An assessment of environmental sustainability in urban areas using multi-criteria decision making method - Linear assignment (Case Study: City of Bandar Turkman)

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Extended Abstract

Introduction
Demand for urban sustainability and a resilient city is one of the important challenges of humanity in the twenty first century. In other words, today the main world opportunities and challenges are embedded in cities and the rapid growth of urbanization accompanied by industrial activities led to inefficiency of urban infrastructures and an intensive increase of environmental destruction. In the current situation, assessing environmental sustainability is one of the most important tools in the process of planning for sustainable development. This assessment is a type of ecological assessment which would be carried out in different levels in sequential way to present a framework for analyzing and assessing the impacts of plans, strategies and polices on environment in a comprehensive method by offering some recommendations to mitigate environmental pressures. So, providing an appropriate milieu for assessment and measuring environmental sustainability is inevitable in the process of urban development and planning. In this paper by a short review on environmental sustainable literature and measuring methods we tried to present a background and appropriate method for selecting the indicators and assessing the level of sustainability in the different parts of Bandar Turkman city.

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The main research question is: what is the level of environmental sustainability in the different parts of Bandar Turkman? The findings were assessed using multi-criteria methods and in the structure of linear assignment model.

Research Methodology
Discovering the main components and indicators of environmental sustainability in a comprehensive and organized way for evaluation and assessing sustainability in urban areas is multi-criteria techniques in the structure of integrated sustainability assessment. Such technique helps the users to understand the results of integrated assessment like evaluating policy aims and applying these results in a system and proposed decision making for sustainable development. There are various tools in the field of multi-criteria decision making models which could help planners and policy makers to solve decision difficulties with respect to different and contradict opinions. These models are TOPSIS, SAW, LINMAP, AHP, ANP, ELECTRE, Linear Assignment, PROMETHEE I & II, Compromise Programming and other methods. In the present paper linear assignment was applied which is a concordance subset. Coordinate subset is the third subset of compensatory models in MADM which their output would be a set of ranks so that provide necessary coordination in a most proper way. This subset includes ELECTRE and linear assignment methods. The data and information of the research were collected by reviewing different documental proofs in the related offices. Also a field survey was conducted to gather main research data and information by completing questionnaires in five different zones of the city in classified random sampling. The number of samples (380) was obtained using Cochran method and the head of households were interviewed. The statistical society of different areas was chosen by cluster sampling and based on each zones population.

Results
The obtained results of using Shannon Entropy for finding out the indicator's weights are shown. In this study zones are showed with $A_j$ and $i= 1,2,3,4,5$ indicators with $x_{ij}$ and $j= 1,2,..,26$ in tables 1 and 2.

Results of Shannon entropy method used to determine the weights of indicators. Also ranking of the zones was done regarding 26 indicators. The stages of linear assignment algorithm and the ranking results of five zones were analyzed based on rank and case limitations. The following table shows the results obtained from the model for five zones. In overall, zone 5 placed in first priority and zones of 1, 4, 3 and 2 have the next priority respectively by their environmental sustainability.

Conclusion
Environmental sustainability assessment can be as important tool in the process of urban sustainable development to direct development trend towards sustainability and consequently desalinate an optimum perspective of urban environment. Accordingly since many models and techniques were applied in different levels to
measure and assess sustainability, however have not been able to reach an appropriate framework for measurement and assessment in urban areas. So, in this context and with regard to the literature review, different indicators were selected which finally the integrated approach and multi-criteria assessment based on linear assignment technique were applied for the present research. Also, the view of different experts was considered to determine the value and importance of criteria, the given weights were incorporated in decision matrix and the final weights of indicators were calculated using Shannon entropy. The result from model application revealed that zone 5 (Isteghlal) gained the first priority and zone 1 (Farmandari), 4 (back of eastern rail way), 3 (back of western rail way), and 2 (city center) were placed in the next priorities respectively regarding their environmental sustainability. Also the results from field survey in the different zones of the city of Bandar Turkman showed that the model of linear assignment has the capacity to determine the level of sustainability in different parts of the city and then prioritize these zones. So that direct observation showed that the results from model application correspond with existing conditions in the ground.

**Key Words**: Environmental sustainability, assessment, multi-criteria decision making, linear assignment, Bandar Turkman.

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