Supporting the Integrated Planning for Land Use and Transport Systems by Examining the Distribution of Urban Centres and Public Transit Networks

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Abstract

The transit system is a well-known concept that can integrate land use and transport systems. One of the key strategies to implement such a system is to recognise the viable centres of activity. Moreover, a certain urban spatial form is required to achieve successful implementation. The type of the urban form is represented by the physical form of land use pattern and transport system. This research aims to find a way to adjust the transport system to the already established urban area and identify suitable urban spatial structure for the implementation of public transit systems. This research thesis set out to provide an empirical analysis of how Makassar's urban centre identification can be used as a basis for planning an urban form that can enhance the implementation of a transit-based public transport system. The research aims are divided into four steps which include: 1) identifying the proxy indicators to identify the urban centre; 2) defining the centre hierarchy/classification; 3) comparing the results with the current and planned public transportation system; 4) defining the suitable urban spatial structure that can be developed to support an integrated transportation system. The study takes Makassar-Indonesia as the case study. Data of urban physical characteristics are obtained from open street maps and from the Makassar local spatial planning authority. This research combines quantitative and qualitative approaches. Spatial cluster analysis with a k-means algorithm is used to identify the urban centres while content analysis is applied to expert interviews analysis. The results of the expert interviews are used to obtain knowledge of local information and validate the results from the quantitative approach. The results show that 1) density, diversity and design (3Ds) are suitable proxy indicators to identify Makassar's urban centres; 2) Makassar's urban centres can be classified into primary, secondary, and tertiary centres; 3) Makassar's urban centre distribution is not entirely integrated with the actual and planned public transportation system; 4) the combination of a strong monocentric and linear polycentric form is recommended for supporting an integrated transport system which adopts the public transit concept to the many pre-existing expanded cities. The linear polycentric form can be achieved by improving the 3Ds around the transportation nodes and networks.

Keyword: built environment dimensions, spatial cluster analysis, experts' interview, transit system, linear-polycentric, developing countries

Chapter 7
Concluding Remarks

Transit-based public transport systems offer a favourable solution to overcome automobile dependency and traffic congestion in more complex urban areas. Many cities all over the world are keen to adopt such systems. Therefore, approaches that can help to match the transit system to complex urban areas with their individual characteristics becomes valuable knowledge.

The main objective of this research has been to find a way to adjust the transport system to the already established urban area and identify urban spatial forms that can improve the implementation of the public transit system. This research thesis set out to provide an empirical analysis of **How can activity centres be identified for the city of Makassar and what are the implications of the results for an integrated land use and transport planning?** Four steps have been set to achieve the main research objectives, i.e., a) identifying relevant indicators and analysis methods to identify the urban centres that significantly attract people in Makassar's urban area; b) defining what the spatial distribution of centres looks like and determining whether they can be categorised or divided into hierarchy; c) comparing the urban centre distribution to the planned public transport nodes and identifying its implications in the local planning policy; 4) defining recommended urban forms that can be developed to support a transit-based public transport system.

To achieve the first two steps, an extensive literature review in Chapter 2 and a quantitative analysis method in Chapter 5 have led to the conclusion that indicators that represent built environment dimensions, i.e., density, diversity, design, distance to transit, and destination accessibility (5Ds), can be used as proxy indicators to identify the urban centre. Based on the empirical results, using only the 3Ds (density, diversity, and design) in the case of Makassar resulted in the successful depiction of the distribution of Makassar's urban

centres. The empirical analysis using these three dimensions with a spatial cluster (k-means algorithm) analysis method yielded a satisfying result that closely resembled the actual situation.

Based on the empirical results, Makassar's urban centre has been found to be mainly distributed in the CBD neighbourhood, while the centres in the eastern part of the city form a corridor pattern. Based on the indicator thresholds, the centre can be classified into a primary, secondary, and tertiary centre.

