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Land resource availability and climate change disasters in the rural coastal of Central Java - Indonesia

(Conference Paper) (Open Access)

Rudiarto, I.[a,b], Handayani, W.[a,b], Wijaya, H.B.[a,b], Insani, T.D.[a,b]

[a]Department of Urban and Regional Planning, Indonesia
[b]Universitas Diponegoro, Semarang, Indonesia

Abstract

View references (16)

This paper describes the land resource availability and climate change disaster events in three rural coastal area ofthe Central Java Province, Indonesia, i.e.; Wonokerto sub district - Pemalang Regency, Sayung sub district - Demak Regency, and Lasem sub district - Rembang Regency. Land resourceavailability was assessed into land use cover change from the Landsat Image from three periods (1990, 2000, and 2015). Those images data then were combined with the climate change disasters that mostly occurs in the coastalarea as the impact of the sea level rise. The results show that most of the land use in the coastal area was convertedto fishpond from agricultural land and it happens periodically since 1990 as the disasters frequently found which also transform the occupation of community living in the area. From the assessment, it is also shown that the increasing of water body in specific period has a direct impact to the decreasing of rice field. This indicated that tidal flood as an impact of climate change has contributed in changing the availability of land resource in the study area. © Published under licence by IOP Publishing Ltd.

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PREFACE

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Some results that can be concluded in this proceedings are: 1).Better predictions on the urban and sub urban development is equal with better planning, there are many new modelling approaches that presented in this conferences from land use, transportation to smart applications, 2). The emerging development of peri urban often facing the infrastructure and land use issues and 3). The urban that recently need to be revitalized not only on the sense of economic and land use but also gaining social and humanistic approaches to be creative space and igniting the place attachment in the city.

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Table of contents

Volume 202

2018

Previous issue Next issue

CITIES 2017: Multi Perspectives on Peri-Urban Dynamics Towards Sustainable Development 18 October 2017, Surabaya, Indonesia

View all abstracts

Preface

OPEN ACCESS 011001

CITIES 2017: Multi Perspectives on Peri-Urban Dynamics Towards Sustainable Development

+ View abstract View article PDF

OPEN ACCESS 011002

Peer review statement

+ View abstract View article PDF

Papers

OPEN ACCESS 012001

Study on implementation of flood early warning system with internet of things in peri-urban settlement of Palembang for sustainability

A Supani, Y Andriani, A Taqwa and Ciksadan

+ View abstract View article PDF

OPEN ACCESS 012002

Model of transportation mode choice between aircraft and high speed train of Jakarta-Surabaya route

A Y Nurhidayat, H Widyastuti and D P Utomo

+ View abstract View article PDF

OPEN ACCESS 012003

The institutionalisation process of Transit Oriented Development practices for peri-urban development in Indonesia: Actor network perspective

C T Permana, Y Chrisnawati and H S Hasibuan

+ View abstract View article PDF

OPEN ACCESS 012004

Spatial analysis: Mapping potential land for sustainable urban forests using Landsat-TM satellite data imagery in East Jakarta

D M Sundara, D M Hartono, E Suganda and H Haeruman

+ View abstract View article PDF

OPEN ACCESS 012005

Road safety analysis on Srondol – Jatingaleh highway, using Crash Modification Factors (CMFs) Case study: Semarang City, Central Java, Indonesia

B Istiyanto and D Widitasari

+ View abstract View article PDF

OPEN ACCESS 012006

Factors that effect to land use change in Pandaan District

G Prayitno, Surjono, A R T Hidayat, A Subagiyo and N K Paramasasi

+ View abstract View article PDF

OPEN ACCESS 012007

Land use attraction model for Logistic Service Provider (LSP) on Trunojoyo road in the City of Malang

I W Agustin

+ View abstract View article PDF

OPEN ACCESS 012008

Analysis of karst potential using Landsat 8 Imaging and DEM in the District of Sampang, Madura Island, East Java

M F F Putra, I G A T Nuarisanti, U D Sulistyah, I G B Putra and W Utama

+ View abstract View article PDF

OPEN ACCESS 012009

Controlling polycyclic aromatic hydrocarbons emission of peri urban air Jakarta

Miftahudin, S Hudiyono, R H S Koestoer and Budiawan

+ View abstract View article PDF

OPEN ACCESS 012010

Peri-urbanization: a study from ICT perspective

P A Widyanarko

+ View abstract View article PDF

OPEN ACCESS 012011

Strategy of urban settlement planning through a model of public service facilities

S Hariyani, F Usman and E B Kurniawan

+ View abstract View article PDF

OPEN ACCESS 012012

Public transportation accessibility: towards sustainable transit oriented development (Case study: Depok Baru Station – Jakarta, Indonesia)

W Hadi, Y Chrisnawati and H N Ikhsan

+ View abstract View article PDF

OPEN ACCESS 012013

Analysis of flood by using river flow map from landsat 8 imaging to mitigate flood and the use of bamboo planting to prevent the flood study case: Kemuning river, Madura

M F F Putra, I G A T Nuarisanti, U D Sulistyah, I G B Putra and W Utama

+ View abstract View article PDF

OPEN ACCESS 012014

Land-use analysis of eco fishery tourism using a low-cost drone, the case of Lumpur Island, Sidoarjo District

Y Prasenja, A T Alamsyah and D G Bengen

+ View abstract View article PDF

OPEN ACCESS 012015

Application of space syntax method to measure spatial connectivity in campus of Institut Teknologi Sepuluh Nopember (ITS)

A M Navastara, M Yusuf and P Navitas

+ View abstract View article PDF

OPEN ACCESS 012016

Appropriate technologies for local economic development based on fisheries products in Poteran Island

