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ORIGINAL ARTICLE

Selection of Alternative Fuels for Sustainable Urban Transportation under Multi-criteria Intuitionistic Fuzzy Environment

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Abstract The unrestrained expansion in urbanization and increasing development of new means of transports result in major urban land use and transportation system which is socially, economically and environmentally unsustainable. Hence the major challenge for the decision makers regarding the transportation policies is to choose the alternative fuel operated vehicles resulting in a sustainable transportation system. In real life situations, it is difficult to get exact data, so to express the uncertain data, intuitionistic fuzzy data has been considered. The problem is to select the best fuel technology for land transportation subject to multiple criterions resulting in a sustainable transportation system in an uncertain environment. Here, the similarity measures of Intuitionistic fuzzy sets (IFSs) are applied for developing a methodology for identifying the best option. The weights of the attributes may be known or partially known or unknown. The unknown weights are determined by normalizing the average score functions of the intuitionistic fuzzy data for the criterion. Algorithms are given for handling different situations and numerical examples illustrate the varied cases.

Keywords Sustainable urban transportation · Multi-criteria decision making · Similarity measures · Intuitionistic fuzzy sets

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1. Introduction

Sustainable transport (or green transport) refers to any mode of transport with less impact on the environment, and includes non-motorized transport, i.e., walking and cycling, transit oriented development, green vehicles, car sharing, and developing urban transport systems that are fuel-efficient, reduces noise and air pollution, space-saving and promote healthy lifestyles. Transport is a vital part of our everyday life. The prevailing 20th century view was to rely on fossil fuels for most of our transport needs and to ignore any consequences. In the 21st century people have become more environmentally conscious and there is now an almost universal appreciation of the fact that the world's resources will not last for ever. As a result, there have been moves, efforts and progress to introduce cleaner and more fuel-efficient and eco-friendly means of urban transport using different type of fuel.

Sustainable transport systems make a positive contribution to the environmental, social and economic sustainability of the communities they serve. Transport systems exist to provide increased mobility resulting in social and economic connections. The advantages of increased mobility need to be weighed against the environmental, social and economic costs that transport systems pose. The social costs of transport include road crashes, air pollution, physical inactivity.

Commuting time and vulnerability to fuel price increases. Traffic congestion imposes economic costs by wasting people's time and by slowing the delivery of goods and services. Traditional transport planning aims to improve mobility for vehicles, and may fail to adequately consider large scale impacts. But the real purpose of transport is access - to work, education, goods and services, friends and family - and there are proven techniques to improve access while simultaneously reducing environmental and social impacts, and managing traffic congestion. Communities which are successfully improving the sustainability of their transport networks are doing so as part of a wider program of creating more vibrant, livable, sustainable cities. Rising oil prices in combination with a massive increase in private cars on the highways and in the cities creates a demand for traffic planning that prioritizes flexible use of a wide variety of green traffic modes. People are looking for improved mobility in a time of limited financial possibilities. As an alternative to the oil-based engine, electric vehicles can be plugged in to a grid powered by renewable energy sources such as wind power or solar energy and charged overnight when the general electricity demand is low. New transportation options can help to cut back on greenhouse gasses and reduce air pollution in the environment. New technology and innovative methods are being used with efforts to provide a more reliable, responsible and sustainable transportation system. Steps are being taken to conserve fuel and energy, reduce carbon emissions, and protect our natural environment while keeping people and goods moving. Adequate support infrastructure for electric and other alternative fuel vehicles should be built for helping citizens and businesses reduce their carbon footprint in new ways. Traffic jams and air pollution due to CO_2 emissions of cars are two challenges caused by rapid urbanization and increasing mobility needs. An efficient