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Exploring Methods and Strategies for Sustainable Urban Development

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Abstract**—**Urban areas, as they have been developed and operate today, are areas of accumulation of a significant amount of people and a large number of activities that generate desires and reasons for traveling. The territorial expansion of the cities as well as the need to preserve the importance of the central city areas lead to the continuous increase of transportation needs which in the limited urban space results in creating serious traffic and operational problems.

The modern perception of urban planning is directed towards more holistic approaches and integrated policies that make it economically competitive, socially just and more environmentally friendly. Over the last 25 years, the goal of sustainable transport development has been central to the agenda of any plan or policy for the city. The modern planning of urban space takes into account the economic and social aspects of the city and the importance of the environment to sustainable urban development. In this context, the European Union promotes direct or indirect related interventions according to the cohesion and environmental policies; many countries even had the chance to actually test them.

This paper explores the methods and processes that have been developed towards this direction and presents a review and systematic presentation of this work. The ultimate purpose of this research is to effectively use this review to create a decision making methodological framework which can be the basis of a useful operational tool for sustainable urban planning.

Keywords**—**Sustainable urban development, urban mobility, urban regeneration methods.

I. Introduction

URBAN areas, as they have been developed and operate today, are areas of accumulation of a significant amount of people and a large number of activities that generate desires and reasons for traveling.

In Europe, the current trend is to develop integrated urban and transport strategies, in which individual policy instruments are combined to complement one another and to achieve improved performance against a given set of policy objectives. In this context, the main areas of intervention within the European Union include the improvement of urban mobility, the upgrading of public spaces and the efficiency of land use planning. However, when planning a sustainable city there are certain barriers to overcome, that include: the legal and institutional barriers which refers to the lack of legislation to permit a given policy instrument as well as lack of direct responsibility. There are also financial barriers that include lack of funds and restrictions on what funds can be spent on and when as well as weaknesses in pricing. The administration barriers refer to the competition and the difficult cooperation among agencies as well as the inefficient communication among different levels of government, etc., whereas the political and cultural barriers include the limited integration, management and coordination of policies, lack of political will, lack of organization of the civil society, etc. Finally, the practical and technological barriers refer to engineering details and technical performance, site availability, data gaps, etc. [1]. Under these circumstances, which strategic vision of a sustainable city is feasible? The key to overcome these barriers is to identify them as early as possible, ideally when considering the potential methods, techniques and policy instruments. Designing a strategy which limits the barriers impact as well as involving stakeholders in trying to reduce those impacts is further key methods to address those barriers. Furthermore, focusing on people who are mostly affected and providing compensation when it is necessary are also ways to overcome these difficulties.

Over the past three decades, achieving sustainable urban development has been central to the agenda of any city plan or policy. In principle, the modern perception of urban planning is directed towards more integrated policies and ways of development and operation of the city that makes it economically competitive, socially just and more environmentally friendly. In fact, there is a broad acceptance that integrating decisions across the sectors of land use planning, urban mobility and environment policy is crucial for sustainable development.

This paper explores the methods and processes that have been developed towards this direction and presents a review and systematic presentation of this work. It focuses on exploring the different approaches for urban regeneration with regard to the available methods and techniques that have been developed and tested in pilot areas through programs, academic research and operational plans of cities in parts of Europe, Asia and America; the urban and transport parameters are particularly studied.

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II. Methods and Techniques for Urban Regeneration

A. Research Projects

The methods and techniques that have been used as policy instruments are tested in the scope of various projects in specific pilot cases.