A Pamungkas, E Nurmianto, V K Siswanto and A Sulistyono

+ View abstract View article PDF

OPEN ACCESS 012017

Land use change simulation based on land price spatial model in Tembelang, Indonesia

C Susetyo and M N E Sasono

+ View abstract View article PDF

OPEN ACCESS 012018

Spatial pattern analysis using spatial metrics: a case study in Surabaya, Indonesia

F Firmansyah, A Pamungkas and K D Larasati

+ View abstract View article PDF

OPEN ACCESS 012019

Commuters' travel behaviour and willingness to use park and ride in Tangerang city

K D M E Handayeni and B S P Ariyani

+ View abstract View article PDF

OPEN ACCESS 012020

LanduseSim Algorithm: Land use change modelling by means of Cellular Automata and Geographic Information System

N A Pratomoatmojo

+ View abstract View article PDF

OPEN ACCESS 012021

An application of Multinomial Logit Model (MNL) on tourist destination choices

S Nurlaela

+ View abstract View article PDF

OPEN ACCESS 012022

Modelling toll traffic pattern: the Jagorawi toll case study

Yosritzal, S Nurlaela, M Rizki and H M Taki

+ View abstract View article PDF

OPEN ACCESS 012023

LanduseSim Methods: Land use class hierarchy for simulations of multiple land use growth

N A Pratomoatmojo

+ View abstract View article PDF

OPEN ACCESS 012024

Time and cost analysis of jacket structure load out using skidding

Silvianita, R D Pradana, D M Chamelia and W L Dhanistha

+ View abstract View article PDF

OPEN ACCESS 012025

Peri-urban farmland owner in the growing municipality, case study Kediri Municipality

A R T Hidayat

+ View abstract View article PDF

OPEN ACCESS 012026

Exploring farming strategies in a metropolitan area: case study of inland aquaculture in Bogor Regency

A Syaifudin and G J Carsjens

+ View abstract View article PDF

OPEN ACCESS 012027

Transformation of metropolitan suburban area *(a study on new town development in Moncongloe-Pattalassang Metropolitan Maminasata)*

B Surya, H Saleh and Ariyanto

+ View abstract View article PDF

OPEN ACCESS 012028

Providing simple healthy latrine based on community empowerment in Gebang Putih Village and Kejawan Putih Tambak Village

E S Soedjono, J R Budiani, B D Marsono, A Purnomo, I Ulfin and K P Tucunan

+ View abstract View article PDF

OPEN ACCESS 012029

Land resource availability and climate change disasters in the rural coastal of Central Java – Indonesia

I Rudiarto, W Handayani, H B Wijaya and T D Insani

+ View abstract View article PDF

OPEN ACCESS 012030

The benefits of an agrarian reform model in Indonesia

M Sadyohutomo

+ View abstract View article PDF

OPEN ACCESS 012031

Peri-urban interaction and connectivity to the development area of Indragiri Hulu Regency, Riau Province

P Astuti, I Nugraha, A Afriadi, R B Leksono and Mardianto

+ View abstract View article PDF

OPEN ACCESS 012032

Analysis of Marketability, Sustainability, Participatory and Disaster Mitigation (MSP+DM) for the development of rural Community-Based Tourism (CBT) destinations Case study: Depok beach, Bantul, Yogyakarta

S Priatmoko

+ View abstract View article PDF

OPEN ACCESS 012033

Water supply provision characteristics in peri-urban area

S Maryati and A N S Humaira

+ View abstract View article PDF

OPEN ACCESS 012034

An integrated and sustainable infrastructure development to improve the quality of rural area in peri-urban

T Madiasworo

+ View abstract View article PDF

OPEN ACCESS 012035

Towards an independent city: The role of Ungaran City as a sub-center of Semarang City

T R Setiyowati, W Handayani, M Damayanti and I Rudiarto

+ View abstract View article PDF

OPEN ACCESS 012036

The impact of disaster risk reduction information on the change of spatial pattern of Padang City

T A Rachmawati, H Apriyenson and A W Hasyim

+ View abstract View article PDF

OPEN ACCESS 012037

The concept, form and mechanism transfer of knowledge in peri-urban areas in Indonesia

Wahyudi and P Nugroho

+ View abstract View article PDF

OPEN ACCESS 012038

Spatial analysis of educational facilities services pattern in Malang peripheral areas

D A Setyono and D D Cahyono

+ View abstract View article PDF

OPEN ACCESS 012039

Peri-urbanization and the dynamics of urban-rural linkage: the case of Sukoharjo Regency, Central Java

W Pradoto, B Setiyono and H Wahyono

+ View abstract View article PDF

OPEN ACCESS 012040

SMEs agglomeration and its contribution to socioeconomic transformations in peri-urban area (Case study: Semarang City)

Y R Adhitama, M H Satria, G Pamungkas and P Nugroho

+ View abstract View article PDF

OPEN ACCESS 012041

Integrated coastal tourism development strategy in Parigi Moutong, Central Sulawesi

Sutikno, M Yusuf, Soedarso, Sukardi and D A Azmi

+ View abstract View article PDF

OPEN ACCESS 012042

Contingency planning of Mount Bromo's cold lava flood in Probolinggo peri-urban areas

C P Nurcahyo, M Yusuf, K D Larasati and G A Rahadyan

+ View abstract View article PDF

OPEN ACCESS 012043

Adaptive aspects of a resilient city

C Susetyo and M N E Sasono

+ View abstract View article PDF

OPEN ACCESS 012044

Ecological sustainability level of Surabaya City based on ecological footprint approach

E B Santoso and B U Aulia

+ View abstract View article PDF

OPEN ACCESS 012045

The accessibility enhancement of park and environment tourism for tourists by applying Surabaya's tourism route

