A System for Optimizing Private House Owner’s Spendings and Benefits

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ABSTRACT

Investment decisions about privately-owned houses are usually based on limited investment budget and vague information about choice alternatives available. Since a household buying a dwelling has to compare the housing expenditure with other expenditures, the financial consequences of the housing investment should be transformed on an annual basis. Furthermore, to be able to make a choice out of various choice alternatives within the annual housing budget, the annual costs of the most important attributes have to be calculated separately. Cost information about the choice alternatives should be used in combination with their utility in order to be able to allocate the household’s budget. The cost information is objective while utility depends on an individual household. As a consequence, the household should determine its own utility scale. This is accomplished by defining a willingness to pay amount for each choice alternative using a bidding game. The willingness to pay amount reveals the maximum additional amount of money the household is willing to pay for an additional quantity or quality of a certain attribute. In order to maximise the total utility within the budget, the ratios of marginal utility to marginal cost for the attributes have to be compared. The definition of subjective utilities as willingness to pay amounts has drawbacks. Future research should improve the system as concerns utility measurement for the decision support of individual households.

Keywords
Private house owner, attributes, annual budget, marginal utility, marginal cost

1 INTRODUCTION

Private house owners invest in houses partly because of speculative reasons and partly to have a good housing environment available. The financial limit for the investment is usually defined by the maximum financial consequences of the mortgage the household can bear besides equity capital available (Ruokolainen 1996). As a result, the comparison of spendings on housing to other spendings as well as the choice out of the various housing attributes become to be poor. Detailed cost information is lacking as well as the information about the benefits which can be expected to obtain from the different choice alternatives.
A decision support system has to be developed to assist future private house owners with allocating the budget to various housing attributes and making decisions as close to the optimum as possible. In the decision support system attention should be paid to the presentation of adequate cost information as well as to finding out the households’ utilities for the attributes.

2 ALLOCATION OF HOUSEHOLD BUDGET

2.1 Definition of Household Budget

Most of the households expect their income to increase at least at the level of inflation. Hence, if the investments are based on the prevailing annual income, no problems can be expected to appear in the long run. Furthermore, the households anticipate the prices of private properties to go up faster than the inflation. Future expenditures such as maintenance and upgrading are not taken into account since it is expected that additional income or mortgage will cover these costs. However, in most countries we have experienced that prices are not constantly sharply rising anymore and increases in income are only moderate. Hence, it is reasonable to find out a more conscious balance between income and housing expenditure. As a consequence, all components of household income have to be taken into account on an annual basis. This concerns capital income besides labour income (see figure 1). The significance of the capital income is that an interest on the net family capital is calculated and the capital is not just considered to be available for property investments for own use.

![COMPOSITION OF HOUSEHOLD INCOME](image.png)

Figure 1: Composition of Household Income
2.2 Marginal Costs and Marginal Utilities

The household income should be used in such a way that the total utility for the household will be maximised per annum. According to the traditional consumer theory (see e.g. Lancaster 1971), utility will be maximised within the budget available when the ratio of marginal utility to marginal cost is equal for all chosen attributes (figure 2). Hence, the household should be able to judge the utility as well as the cost of choice alternatives. The costs of the choice alternatives can be calculated using cost data available in construction sector. The data only have to be transformed into an annual basis.

The measurement of the utilities will cause more problems since they are based on subjective information. The traditional approach deriving utility functions from the observed market behaviour of households cannot be applied to solve the problem. The approaches based on the hypothetical preferences of households have to be considered.

![MAXIMIZATION OF HOUSEHOLD UTILITY](image)

Figure 2: Utility maximization within budget: combination of $M_A$ and $M_B$.

3 PARAMETERS IN DECISION MAKING

3.1 Attributes

The attributes to be taken into account in decision making are defined on the basis of household activities demanding functions. The functions represent the physical
environment (e.g. climate and space) of a building which enables the accomplishment of the activities (Tempelmans Plat 1996). The requirements for the functions are translated into performances which can be expressed in measurable terms such as degrees centigrade and square meters. The types of performance are stated as attributes which may each possess several levels of the performance. The required performance level is fulfilled by technical solutions. In order to fulfil the requirements for climate, for example, solutions can be defined by the specifications like wall insulation and capacity of heating installation. Several combinations of the specifications may result in the same performance while within the performance a choice out of materials and structures is still possible. The technical solutions (e.g. walls, installations) generate expenditures which are needed to be transformed into the annual costs of the attributes. The technical solutions are clustered in component groups responsible for the performances supplied over equal economical life spans. Within the component groups a limited number of attributes will be defined.

3.2 Annual Housing Costs

The financial consequences of construction activities which are needed to have particular housing services available should be transformed into the costs on an annual basis. Since the total using period of a property is usually much longer than the period of use by an individual household, we should take unavoidable expenditure outside the household’s using period into account as well (Flanagan et al. 1989). We have to distinguish the investment expenditure concerning new construction and succeeding expenditures (i.e. maintenance and adaptation expenditure) needed to keep the building usable. Furthermore, the maintenance expenditure has to be distinguished from adaptation expenditure. Maintenance is meant to keep the building usable on the level as it was initially built while adaptation depends on future demand and future investment decisions. As a consequence, the maintenance activities have to be planned at the moment of an initial investment while for adaptation only the opportunity has to be created. This is achieved by depreciating the components of the building needed to be replaced completely before the moment of adaptation. Since the replacement of the components should be able to be done freely like in the circumstances of new construction, the components under replacement should not have any financial consequences in the future. Hence, disposal expenditure has to be considered as costs of the components to be replaced.