In particular, in the project PROPOLIS: *Planning and Research of Policies for Land Use and Transport for Increasing Urban Sustainability*, integrated urban and transport policies have been studied and implemented. Comprehensive tools and assessment methodologies have been designed and used in order to define sustainable long-term urban strategies. This project concluded that the key contributors to the urban regeneration were: (i) the improvement of public transport, (ii) services and fares, (iii) pricing of urban car use and (iv) more concentrated land use development. This project was tested in 7 pilot European cities - Bilbao, Brussels, Dortmund, Helsinki, Inverness, Naples and Vicenza [2]. Additionally, strategic approaches and methodologies towards sustainable urban transport were developed, in the scope of the project PROSPECTS: *Procedures for Recommending Optimal Sustainable Planning of European City Transport Systems*. The specific conditions of each pilot area -Vienna, Stockholm, Oslo, London, Santander and Helsinki- have been considered. The possibility of transferring the concept of the PROSPECTS project in the Southeast Asia has been examined in the project SPARKLE: *Sustainability Planning for Asian Cities making use of Research, Know-How and Lessons from Europe* [3] in cities of 4 Asian countries - Thailand, Vietnam, Cambodia, Laos.

With regards to sustainable urban transport, integrated solutions are developed in the scope of various projects. In particular, a series of innovative solutions for buses and new generation bus systems have been investigated in the project EBSF: *European Bus System of the Future*. New urban route layouts have been developed, remote maintenance systems have been upgraded, communication systems have been improved and eco-efficient engines have been used in 7 pilot European cities - Bremerhaven, Budapest, Gothenburg, Lyon, Madrid, Rome and Rouen. The effectiveness of the measures and the transferability to other cities has been assessed in the scope of this project [4].

Giving emphasis to decision-making tools that promote the implementation of innovative techniques and policies, rather than dictating possible solutions and measures is another further approach for sustainable urban development. The project DISTILLATE: *Design and Implementation Support Tools for Integrated Local LAnd use, Transport and the Environment* is an indicative example of providing ways of addressing the difficulties of decision-making processes [5].

B. Further Approaches

Apart from the context of the projects, further research is conducted in developing and testing methods and techniques for sustainable urban development. In particular, a 52 indicator system, the *Full Permutation Polygon Synthetic Indicator*, is another suitable method aiding the decision-making process and its efficiency in the field of sustainable urban development. The method provided a comprehensive, intuitive approach that reflects the principle of the system integration, whereby the whole can be more than the sum of its individual parts. The method has been applied in the city of Jining in China [6].

Through the redesign of the public transport system, the *heuristic-expert design method*, another integrated approach for sustainable urban transport is developed and applied in Krakow in Poland. It is a design and evaluation methodology for transport solutions that result in the creation of an integrated urban public transport system. This research suggests that the public transport system should be working efficiently in order to be competitive with the private car use [7]. Additionally, in order to enhance the implementation of a sustainable urban strategy, 18 decision-making tools have been developed. For this purpose the action research methods have been used and applied in several European cities [8].

III. Instruments for Urban Regeneration

The methods and techniques that have been described in the previous chapter are guided by instruments that are directly linked with the use of specialized, processing and decision-making software. In this section, a presentation of the most representative instruments and models is conducted.

Two of the most applied quantitative multi-criteria land use planning techniques that were applied at a local level as decision making tools are, (i) the *Analytic Hierarchy Process* (AHP), and (ii) the *Fuzzy AHP*. The methods have been based on the relative comparison among the factors that determine every decision and its alternative. A comparative application of these techniques has been practiced in the cities of Gold Coast and Brisbanein Queensland (USA), as a decision-making tool for urban regeneration [9].

For the evaluation of sustainable urbanization, the *hybrid Entropy–McKinsey Matrix method* has been applied in a survey held in Jinan City, in China. According to the findings of this survey, the method is an effective tool in the effort of policy makers to understand the performance of urban sustainability and therefore to formulate appropriate strategies for more sustainable solutions towards urban development [10].