E Umilia, H Idajati, E W Safitri and M H Efendi

+ View abstract View article PDF

OPEN ACCESS 012046

Sustainable agricultural land use determination modelling in Banyuwangi

F Firmansyah, N A Pratomoatmojo, U F Kurniawati, C Susetyo, A Pamungkas and H Idajati

+ View abstract View article PDF

OPEN ACCESS 012047

Defining smart city, smart region, smart village, and technopolis as an innovative concept in indonesia's urban and regional development themes to reach sustainability

R Sutriadi

+ View abstract View article PDF

OPEN ACCESS 012048

The sustainable management priority of ecotourism mangrove Wonorejo, Surabaya-Indonesia

H Idajati and M Widiyahwati

+ View abstract View article PDF

OPEN ACCESS 012049

Role of social media towards flood disaster adaptation in Bojonegoro region of East Java, Indonesia

B S Waloejo, I R D Ari, M Anggraeni, D M Zakiyah and R Alfiah

+ View abstract View article PDF

OPEN ACCESS 012050

Community livelihood vulnerability level in northern and southern coastal area of Java, Indonesia

E Gravitiani, S N Fitriana and Suryanto

+ View abstract View article PDF

OPEN ACCESS 012051

Exploring distance decay pattern of public transport-induced agglomeration and its impacts on train ridership attraction

S Nurlaela, J (C) Xia, D Tuladhar, T (Grace) Lin and P Lie

+ View abstract View article PDF

OPEN ACCESS 012052

Defining place attachment in community base development program for urban settlement – a theoretical review

I N S Wijaya, W D Purnamasari and D Sitaresmi

+ View abstract View article PDF

OPEN ACCESS 012053

Creative class for making good city

I S Fitrinitia, Herlily, M Rahmawan and E Suyanti

+ View abstract View article PDF

OPEN ACCESS 012054

The resilience of Yogyakarta urbanized area: perspective of policy for disaster risk reduction

N M Ni'mah and L M Fitria

+ View abstract View article PDF

OPEN ACCESS 012055

Potential and problems participatory mapping of creative industry in Kampong Dolly, Surabaya

V K Siswanto, B U Aulia, E B Santoso, E Umilia and N Zakina

+ View abstract View article PDF

OPEN ACCESS 012056

MSME (Micro Small Medium Enterprise) development strategy with LED approach in the Dolly ex-red light district

B U Aulia and V K Siswanto

+ View abstract View article PDF

OPEN ACCESS 012057

Gated community in Indonesian peri-urban: security or segregation?

S W Ginting and R Sakinah

+ View abstract View article PDF

OPEN ACCESS 012058

Towards sustainable development: resource approach through interaction of peri-urban and surrounding areas

S N Rukmana and A A S A Widyastuti

+ View abstract View article PDF

OPEN ACCESS 012059

Contingency planning for fire protection in built environment: Risk analysis in campus area

D Rahmawati, A Pamungkas, A M Navastara, M Yusuf, G A Rahadyan and K D Larasati

+ View abstract View article PDF

OPEN ACCESS 012060

Pattern matching evaluation of spatial planning policies in Surabaya coastal area

M E N Sasono and K P Tucunan

+ View abstract View article PDF

OPEN ACCESS 012061

Hierarchy model of Tambak Lorok slum area transformation to support marine tourism kampong

Sunarti, M Rahdriawan, A P Dewi and J R Widiarta

+ View abstract View article PDF

OPEN ACCESS 012062

Architecture spatial arrangement of Bajo tribes settlement in Kabalutan Island of Central Sulawesi

S Syam, A Yudono, R Wikantari and A Harisah

+ View abstract View article PDF

OPEN ACCESS 012063

Exploring the concept of sustainable urban water management: Key influencing factors and principles of SUWM in Bandung metropolitan area

W Mulyana and S S Moersidik

+ View abstract View article PDF

OPEN ACCESS 012064

Children's perception and behaviour in using social space of formal and organic/kampung settlement (Case study: Blimbing District in Malang City)

W D Purnamasari, H A Jessikayanda and O I Rudinanda

+ View abstract View article PDF

OPEN ACCESS 012065

Rain harvesting patterns for a dynamic secondary city: a case study of Semarang City

Y Prihanto, R H Koestoer, D Sutjiningsih and L Darmajanti

+ View abstract View article PDF

OPEN ACCESS 012066

Typology of slum settlements in Keputih sub district

A Y Koswara, P G Ariastita, K D M E Handayeni and N Farikha

+ View abstract View article PDF

OPEN ACCESS 012067

Determination of micro and medium enterprises development needs based on business characteristics in Dolly

B U Aulia and V K Siswanto

+ View abstract View article PDF

OPEN ACCESS 012068

Smart *kampung* for Surabaya smart city: Criteria redefined

D Rahmawati, H Sulistyarso, P G Ariastita, M Yusuf and D A Paramasatya

+ View abstract View article PDF

OPEN ACCESS 012069

Rain water harvesting: barrier, potency and projections. Case study: Keputih, Kejawan and Gebang Putih Surabaya

K P Tucunan, P G Ariastita, Setiawan, A M Navastara and A N Medha

+ View abstract View article PDF

OPEN ACCESS 012070

Quality improvement strategy of slum settlement in Kingking sub district, Tuban Regency

Sardjito, E B Santoso, K D M E Handayeni and N Farikha

+ View abstract View article PDF

OPEN ACCESS 012071

An example of transport policy assessment in TRESIS 1.4 to reduce greenhouse gas emission in Sydney, Australia

