



Comparative analysis of MCDM methods for the assessment of sustainable housing affordability[☆]

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ABSTRACT

While affordability is traditionally assessed in economic terms, this paper tests a new assessment method that draws closer links with sustainability by considering economic, social and environmental criteria that impact on a household's quality of life. The paper presents an empirical application and comparison of six different multiple criteria decision making (MCDM) approaches for the purpose of assessing sustainable housing affordability.

The comparative performance of the weighted product model (WPM), the weighted sum model (WSM), the revised AHP, TOPSIS and COPRAS, is investigated. The purpose of the comparative analysis is to determine how different MCDM methods compare when used for a sustainable housing affordability assessment model. 20 Evaluative criteria and 10 alternative are as in Liverpool, England, were considered. The applicability of different MCDM methods for the focused decision problem was investigated. The paper discusses the similarities in MCDM methods, evaluates their robustness and contrasts the resulting rankings.

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1. Introduction

It is imperative that both affordability and sustainability issues are simultaneously tackled in order to create successful housing and communities. Affordable housing alone is not enough to achieve community and family wellbeing; households need decent quality affordable housing that is well located within good quality environments that are clean, safe and have good access to jobs, key services and public transport [1–3]. There is both an efficiency and equity imperative to ensure that affordable housing is environmentally sustainable and socially equitable [4]. Accordingly, it may not only be the cost of housing that needs to be addressed in order to improve housing affordability; access to amenities, facilities and the energy efficiency of housing may need to be improved to create successful and sustainable living environments [5,6]. However, traditional measures of affordability are one dimensional and continue to focus solely on economic criteria as the basis of assessment [7–10].

Researchers suggest that the traditional way of defining and measuring housing affordability – the relationship between

household's income and expenditure – is too limited [11–13]. Accordingly, in order to assist in achieve successful housing outcomes, there is a need to develop a more holistic housing affordability assessment tool that is better aligned with sustainability concerns and household wellbeing.

Limitations in the assessment of affordability can be eliminated by the use of methods which are able to take into account a wider range of criteria than traditional methods do. The paper aims to test a housing affordability assessment methodology that is more holistic and capable of considering such a broad spectrum of criteria that affect the wellbeing of households, including economic, environmental and social aspects. Here, a number of widely used MCDM methods – the Weighted Sum Model (WSM), the Weighted Product Model (WPM), the revised Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Complex Proportional Assessment (COPRAS) – applied for the assessment of sustainable housing affordability. The rankings of the alternatives and their tolerance to change in criterion weights are compared amongst selected MCDM methods. The comparative analysis of these different methods will aid in establishing the most appropriate and compatible methodology for the purpose of sustainable housing affordability assessment.

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2. Housing affordability

Housing affordability has received considerable attention across the globe for a number of years [13–20]. However, the concept and measurement of housing affordability remains a challenging and contested issue. Affordability measures generally focus on the financial burden of housing costs, such as the house price to income ratio approach [20], the residual measure (income remaining after housing costs) [21] and, since the impact of the latest recession, purchase and repayment affordability measures [7]. The most commonly referred to and internationally recognised method of measuring affordability is the ratio method, which determines the proportion of income spent on housing costs [10]. This is not surprising since it has the advantage of being easy to compute as it only relies on a few, usually easily accessible, variables. Nevertheless, this simplicity is precisely what limits its effectiveness since it does not incorporate a number of factors that affect housing affordability and the household situation. This traditional approach is one-dimensional and researchers [5,11–13,22–24] are increasingly documenting its limitations. In particular, the ratio measure fails to account for differences in housing costs that are the result of perceived higher neighbourhood quality [23]. Belsky et al. [22] suggest that an ideal affordability appraisal would account for the trade-offs that households make to lower housing costs, such as transportation, access to public services, health and safety. Stone et al. [25] also emphasise a growing concern that standard affordability measures do not recognise the trade-offs between cheap or affordable housing; just because a household has an ‘affordable dwelling’ does not necessarily mean it has ‘affordable living’, owing to trade-offs. Likewise, Rowley and Ong [13] recognise that, in reality, housing affordability encompasses quality and location trade-offs. Additional costs may be imposed on households as a result of such trade-offs, both monetary and socioeconomic costs, which are disguised by traditional measures of affordability.

