

Transport network in relation between road and railway Comparison of Addis Ababa and Toyama

Architecture and Civil Engineering
Spatial Planning and Design

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1. Introduction

Addis Ababa city is growing in population, where traffic congestion is a major problem. Toyama is selected as a comparison due to its compact city planning and eco-friendliness. This research looks at the transport network of Addis Ababa and Toyama cities, in which population, road connectivity, traffic load, and road serviceability are examined. Graph theory including Space Syntax is applied to compare the connectivity of road networks between the two cities.



Fig. 2 Addis Ababa Merkato, the market, and LRT

3. Toyama compact city planning

Toyama is the capital city of Toyama prefecture on the Japan Sea side, which had been a castle town until the modern establishment in 1889. Its 70% area is covered with forest and agricultural fields. The city since the 2000s has been faced with an aging society, car dependency and the city center declining, and come up with compact city planning to improve amenity and mobility through public transportation network including the light rail transit (LRT) reusing the ex-port railway and development around the stations.

Table 1 Addis Ababa and Toyama scales

	Addis Ababa	Toyama	Toyama CPA	Toyama DID
Population	3,519,000	422,000	292,790	223,250
Area (km ²)	540	1,242	230	55.56
Pop. per km ²	6,517	340	1,273	4,018

CPA: City Planning Area, DID: Densely Inhabited Area

2. Addis Ababa city development

Addis Ababa city primarily developed in “sefer” (village) structure. The opening of Legehar transit hub defined the city center. The modal transportation shares walking 54%, public transport 31% and private cars 15%. Walking and public transport dominate 85% [1]. Addis Ababa presently suffers from increasing traffic congestion and poor public transport.



Fig. 3 Toyama compact city planning [3] and LRT

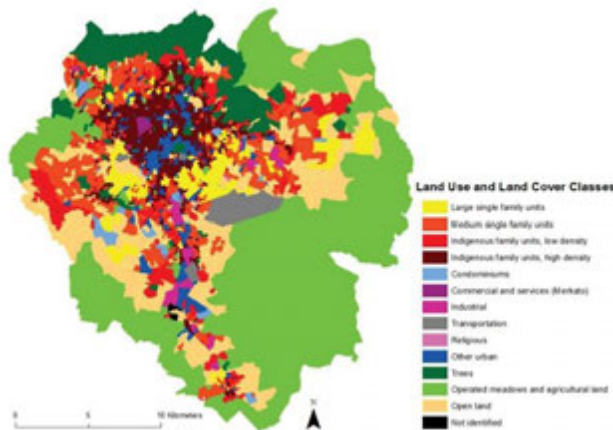


Fig.1 Land use of Addis Ababa [5]

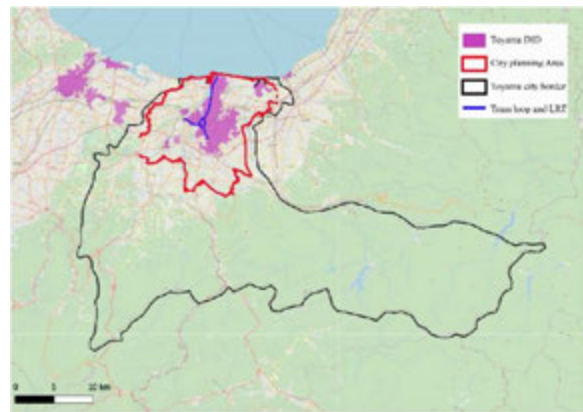


Fig. 4 Toyama city (black), DID (purple) and city planning area (red)

4. Transport network analysis

Basic indexes of connectivity of graph theory are examined to evaluate Addis Ababa's road network. Numbers of segments (e : edge) and nodes (v : vertex) are counted in the sub-cities from the road map Fig.5. The index β [$=e/v$], link-node ratio, shows 1.24-1.50 while 2.5 as perfect grid and 1.4 as a good planning target. The Index α [$=(e-v+1)/(2v-5)$], a measure of redundancy and duplication, shows 0.14-0.37 while 0 as simple network and 1 as high integration. The index γ [$=e/3(v-2)$], a measure of relationship between observed and possible links, shows 0.44-0.59 while 1 as complete network. On the ground of the indexes above, the road connectivity of Addis Ababa is not perfect but in acceptable range.



Fig. 5 Addis Ababa road network [5]

Table 2 Connectivity indexes

Sub-cities	e	v	α	γ	β
Addis-Ketama	42	29	0.26	0.52	1.45
Arada	84	56	0.27	0.52	1.50
Kirkos	119	85	0.21	0.48	1.40
Lideta	57	46	0.14	0.43	1.24
Nifas-Silk	120	89	0.18	0.46	1.35
Bole	158	92	0.37	0.59	1.72
Gulele	69	44	0.31	0.55	1.57
Akaki-Kaliti	112	82	0.19	0.47	1.37
Kolfe-keranio	120	93	0.15	0.44	1.29
Yeka	130	101	0.15	0.44	1.29
Addis Ababa	1011	717	0.21	0.47	1.41

Space Syntax

Space Syntax is used to analyze the pattern of cities through the connectivity of streets as segments. Yellow in the maps represents high connectivity of road network with numerous intersections and blue indicates low. Poor connectivity in blue is found around the railway in

Addis Ababa, while Merkato, the market, around the city center and new development areas in the east and the south-west show better in yellow. Toyama city center carrying LRT and trams shows high in yellow.

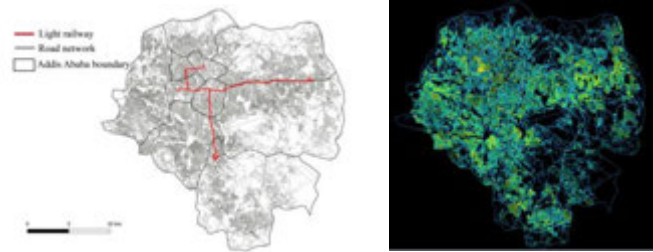


Fig. 6 Addis Ababa railway (left) and connectivity

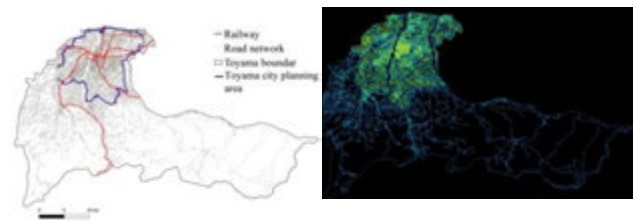


Fig. 7 Toyama railway (left) and connectivity

5. Summary

Toyama's road network shows high connectivity in the city center facilitated with public transportation, which indicates the road and the railway enhance mobility each other. Addis Ababa's road network is statistically well connected and, however, locally shows low connectivity along the railway, which indicates the road and the railway are less integrated yet to improve the mobility in the city.

Reference;

1. ARUP. (2015). Consult Service of Transit-Oriented Development (TOD) Around 10 Stations of Addis Ababa Light Rail Transit. Addis Ababa.
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5. Agata, R., and Martin, K. (2014). Spatial integration of waste management data in urban areas. ee publishers.