S Nurlaela

+ View abstract View article PDF

OPEN ACCESS 012072

Community mapping condition of settlements in Kelurahan Keputih

U F Kurniawati, H Idajati, C Susetyo, F Firmansyah and N A Pratomoatmodjo

+ View abstract View article PDF

OPEN ACCESS 012073

Social sustainability indicators in kampung; dialogue between Ibn Khaldun's *Tamadun* concepts and sustainable developments approaches

K P Tucunan, Sutikno and A N Medha

+ View abstract View article PDF

OPEN ACCESS 012074

Mapping and arrangement of development strategy for creative industry of UMKM Kampong Dolly in Surabaya, Case study: fashion small industry

V K Siswanto, B U Aulia, E Umilia and I Hekmachtyar

+ View abstract View article PDF

OPEN ACCESS 012075

Sustainable kampong model in Kelurahan Keputih, Kejawan Putih Tambak and Gebang Putih of Surabaya City

K P Tucunan, Y H Ridwan, A S Putri and E S Soedjono

+ View abstract View article PDF

OPEN ACCESS 012076

Local economic development of dolly lane Surabaya: A descriptive study

D S Dewi, Setiawan, M Yusuf, Waluyohadi and N I Sari

+ View abstract View article PDF

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The institutionalisation process of Transit Oriented Development practices for peri-urban development in Indonesia: Actor network perspective

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The institutionalisation process of Transit Oriented Development practices for peri-urban development in Indonesia: Actor network perspective

C T Permana[1], **Y Chrisnawati**[2] **and H S Hasibuan**[3]

[1] Department of Geography and Planning, University of Liverpool, Chatham Street, Liverpool L697ZT, United Kingdom
[2] Faculty of Engineering, Jakarta State University, Rawamangun Muka Street, East Jakarta 13220, Indonesia
[3] Department of Environmental Science, University of Indonesia, Salemba Raya Street No 4, Central Jakarta 10430, Indonesia

Email: c.permana@liverpool.ac.uk

Abstract. Transit Oriented Development (TOD) has increasingly become a popular concept for peri-urban developments in Indonesia. It offers regeneration approaches to create compact, mixed-use, and walking-distance public transit areas that promote more effective land-use growth and efficient public transport uses towards sustainable environment in urban peripheries. This paper focuses on the institutionalisation of TOD peri-urban through analysis of stakeholder interactions in TOD peri urban. Interpretations of stakeholder interactions are observed from a case study of the establishment of TOD planning standard from two TOD peri-urban plans, Gedebage (Greater Bandung) and Purabaya (Greater Surabaya). Applying the logic of Actor Network Theory (ANT), this paper discusses emerging networks, key actors, intermediaries, and their interaction process. Data and information are produced from triangulation of semi-structured interviews and documentary reviews. The conclusion provides dynamic stakeholder interaction maps for TOD peri-urban institutions, which identify strong engagements of cross-boundary transportation agencies, planning agencies, public transport operators, the state government, and property developers.

1. Introduction

Rapid urbanisation in Indonesian metropolitan cities has been growing uncontrolled and leading to massive increases of land conversion, car-dependent commuters, and environmental issues in peri-urban areas. In Jabodetabek metropolitan area, for instance, in last 40 years, there have been going intensive land conversions in about 32,000 hectares of agriculture and green spaces in peri-urban areas into housing and urban settlement functions [1]. There are also around 1,105,000 daily commuters travel to the centre of Jakarta from its peripheries, which contribute to traffic congestion, air pollution, and inefficient energy consumption issues [1]. In facts, urbanisation process in many Indonesian cities is still depending on core cities as their peri-urban areas are still poorly organised, especially in terms of the provisions of workplace, commercial, and public facilities for local residents [2, 3].

The so-called Transit Oriented Development (TOD) recently came into account as one of the strategies to encourage more effective, productive, and sustainable development in peri-urban areas in

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Indonesia. It is a combination of transport integration and compact land use in strategic transit areas providing convenient high density settlement, working space, shopping centre, and many other facilities all in one [4]. In the context of peri-urban, its main objective is to generate high quality settlements as alternative growth poles for the city centre in urban system. It is also featured to solve typical peri-urban issues such as poor infrastructure, unorganised land uses, and dereliction. According to some studies, TOD in peri-urban could potentially decentralise urban development, and hence, reduce commuting activities [2]. TOD in peri-urban also encourages the developments of transport integration for commuters that help to promote public transport uses and reduce car dependency [5]. From different perspectives, some studies believe TOD in peri-urban is an effective means of promoting health and green environment through the promotions of walking, cycling, and green spaces in TOD areas [4].

Implementing TOD peri-urban is very challenging, especially in terms of institution, politics, business viability, and administration. TOD peri-urban requires multi-sectoral actions or close coordination amongst different stakeholders such as government from cross-boundaries, traditional and private land providers, transport operators, developers, planners, community and informal businesses [6, 7]. Problems such as conflict of interests and lack of coordination amongst stakeholders appear as the common barriers in peri-urban management [8].

Having reviewed different research in TOD institutionalisation process in many countries, there are generally two types of TOD institutional model, which are government-led and private-led TOD developments. In many European cities, government played more facilitating roles in promoting TOD. Whilst they usually only focused to release public land into market and provided incentives, real estate developers played an active role such as engaged with banking industries to secure financial arrangements to realise property projects in TOD areas. Developers were also responsible as enablers for designs, constructions, and maintenance works [9]. These collaborations provided strong engagements towards individual residents [9]. In some Asian cities, on the other hands, government dominated TOD development including managing public transport, land values, and property revenues to finance redevelopment and maintenance of TOD areas. In this regard, government set regulations and working schemes for other stakeholders. Private developers focused as enablers in construction projects, but they had limited authorities to determine designs and concepts [9]. In Hong Kong, for instance, the program called 'Rail+Property' (R+P) was introduced as government initiative to organise and manage regulations, plans, development strategies, and property leasing agreements for TOD. They also determined other stakeholders roles in the process [10, 11]. In few cases, government engaged with few private sectors in managing property in TOD areas resulting a monopoly and leading to inequality and critical level of individual and community group opportunities to secure property and social spaces [11].

