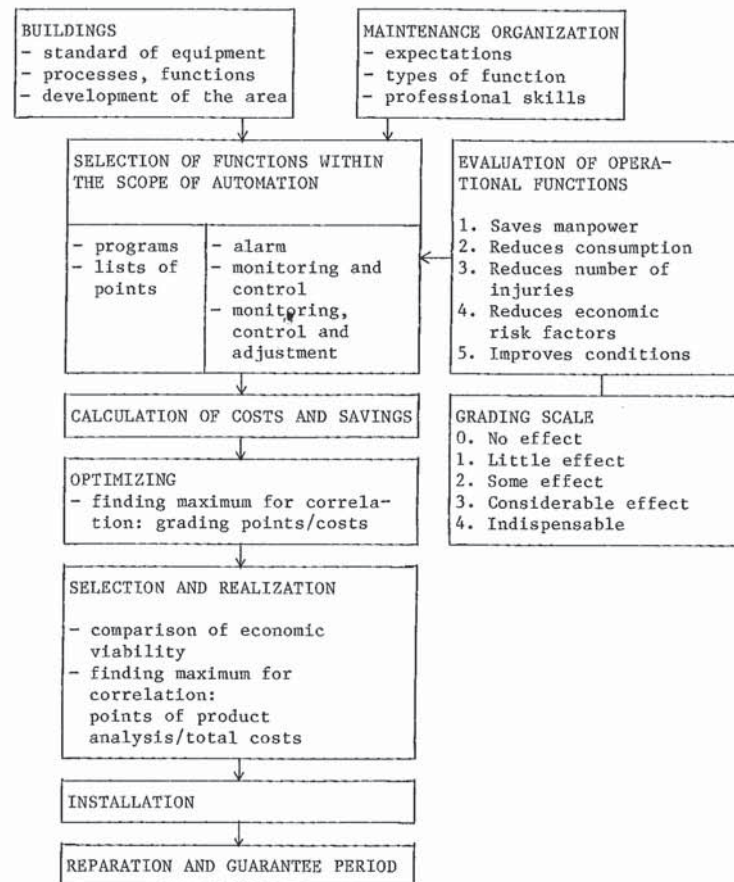


Figure 2. Planning and Acquisition of Control System.

Essential procedures involved in the selection of Automation Equipment

- a) The equipment and apparatus of the buildings in the real estate are listed in an index systematically according to their functions.
- b) The functions of the organization are listed, the standard of maintenance and objectives of development are examined.

The valuation of the standard of maintenance is based on a number of parameters and on analysis of wage structure according to the following principle:

$$Y = f(L, E, Q) \quad (1)$$

where L is labour
E efficiency
Q quality
Y earned income

The amount of labour (L) is measured, and the efficiency (E) is calculated with the help of the correlation: estimated expenditure/actual expenditure, taking into consideration the factors which the worker can influence through his action. These include the amount of energy and water consumed, and the use of outside services. The factors of the above equation provide the basis for organization development programs.

In our calculations the savings in maintenance work in buildings with automation was found to be 20 - 30 % in tenement blocks and 20 - 50 % in office blocks, depending on the location of the maintenance unit.

- c) Selection of the monitoring system involves the evaluation of operational functions in relation to five factors (figure 2):

The buyer of the equipment can weigh the importance of the different factors according to his needs. The grading scale (referred to above) is divided into five categories; the specific, criteria for evaluation can be obtained from separately compiled data.

- d) The calculation of costs and savings
The calculation of costs is based on price quotations collected and on estimates of the consumption of energy and water and the amount of labour used. Sets of standards and programs for the calculation of energy can also be used.

- e) The optimizing of the system involves comparison of the rate of return with the annual expenses. If the rate of return exceeds the requirements set, the system can be accepted. With the help of sensitivity analysis the correlation between the rate of return and expenses can be set at an optimum level.

The present study examines six types of building, six types of real estate and six types of real estate area representing rather typical Finnish design. The objective is to give a detailed plan for each of these cases. The main emphasis is on the evaluation of operational functions and properties.

- f) The realization stage involves comparing the different alternatives in terms of costs and properties of different products. The selector has a list of properties considered essential or advantageous. These are given points from 1 to 3. The costs are accounted for as follows:

$$P = I + K + V - T - J \quad (2)$$

where P is present worth of expenditure
I investment cost
K maintenance cost
V discarding cost
T return
J remainder

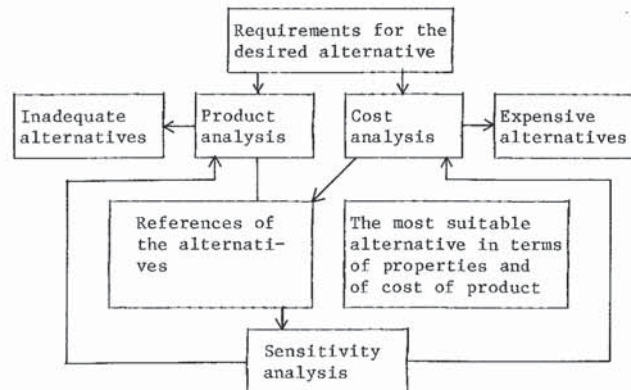


Figure 3. Stages of the comparison of economic viability.

References and Sensitivity Analysis

Proportioning the total number of points obtained in the product analysis to the total expenditure given as a result of cost analysis will show how the different alternatives differ in terms of economic viability:

$$\text{reference of alternative} = \frac{\text{number of points in product analysis}}{\text{total units}} \quad (3)$$

Sensitivity analysis can be applied if the effect of any given property on the total costs is known. In this case:

$$\text{reference of alternative} = \frac{\text{points in product analysis} \pm \text{points of additional property}}{\text{total costs} \pm \text{cost of additional property}} \quad (4)$$

In the reference obtained in this way is greater, the inclusion or not of the additional property will be profitable, provided that the costs remain below the maximum set. Sensitivity analysis is relevant if the reference values of two or more systems are almost the same, or the inclusion of additional properties is considered profitable. The latter alternative will have to be considered if, for instance, there is room for extra points in the data gathering panels.

Simplified Models for Monthly HVAC System Performance in Large Buildings

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KEY WORDS

Cooling, HVAC, Building, Energy Analysis.

ABSTRACT

Heating and cooling load relations are formulated for a variety of HVAC systems in common use today. These equations are integrated over operating temperature ranges. The resulting expressions can be interpreted in terms of degree-days. This allows the use of previously generated weather statistics to determine monthly and annual heating and cooling energy requirements. The results of this approach are compared to those using actual weather records. It is shown that the simplified approach yields results within 5% of more exact methods. The techniques developed are suitable for use on microcomputers.