Housing affordability is a complex and multi-dimensional issue. Accordingly, to gain a better insight into the problem, it should not be analysed using just one concept, measure or definition [26,27]. It is clearly difficult, perhaps impossible, to address all concerns related to affordability within one simple measure. Issues such as housing adequacy, e.g. physical quality, location and access to services and appropriateness may need to be addressed by additional complementary indicators [12]. McCord et al. [27] elucidate that a one measure fits all approach to assessing affordability is problematic and policy makers must consider more than one measure when reforming policy instruments. Despite these findings, research often continues to focus on economic criteria alone as the basis of housing affordability assessments [7–10], with little regard for what households get in return for what they spend on housing in terms of housing location and neighbourhood characteristics. There is a specified need for the criteria by which housing is judged as affordable to be refined [11].

The literature highlights the need for innovations in the assessment of housing affordability. The researchers postulate that housing affordability must be defined and assessed in a more meaningful way, requiring a new paradigm of thinking that goes beyond the financial implications experienced by households. An international desire to create more affordable and more sustainable communities means that closer links must be drawn between economic, environmental and social concerns. Housing affordability and sustainability issues are increasingly being discussed mutually and are recognised as being interlinked. Affordable housing clearly has a fundamental role to play in contributing to the improved economic, environmental, social and physical health of communities [28,29]. While at the same time, a sustainable

living environment has an essential role to play in contributing to the success of affordable housing [2,3]. It is important that such issues are tackled simultaneously and accordingly a broader range of criteria ought to be considered in the assessment of housing affordability [30]. Limitations in the assessment of affordability can be eliminated by the use of methods which are able to take into account a wider range of criteria than traditional methods do.

Methods such as cost benefit analysis (CBA) and hedonic modelling were considered for this purpose. CBA seeks to quantify the benefits and costs associated with a particular alternative. However, critics claim that CBA is of limited use in complex situations because all criteria must be measured in monetary terms [31]. A monetary value cannot be assigned to all factors related to housing affordability, such as social and environmental considerations, including individuals’ welfare. Hedonic modelling is based on the fact that prices of goods in a market are affected by their characteristics and does not consider sustainability related features. This helps to estimate the value of a commodity based on people’s willingness to pay for the commodity as and when its characteristics change. However, if consumers are unaware of the relationship between certain characteristics and the benefits they may have on them or their housing, then the value will not be reflected in the property price. Once more, this method focuses on obtaining economic values for characteristics and this may be difficult to ascertain for some environmental and social factors. Moreover, the amount of data that needs to be collected for hedonic modelling is extremely large. Given the presence of numerous conflicting factors, multiple criteria decision making (MCDM) methods were deemed particularly suitable for this issue and are utilised as the basis of the sustainable housing affordability assessment.

3. Overview of multiple criteria decision making methods

MCDM is a set of methods which deal with the evaluation of a set of alternatives in terms of numerous, often conflicting, decision criteria [32,33]. Thus, given a set of alternatives (options) and a number of decision criteria, the goal of MCDM is to provide a choice, ranking, description, classification, sorting and in a majority of cases an order of alternatives, from the most preferred to the least preferred option [34–36]. There are three stages that all MCDM techniques follow [32]:

1. Determine relevant criteria and alternatives;
2. Attach numerical measures to the relative importance of the criteria and to the impacts of the alternative on these criteria;
3. Process the numerical values to determine a ranking of each alternative.

MCDM can consider qualitative and quantitative criteria. While criteria based on quantitative variables are expert independent, qualitative criteria (variables) are expert dependent and may be subjective, since different approaches such as ranking, point or other systems can be used to transform qualitative variable into quantitative units compatible with MCDM methodology. Thus, in decision making, qualitative variables (criteria) are transformed into quantitative variables using expert-designed indicators and units.

This paper is concerned with the processing of the numerical values in the final decision matrix and the determination of the ranking of the alternatives; i.e. the weights of the decision criteria and the performance of the alternatives in terms of each criterion are predetermined by the expert method.

The literature presents an array of MCDM methodologies, each with their own characteristics, varying levels of sophistication and

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