Although many research have been conducted to discuss TOD topics in Indonesian literature, there are still few of them touched the institutional and organisational issues. Most research only focus on conceptual design, technical plan, economics, and business aspects [1, 12, 13]. This paper focuses on studying the institutionalisation process of TOD peri-urban in Indonesia. It examines stakeholder interactions in TOD peri-urban development. We define stakeholder interactions from stakeholder activities in the establishment of TOD peri-urban planning standard in two TOD peri-urban case studies, Gedebage (Greater Bandung) and Purabaya (Greater Surabaya). Applying the logic of Actor Network Theory (ANT), this paper discusses key actors, networks, intermediaries, and their interaction processes. Findings of this paper provide actor interaction maps in TOD peri-urban that can be considered for further establishments of TOD peri-urban institutions.

2. Case Study and Methodology

2.1. Case Study

In 2014, the government of Indonesia through Directorate General of Spatial Planning, the Ministry of Public Works (now Ministry of Land and Spatial Planning) launched a project called the establishment of Spatial Planning Standard for Transit Oriented Development (TOD). It was conducted in 7 (seven) months involving planners, supervisory team from the Ministry of Land and Spatial Planning, and local

stakeholders as the study team. The work focuses on developing a standard model of TOD containing technical and institutional provisions to guide local stakeholders in the development of TOD in their regions.

One of the models developed in the standard is TOD peri-urban. It is developed from several case studies of TOD peri-urban plans, which the two largest cases are TOD Gedebage (Greater Bandung) and TOD Purabaya (Greater Surabaya). TOD Gedebage has been formally mandated by Bandung City Spatial Plan 2011-2031 and Local Transportation Plan. Meanwhile TOD Purabaya has been included as a plan in Regional Transport Plan of Gerbang Kertosusila (Greater Surabaya) 2012-2032. In the process of establishing the standard, stakeholders from the two TOD peri-urban are encouraged to work together to define the consensus standard through meetings, focus group discussions, workshops, and many other forums chaired by the study team.

2.2. Data and Information

There are two major information required in this study. First information is about general overview of TOD policy, especially TOD peri-urban plans and characteristics in Indonesian metropolitan cities. This information provides basic understanding about TOD peri-urban in Indonesia including its objectives, development models, and involved stakeholders. These information are obtained from the final draft of TOD planning standard document, TOD plan documents and other city plan documents such as local transportation plans, city and provincial spatial plans, city and provincial mid-term development plans in two case areas, Bandung-West Java Province and Surabaya-East Java Province, and also research documents with relevant topics.

The second information is about the networks or stakeholder groups and their interactions within the establishment of TOD peri-urban plans in each case study area. These information give main inputs for the actor network analysis. We applied semi-structured interview to explore information, opinions, problems, and conflicts amongst stakeholders in the planning of TOD in their areas. Semi structured interviews were conducted during the project of 'The Establishment of Spatial Planning Standard for Transit Oriented Development (TOD)' in 2014 facilitated by the Indonesian Ministry of Public Works. We defined our relevant interviewees through snowball process by asking participants in regular meetings and focus group discussions, which conducted as parts of the project in April-November 2014. Our semi-structured interviews involved 25 interviewees including representatives of planning agency, transport agency, experts from the Worldbank, JICA, police department, Indonesian railway company, NGOs, and academicians from Surabaya and Bandung cities and relevant provinces.

2.3. Methodology

This research applies the logic of Actor Network Theory (ANT) to analyse stakeholder interactions in TOD peri-urban. It is applied in three steps, which are (1) defining networks within TOD peri-urban, (2) identifying actors and examining their interactions within the networks, and (3) analysing the strengths and weaknesses of networks. Analysis is conducted in two cases of TOD peri-urban providing comparative results of stakeholder interaction maps that can be used as consideration materials to draw institutional frameworks for TOD peri-urban in the future.

ANT is a social science approach to explore how socio-material interactions emerged and interrelated each other to construct particular fluid networks or assemblages that create actions towards particular topics or subjects [14]. The use of ANT logic in this study has a meaning that this study attempts to examine stakeholder interactions within TOD peri-urban by adopting few key aspects of ANT analysis, which are 'networks', 'translation', 'key actors', 'intermediaries', and 'blackbox'. Network is a dynamic group comprising of actors with similar perspectives [15]. Translation is the way actor defines particular subjects or the understanding of actor that bring him to join his allies in a network [15]. Key actor is defined as determinant actor that connects, encourages and enrolls other stakeholders as allies to support particular subjects [16]. Intermediaries are entities, can be human actors, agencies, documents, materials, concepts, and artefacts that have functions to engage actors to stay in the network [15]. And, blackbox are entities that can be law, policy, agreement, contract, and many others that implicitly exist

and accepted by all actors without any obligation [14]. Nevertheless, this study adjusts the ANT concept by limiting the discussions only on human actors (people, institution, agency) and their interactions, although other (non-human) actors such as materials, artefacts, and technology are also involved in the construction of network.

This study uses UCINET network analysis software to draw actor interactions network. Actor interactions are justified from documentary reviews and interviews, which are conducted during the establishment of TOD peri-urban planning standard. The drawing provides illustration about stakeholder interaction within the networks and identifications of key actors, enablers, and followers. This software calculates key actors based on the role of 'betweenness' or level of connection to other actors within the networks [16].