To achieve the third step, a comparison between the empirical result and transport planning policy was conducted. Among the four main networks going into the primary centre, two of the main networks serve the high-density area where the concentration of activity exists, while two others serve the low-density neighbourhood. A secondary network to the southern part of the city has been planned without transit stops. The implications of the empirical results to the Makassar transport planning have shown that Makassar's urban form is not entirely integrated with the planned public transport system. Therefore, adjustments for planning around the transit system are needed.

The recognition of the urban form from the emprirical results has led to the achievement of the fourth research objective. Scholars have concluded that the strong monocentric combined with the linear polycentric form supports an integrated transport system, which adopts the public transit concept to the most expanded cities. Based on the empirical results, Makassar has a strong monocentric form and is currently transitioning to a form that is linear polycentric due to urban expansion. Makassar's linear polycentric structure is appropriate for transit system implementation. To support the transit-based public transport implementation, the local authority has to consider increasing the 3Ds especially in transit centres and the CBD to maintains the continuity of service in the future. In addition, a policy to contain sprawl in a suburban area is necessary to support concentrated travel demands. Afterwards, the linear

polycentric form will enhance transit-based public transport development. In the end, the empirical results make it possible to propose a concept and strategies for integrating public transit as the main system alongside last-mile connectivity.

7.1. Novelty

Since many cities are keen to implement a transit system as a solution for overcoming traffic congestion, this research has introduced an urban form assessment which aimed to improve the development of the urban structure so that it can be matched to public transit system implementation. The assessment began by identifying urban centres.

Based on this research, the definition of urban centre can be described as a place with a high density of firms, various activities, and is well served by public transport facilities. At the same time, the urban centre is also a mobility attractor.

This research has provided an alternative method and proxy indicators to identify the urban centre as a solution for the lack of available census-based data (employment distribution and travel characteristics) that has mostly occurred in cities of the developing world. Urban physical characteristics, known as built environment dimensions, are relevant indicators for identifying the urban centre. Since these dimensions have been used in the land use and transport interaction field, the dimensions can provide a quantitative measure to identify the urban centre as the activity centre, urban attractor, and public transport node. The indicators have been used widely in the implementation of transit-oriented developments to determine the transit centre. Therefore, these indicators can benefit from being used to integrate the land use and transport system. The proposed method can fill the gap concerning the lack of methods in transport planning that considers the typology of urban fabrics mentioned by Newman and Kenworthy (2015). Based on this empirical result, the identified urban centre can be categorised into three different fabrics based on Newman and Kenworthy

(2015), i.e., the walking fabric, transit fabric, and car fabric which show the characteristics of the urban area.

This research has also introduced a new approach to calculate and analyse indicators using PostGIS and GIS-based cluster analysis. This approach adds new knowledge to the field of urban studies due to the advancements in open-source urban characteristics data and analysis tools.

The results have shown that Makassar is a strong monocentric urban area but in a transition to the linear polycentric form. Based on these findings, this research suggests that the polycentric linear form is appropriate for transit system implementation, especially for Makassar's expanded urban area. This research has provided a framework of assessment that can be used as the basis to develop a suitable urban form to implement a transit system. This framework offers a spatial point of view that can help planners or decision-makers to manage their development and investment priorities. Since the study has provided the point of view of the spatial perspective and its direct implications for the public transport system, the framework can be developed into an initial assessment tool to be integrated into public transport system policy. This integration has the potential to provide sustainable, efficient, and effective services within an urban area.

This research has provided a fundamental result from the spatial point of view to support the integrated planning of land use and transport systems, especially for the main public transit and the last-mile service modes. However, further studies are required particularly in other fields, such as socioeconomics and policy, to provide a complete multidimensional point of view of transit-based public transport provision. As an initial assessment, this study has provided valuable insights into dimensions for identifying the urban centre and has also depicted the type of urban form, which is the basis for transit system implementation. The

results of this study will become a valuable source for future planning in Makassar's transport system.