A strategic decision-making model based on the land use and transport interaction is MARS: *Metropolitan Activity Relocation Simulator*. This model uses flow diagrams to study the relationship of cause and effect. The model is capable of analyzing combinations of policies at metropolitan level in less than a minute and to assess their implications for a 30 years planning period [11]. Another instrument with emphasis on aiding decision-making processes rather than dictating possible solutions is the UK *Konsult* tool. It is practically a knowledge base for sustainable urban transport and land use that provides detailed information on individual policy measures. It allows policy makers to specify their context, objectives and strategy, and provides them with a list of possible options for further consideration [12].

For traffic management, the demand estimation model, SATURN: *Simulation and Assignment of Traffic to Urban Road Networks* is appropriate. It is quite flexible and has faster approach for designing road pricing systems. It has been developed and tested in Cambridge, Shrewsbury and London with the appropriate adjustments [13].

In the same context, but a more advanced design tool is the DRACULA: *Dynamic Route Assignment Combining User Learning and microsimulAtion*. It has been enhanced to identify the results of urban traffic management and bus services management and reliability. It represents individual drivers' learning and daily route and departure time choice behaviour, with a microscopic traffic model, which simulates individual vehicle movements through the network. It has been tested in York [14].

For the implementation of a new concept for urban mobility, based on a vision of a broader urban planning that takes into account multiple parameters the I_SUM: *Index of Sustainable Urban Mobility* is appropriate. It is a tool that evaluates the existing conditions of urban mobility and can be used to formulate policy. This tool is flexible and adaptive to different urban environments. However, it is not capable of capturing positive aspects of the city, such as long-term land use policy, average urban transport system [15].

The use of the spatial 'dimension' that incorporates the environmental factor into the local spatial planning process has multiple benefits for the decision-making process. In this section, a presentation of some indicative examples is conducted.

For improving the coherence between spatial and environmental policy at a local level the GIS-based tool STEPP: *Strategic Tool for integrating Environmental aspects in Planning Procedures* is appropriate. An exchange of information between the competent authorities and decision makers is required as well as providing a means to investigate alternatives [16].

A more modern GIS tool aiding the decision-making process is the SNAMUTS: *Spatial network analysis for multimodal urban transport systems*. This tool assesses the centrality and connectivity of the public transport networks. It identifies and visualizes parameters such as the geographical coverage of public transport, the degree of connecting sites with linked activities as well as the competitiveness of the speed between public transport and private car use. The tool has been tested in Perth, Melbourne and Hanover and then applied in Porto and Copenhagen [17].

A significant instrument particularly related to the spatial dimension of urban planning is Space Syntax. It is a theory and a set of methods for the analysis of spatial configurations [18]. It has been widely applied in the fields of urban planning, urban design, transportation planning, etc. This instrument has been particularly used for investigating the relationship between land use density and urban street configuration, interpreting the relationship between the urban environment and the traffic network [19] as well as exploring the structural pattern of urban road networks [18]. The space syntax method has also been recently used for designing new parts of towns, planning open urban spaces, for disaster risk management through the analysis of different urban patterns and for understanding the socio-economic conditions of a settlement in terms of the overall spatial structure [18].

IV. Conclusions and Perspectives

The present paper investigates and presets a systematic review of the methods and strategies that have been developed and applied towards sustainable development in the urban space. This research identifies that the modern trends are directed towards more integrated urban and transport strategies, in which individual policy instruments are combined to complement one another and to be more efficient in terms of policy objectives.

The redesign of the public transport system is explicitly studied in several pilot cases in order to achieve more integrated solutions in urban transport. The contribution of different policy instruments for urban regeneration is also assessed and practiced in several projects. Additionally, the decision-making tools for the implementation of innovative techniques and policies are often more efficient than identifying a list of possible solutions and measures. In this context, the use of the spatial 'dimension' that incorporates the environmental factor into the local spatial planning processes has multiple benefits.

The next step of this research is to create a decision making methodological framework, which can be the basis of a useful operational tool for sustainable urban planning.

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References

[1] A.D. May M. Crass, "*Sustainability in transport: implications for policy makers*". *Transportation Research Record*, 2017, pp. 1–9, 2007.