In summary, the application of method in our case study is based on the rule of ANT 'following the actor'. We firstly defined key stakeholders and outlined their interactions with other actors (including interactions in knowledge and information sharing and decision making process), which are justified from semi-structured interviews and documentary reviews. Interactions are descriptive by describing that particular actors contribute in sharing and providing knowledge, information, and consideration in decisions of other actors in the process of preparing TOD plan in their areas. These interactions were processed by UCINET applying the rule of score '1' for relevant interaction and '0' for no interaction. These practices of outlining stakeholder interactions were done by previous research in actor and social network related topics discussing role of actors in planning practices [17-19].

3. Results and Discussions

3.1. Peri-urban Transport Dynamic

Planning standard of TOD peri-urban defines TOD Gedebage and TOD Purabaya as regional transit centre. Their functions are mainly to serve commuter activities between the city centre and its hinterland and neighboring cities. Detail characteristics of TOD peri-urban in two case studies are explained in the following table 1.

Table 1. TOD Peri-urban as the Case Studies of TOD Planning Standard

Characteristics	TOD Gedebage	TOD Purabaya
Served population	Bandung City (2,429,176 inhabitant) Bandung District (3,235,615 inhabitant)	Surabaya City (1,566,072 inhabitant) Sidoarjo District (1,949,595 inhabitant)
Average commuter trip	District to City (36,785 trip/day) City to District (44,129 trip/day)	District to City (28,713 trip/day) City to District (18,885 trip/day)
Radius area	800 meters	300-800 meters
Distance to city centre (core urban area)	15 km	12 km
Main transport facilities (TOD core area)	Gedebage railway station and bus terminal	Purabaya bus terminal and Waru railway station
Dominant land use	Industries, open space, and residential	Commercial, open space, and residential

Source: Ministry of Land and Spatial Planning (2014)

The standard of TOD peri-urban arranges several requirements for TOD peri-urban as sub-centre transport hub. For instance, in terms of transport characteristics, this type of TOD should at least have

(1) transport integration between city train, bus, and local feeder, (2) transit railway station type B (regional), and (3) located in hinterland of the city. In terms of land use characteristics, the area should have (1) area size of 58 hectares, (2) radius area of 600-800 meters from the railway station to the area borders, (3) a mixed land use functions comprising of high density residential (minimum 30 houses/ha) with office, commercial, and public facility areas, and also (4) supported by basic functions such as pedestrian, cycling lane, bus and small bus shelters, parking facilities, green open spaces, and social facilities.

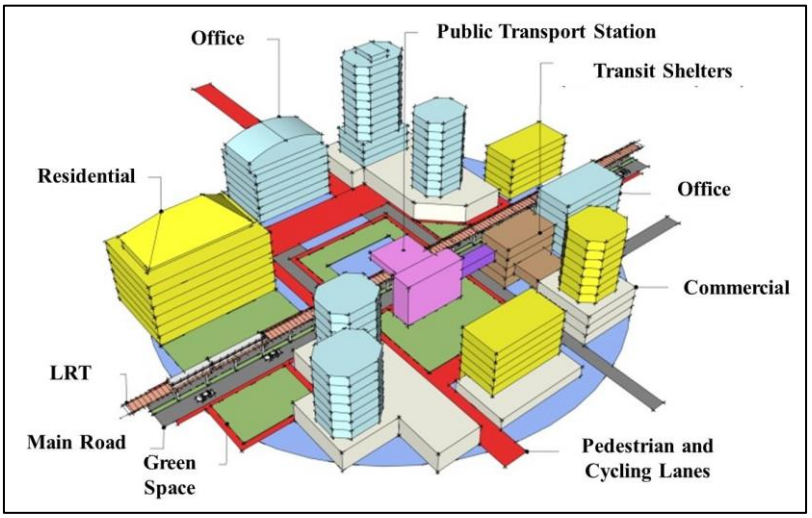

Figure 1. Illustration of the standard of TOD peri-urban (sub-centre)
Source:[1]

3.2. The Dynamic of Actor Interaction in TOD Peri-urban

Our study has identified dynamic actor interactions in the two case of TOD peri-urban. In TOD Gedebage plan, there are 'Bandung Technopolis' and 'Bandung-Jakarta Economic Integration as the two networks promoting the idea of TOD peri-urban. Meanwhile, in TOD Purabaya plan, there are three networks, which are 'Surabaya Integrated Transport', 'Surabaya Smart Growth 2050', and 'Green Surabaya'.

In TOD Gedebage, 'Bandung Technopolis' concerns on the development of new central business district that focuses on creative and high technology industries in the city in accordance with the vision of smart city. TOD Gedebage is translated as transit area to support creative and high technology industrial centre. 'Bandung Jakarta Economic Integration', on the other hands, concerns on the economic connectivity between Bandung and the state capital city, Jakarta. TOD Gedebage is translated as the key transit area to serve investments, workers, and trade movements between the two cities. The TOD is an area that integrates plan of Bandung-Jakarta high-speed train and city public transports so it can be an attractive living and working spaces for intercity commuters, traders, and businessmen. Actor interactions in the two networks of TOD Gedebage is illustrated in the following Figure 2.