Since they provide a point of view for land use and transport, the methodology and measures that have been used in this research are effective for public transport provision regarding the determination of nodes and networks. The centre distribution has provided a spatial configuration as representation of transport demand. At the same time, the comparative results of the urban centre have identified useful transport networks and nodes for the transport supply. The findings have also offered information regarding the possible zones that can be developed for a last-mile modes service area that can support the main public transit service. Therefore, a complete spatial point of view of the main transport system and the potential last-mile support service area have been obtained. By using this approach, the integrated land use and transport system will yield an efficient public transport provision. In terms of policy implications, the research output can be used as a basis for formulating land use planning instruments and urban transport strategies to integrate land use and transport planning policy.

Since many city authorities already have a GIS-based urban database and the possibility to obtain data from open-source platforms, this research framework can be easily replicated to other cities. Planners and practitioners with a basic knowledge of ArcGIS software can easily follow the steps in this research framework (see Figure 14 and 16 in Chapter 4). The assessment should precede the planning stages to have a knowledge of the spatial configuration of land use and the transport system.

In the end, the proposed framework can be used as a starting point for the planners and local authorities to realign the public transit network and last-mile connectivity into the already built urban area. The analysis results have shown that there is only one corridor of the Makassar transit system plan that has the appropriate density and composition to support

the transit corridor. Therefore, for the future development of transit-based public transport provision, it is necessary that Makassar's local authority considers regulating the following suggestion:

1. Control the urban expansion into more concentrated developments along with the public transport network
2. Maintain the respective density that is already aligned with the urban centre. Increase the density around the industrial, warehouse, and single-use residential areas that are served by the public transport network.
3. Develop the transport infrastructure to support the use of last-mile modes as feeders to the transit system.

7.2 Limitations and Suggestions for Future Research

Urban areas especially in developing countries have special challenges (rapid urbanisation, automobile dependency, traffic congestion, lack of public transport supply, and limited funding resources). Therefore, the relationship between land use and the transport system becomes more complex and requires various methods and models to understand the relationship. This research has developed an approach from the planning perspective to assist planners, practitioners, and policy makers with assigning particular planning actions to integrate land use and the transport system. Since the approach has focussed solely on the spatial point of view, it has some limitations that are described as follows:

a. The results of the spatial cluster analysis are vulnerable to accuracy and sensitivity challenges. To overcome these challenges, several indicator filter and selection steps have been made. Several computations with different indicator combinations have also been conducted to obtain more objective results.

b. The expert interviews have also brought subjective data into this research. The size and border of the pointed urban centres are varied among experts. Despite some deviations, the spatial cluster analysis has succeeded in quantifying most of the urban centres that were mentioned by the experts. The urban centres' characteristics have also been supported by the reviewed literature. The cluster analysis has determined the centres size and border with standardised indicator values. Therefore, the issue of experts' subjectivity has been remedied.
c. The replication of this research approach in other cities might yield different indicator combinations. However, this is not a limitation but an advantage of this approach. The different results make it possible for other cities to show their distinct characteristics.
d. Based on this initial assessment, planners, practitioners, and policymakers have a basis for integrated planning regarding land use and the transport system. However, they are required to gather more information from the transport demand and supply to provide appropriate modes capacities for the main public transport system.
e. The approach and indicators cannot be used for simulating the urban model, for example, for creating the spatial scenario when the improvement of the 3Ds (density, diversity, and design) is implemented around the transport system. The simulation requires more detailed information and different tools, but this was not within the scope of this research.
f. The approach cannot forecast the future transport demands and transport supply. The forecast requires detailed information of travel characteristics and market dynamic that required study from different point of view.

An integrated transport system should consider two main aspects, i.e., supply and demand. Since this research has only provided a point of view from the transport demand, especially from spatial analysis, future research should address this issue from the perspective of the potential users of the public transit service and paratransit stakeholders. Studies on the

transport supply side are already well-established in the developed world; however, for cities in the developing world these are especially needed. Cities in the developing world are experiencing rapid population growth as well as limited resources in funding and investment. They also have different socioeconomic and cultural characteristics. Future studies also need to address all the stakeholders' perspectives regarding the planning and implementation of transit-based public transport in their city.

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