The costs are calculated for attributes generated by the groups of components with equal life spans. Within each group the costs concerning investment, operating, maintenance and disposal activities have to be determined over their economical life span (Tempelmans Plat 1995). The annual costs of the various groups can be added to find the total housing costs (see figure 3), which should not exceed the annual budget.
3.3 Utility Measurement by Bidding Game

In order to compare the costs of the choice alternatives with the utilities, we need to find out a household’s utility function for the alternatives. Each housing alternative can be considered to be composed of various attributes. The attributes may have several levels out of which the choice has to be made. Three basic methods to derive utility function for multiattribute choice alternatives can be distinguished. These are the self-explicated utility method, conjoint analysis and contingent valuation method (see e.g. von Winterfeldt and Edwards 1986; Mitchell and Carson 1989).

In the self-explicated utility method a household is assumed to be able to evaluate each attribute separately after which the overall utility for a multiattribute choice alternative is obtained as an integrated function of the separate utility values. The other way to find out the household’s utility function is to apply conjoint analysis. In the conjoint analysis the evaluation scores given to a set of choice alternatives by the household are decomposed by employing appropriate data analysis techniques. As a result of the decomposition, the utility values for single attributes can be received and the overall utility of a certain choice alternative to be calculated by summing up the utility values of the attributes possessed by the alternative. The utility of a certain choice alternative to a household can be also determined by applying the contingent valuation method. In the contingent valuation method two choice alternatives differing from each other in one attribute are compared and the
maximum additional amount of money that a household is willing to pay for an extra unit or higher quality level of the attribute is revealed. The marginal willingness to pay amount is thus assumed to impose the marginal utility on the attribute. Since the utilities have to be compared with the costs on a marginal basis, it is reasonable to base the utility scale on money as well. On the other hand, the use of the conjoint analysis would set remarkable limitations on a number of attributes when measuring utilities on the individual level. Hence, the contingent valuation method based on the household’s willingness to pay amounts has to be selected to determine the household’s utility function. Four types of the methods to elicit the willingness to pay amounts can be distinguished (Mitchell and Carson 1989). The bidding game will be picked for further discussion. In the bidding game a respondent is presented alternative prices of the attributes. One of the prices is defined to be a starting bid. A respondent is asked if he is willing to pay the amount of the starting bid for the attribute. The bidding process is continued downward or upward until the price of the attribute equals the respondent’s maximum willingness to pay amount for the attribute.

4 DESIGN OF THE DECISION SUPPORT SYSTEM

4.1 Structure of the DSS

As a result of the foregoing, the structure of the decision support system can be now established. It starts with the definition of a household budget after which the optimum set of the attributes (and their levels) within the household budget has to be selected. The choice out of the attributes is divided into three phases (figure 4). The first phase includes the attributes such as the type of house, total floor area or the number of rooms and location. In order to be able to calculate the costs, the standard size of spaces and level of equipment have to be assumed. In the second phase the attributes concern the shift of the size of spaces as well as the selection of additional space elements such as sauna. The third phase deals with the finishings and equipment of spaces. Only the attributes of the second and third phase will be judged on the basis of the ratios of the marginal utilities to costs. In the first phase the measurement of the utilities for the attributes is excluded since on the one hand a household budget and on the other hand a small range of options available on the market of newly-build dwellings at a specific moment limit strongly the amount of choice alternatives.
4.2 Comparison of Marginal Utilities and Costs

Each attribute of the second and third phase possesses at least two levels of which the lowest level denotes the minimum level of the attribute. Two types of the minimum levels can be perceived. The first type is dominant if an attribute not necessary in a dwelling, for example sauna, does not exist. Non-existence of the attribute causes neither utility nor costs. The other type of the minimum level generates always both utility and costs and is necessary to be included in a dwelling (e.g. kitchen space or equipment).

A household's marginal willingness to pay amounts for the levels of the attributes are defined by the bidding game in which the maximum additional amount of money the household is willing to pay for a more preferred level of the attribute is elicited. The additional amount of money indicates the marginal utility for the levels of the attribute. The marginal utilities are compared with the actual marginal costs. The ratios of the marginal utilities to the marginal costs result in the measures implying the household’s relative desirability scores for various levels of the attribute (figure 5).
Figure 5: Comparison Module. In this example for each attribute only two levels are available.

Money out of the budget will be allocated to the various attributes in such a way that the ratio of the marginal utility to the marginal costs is approximately the same for all attributes chosen when the total budget is expended.

5 CONCLUSION AND DISCUSSION

It seems to be possible to develop a system which not only generates data but can really support future private house owners’ decision making. Decisions have to be based on the realistically calculated household income and the annual costs of choice alternatives as well as the utilities expected to be obtained from the alternatives. The calculation of the requisite cost information is possible although data bases concerning the economic life spans and demolishing costs of the attributes have to be first developed. Furthermore, households have to be convinced to decide about property investments on a basis of total income and costs instead of cash flows. Now they are not yet familiar with using total annual costs as a basis of their decision making. On the other hand, the measurement of subjective utilities causes problems in the system presented here. The definition of the utilities as willingness to pay amounts has several drawbacks. However, until now previous studies in the field of utility
measurement have dealt with preferences and utility functions on the market level while no particular attention has been paid to the utility measurement on an individual level. A small case study will be accomplished to give the arguments for the improvement of the system in this respect. Hence, future developments in the field of utility measurement may offer a better basis for this kind of decision support systems.

REFERENCES