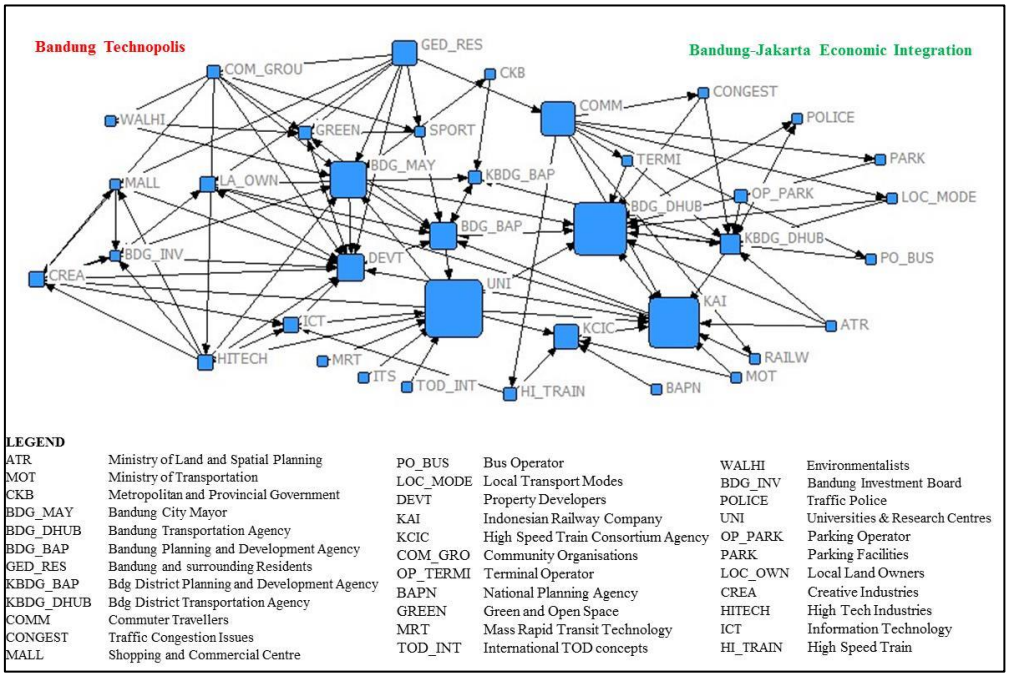

Figure 2. Actor Interactions in TOD Gedebage Networks

In TOD Purabaya, 'Surabaya Integrated Transport' focuses on the integration of transportation system between Surabaya City and its hinterland and neighboring cities. This network defines TOD Purabaya as the sub-centre transit node that serve connectivity between Sidoarjo District to the city centre by providing inter-connections of inter-city railway, bus, and local feeders. 'Surabaya Smart Growth 2050' concerns on smart land use management through the promotion of compact city development towards sustainable development in 2050. In this network, TOD Purabaya is translated as a prototype for compact developments in peri-urban areas by bringing a large station, bus terminal, housing, industries, office, and green and open space areas in a single development zone. As for 'Green Surabaya', this network focuses on the green city vision in the future. This network considers TOD Purabaya to be a strategic settlement promoting more green and open space such as urban parks, pedestrian realms, and outdoor sport facilities. Detail illustration is presented in Figure 3.

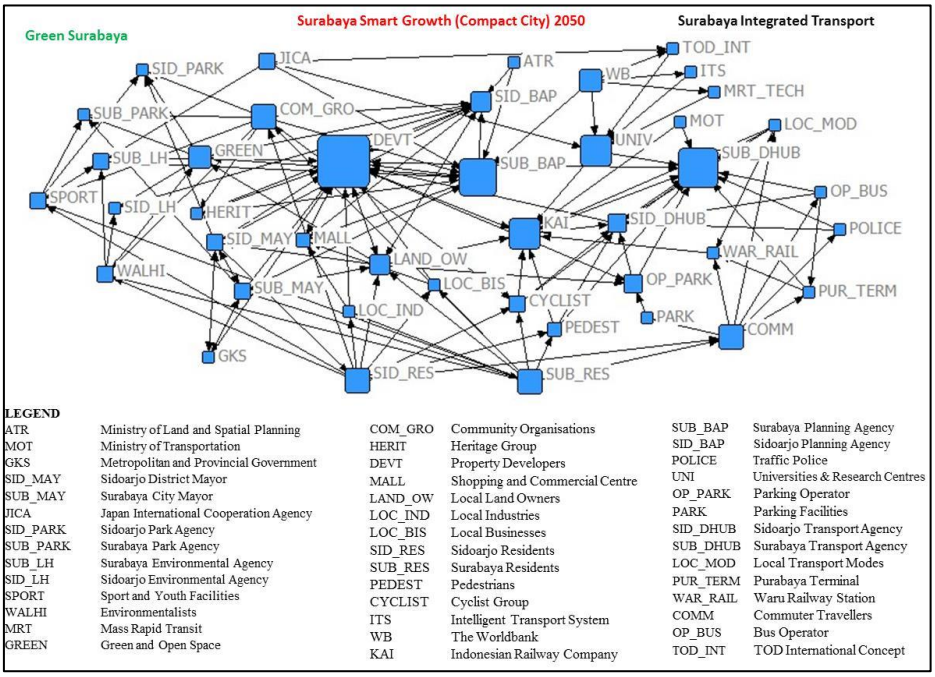

Figure 3. Actor Interactions in TOD Purabaya Networks

By focusing on human and agency actors, our actor interaction network map (Figure 2) shows three most strategic stakeholders as the key actors in TOD Gedebage networks, which are (1) universities and research groups, (2) Bandung City Transportation Agency, and (3) PT KAI (national railway company). Universities and research groups have a central position in terms of knowledge transfer and sharing towards other stakeholders within the two networks. These groups also mobilise other potential stakeholders to support TOD plan, and also help the network to define role of actors in TOD development. They interact through research publications, seminars and workshops events, and professional advisory services and consultancies.

Other key stakeholders in TOD Gedebage are Bandung City Transportation Agency and PT KAI. The two agencies have strong connections to other relevant stakeholders in terms of providing transport integration in the area. PT KAI ensures the integration between high-speed train project stakeholders and the city transport stakeholders, whilst Transportation Agency facilitates the integration between local transport networks in the city and also provides communications with the neighboring city, Bandung District. These agencies interact through meetings, physical projects, and transport management policies.