[2] K. Lautso, Spiekermann, M. Wegener, I. Sheppard, P. Steadman, A. Martino, "*PROPOLIS-Planning and Research of Policies for Land Use and Transport for Increasing Urban Sustainability", PROPOLIS-Project funded by the European Commission*, Helsinki, 2004.

[3] G. Emberger, P. Pfaffenbichler, S. Jaensirisak, P. Timms, "*'Ideal' decision-making processes for transport planning: A comparison between Europe and South East Asia"*, *Transport Policy*, 2008, 15, pp. 341–349.

[4] A. Musso, M.V. Corazza, "*The European Bus System of the Future: Research and Innovation"*, *Transportation Research Procedia*, 5, 2015, pp. 13 – 29.

[5] A.D. May, M, Page, A. Hull, "*Developing a set of decision-support tools for sustainable urban transport in the UK"*, *Transport Policy*, 15, 2008, pp. 328–340.

[6] F. Li, X. Liu, D. Hu, R. Wang, W. Yang, D. Li, D. Zhao, "*Measurement indicators and an evaluation approach for assessing urban sustainable development: A case study for China's Jining City"*, *Landscape and Urban Planning*, 90, 2009, pp. 134–142.

[7] K. Solecka, J. Żak, "*Integration of the urban public transportation system with the application of traffic simulation"*, *Transportation Research Procedia,* 3, 2014, pp. 259 – 268.

[8] A.D. May, S. Ison, "*Decision-support for sustainable urban transport strategies"*, *Transport Policy*, 15, 2008, pp. 325–327.

[9] R. Mosadeghi, J. Warnken, R. Tomlinson, H. Mirfenderesk, "*Comparison of Fuzzy-AHP and AHP in a spatial multi-criteria decision making model for urban land-use planning*", Computers, Environment and Urban Systems, 49, 2015, pp. 54–65.

[10] L. Shen, Z. Jingyang., M. Skitmore., B. Xia, "*Application of a hybrid Entropy–McKinsey Matrix method in evaluating sustainable urbanization: A China case study*". *Cities*, 42, 2015, pp. 186-194.

[11] P. Pfaffenbichler, G. Emberger, S.P. Shepherd, "*The integrated dynamic land use and transport model MARS*", *Networks and Spatial Economics*, 8 (2–3), 2008, pp. 183–200.

[12] KonSULT, *Knowledgebase on Sustainable Urban Land use and Transport*, http://www.konsult.leeds.ac.uk/

[13] S.P. Shepherd, A. Koh, A.D. May, "*How to design effective road pricing cordons*". *Proceedings of the Institution of Civil Engineers Transport*, 161, 2008, pp. 155–165.

[14] R. Liu, S. Sinha, "*Modelling urban bus service and passenger reliability.Proceedings of the INSTR2007: The Third International Symposium on Transportation Network Reliability*, 2007

[15] H.F. Miranda, A.N. Rodrigues da Silva, *Transport Policy*, 21, 2012, pp.141–151.

[16] G.J. Carsjens, A. Ligtenberg. "A GIS-based support tool for sustainable spatial planning in metropolitan areas", *Landscape and Urban Planning*, 80, 2008, pp. 72–83.

[17] C. Curtis, J. Scheurer, "*Planning for sustainable accessibility: Developing tools to aid discussion and decision-making*", *Progress in Planning*, 74, 2010, pp. 53–106.

[18] B. Ahmed, R. Hasan, K.M. Maniruzzaman, "*Urban Morphological Change Analysis of Dhaka City, Bangladesh, Using Space Syntax*", *Geo-Inf*, 3(4), 2014, pp. 1412-1444.

[19] M. Giannopoulou, Y. Roukounis, V. Stefanis, "*Traffic network and the urban environment: an adapted space syntax approach*", *Social and Behavioral Sciences*, 48, 2012, pp. 1887-1896.