Table 2. Summary of Key Actors in TOD Gedebage

Network	Key Actor	Main Ally / Enabler	Potential Ally	Non-Human Aspects
Bandung Technopolis	Universities and research groups Bandung Transport Agency	Bandung City Mayor and Planning Agency Property developers High speed train operator (KCIC) Indonesian Railway Company (KAI)	Metropolitan and provincial govt Resident, land owners, and community groups High tech and creative industries Investment board Environmentalists Bandung District Mayors, Transport Agency, and Planning Agency	High speed train project Information technology Intelligent transport system MRT technology TOD best practices Shopping and commercial center Green and open space

Network	Key Actor	Main Ally / Enabler	Potential Ally	Non-Human Aspects
Bandung-Jakarta Integration	Bandung Transport Agency Indonesian Railway Company (KAI)	High speed train operator (KCIC) Bandung City Mayor and Planning Agency Bandung District Mayors, Transport Agency, and Planning Agency Parking and Terminal Operators	Bus Operators Local transport operators Police Commuter travelers State Government Agencies High tech and creative industries Investment board Resident, land owners, and community groups	Parking facilities Railway station Bus terminal Traffic congestion High speed train project MRT technology High tech and creative industries

Our study suggests high-speed train planning project as the key intermediary for TOD Gedebage networks, and TOD international best practices as the potential blackbox. Although still in a preliminary stage, high speed train project has attracted many stakeholders to believe TOD Gedebage is a prospective area in the future for Greater Bandung. Many stakeholders accept TOD international best practices and they believe TOD is a good and suitable development approach for Indonesia, moreover for peri-urban area.

Furthermore, if we analyse Figure 3, by focusing on human and agency actors, our study identifies two stakeholders as the most strategic actors in the development of TOD Purabaya, which are (1) property developers and (2) Surabaya-Sidoarjo collaborative local governments. Property developers play the most strategic actor in all networks providing strong connections and influences to other stakeholders such as local businesses and industries, metropolitan government, heritage and environmental groups, and also local governments from the two administrative regions. This stakeholder can engage other stakeholders by initiate stimulant projects in TOD area such as housing projects, industrial park projects, innovative green parks, and or shopping mall projects.

Other strategic actors in TOD Purabaya are Surabaya-Sioarjo collaborative governments, which appear in strong communication between Transportation and Planning Agencies of the two administrative areas in terms of land use and transport planning policy issues for TOD Purabaya area. Collaborative transport agencies ensure the integration of a railway company, bus operators, local modes, and commuters through instruments such as traffic management, public transport rerouting, and public transport facility revitalisations in TOD Purabaya area. Meanwhile collaborative planning agencies ensure the integration of land uses in the TOD area through the instruments of spatial plan, intercity agreement plan, and collaborative land use projects.

It is strongly highlighted that inter-city collaboration is required due to the nature of Purabaya peri-urban terminal as the centre of TOD plan area that located in between two city administratives. This terminal is developed under local government agreement between Surabaya City and Sidoarjo District where Surabaya operates and develops the facilities and Sidoarjo leases the land for certain period. This situation demands the collaboration as transport system will be led by Surabaya Transport Agency, whilst land use plans could be mainly initiated by Sidoarjo Planning Agency.

Table 3. Summary of Key Actors in TOD Purabaya

Network	Leading Stakeholder	Key Follower / Enabler	Passive Supporter	Non-Human Aspects
Surabaya Integrated Transport	Property Developers Surabaya-Sidoarjo collaborative local governments	State Agencies Indonesian Railway Company (KAI) The Worldbank Universities and research groups	Metropolitan and provincial govt Bus operators Local transport operators Commuter travelers Police Parking operators	Parking facilities Railway station Bus terminal Intelligent transport system MRT technology TOD best practices

Network	Leading Stakeholder	Key Follower / Enabler	Passive Supporter	Non-Human Aspects
Surabaya Smart Growth	Property Developers Surabaya-Sidoarjo collaborative local governments	Local businesses and industries Residents and community groups	Local transport operators Commuter travelers Residents, land owners, and community groups Metropolitan and provincial govt	Parking facilities Railway station Bus terminal TOD best practices Shopping centre
Green Surabaya	Property Developers Surabaya-Sidoarjo collaborative local governments	JICA Environmentalist Residents and community groups	Heritage group Metropolitan and provincial govt Residents, land owners, and community groups Pedestrians and cyclists	Railway station Bus terminal TOD best practices Green and open space

Our study suggests Greater Surabaya Spatial Plan and Regional Transportation Plan as the two intermediary documents to engage all stakeholders in the networks, and TOD international best practices as potential blackbox similar to the case of TOD Gedebage. The regional plans clearly mention the agenda to improve transport networks, realise compact city development, and achieve green sustainable development through TOD peri-urban concept. These documents also define role sharing amongst stakeholders and their benefit in the future. All stakeholders show very strong supports and use these plans as the fundamental guidance for them to contribute in the development of TOD peri-urban in Greater Surabaya. In this regard, Surabaya City stakeholders lead the engagement process. As for the blackbox, likely to the case of TOD Gedebage, our study also identifies TOD international best practices come as very potential blackbox in the three networks of TOD Purabaya. All stakeholders have strong opinions that TOD is very good approach to be applied in their region to achieve three missions, transport integration, smart growth, and green development.

4. Conclusion

Our study concludes that the initiatives of TOD peri-urban in Indonesian metropolitan cities are mainly involving four key actors, which are inter-city local government stakeholders, Indonesian railway company, property developers, and universities and research groups. Their interactions were shaped into cross boundary administrative and public private partnership collaborations. Cross boundary administrative collaboration has significant roles in mediating transport and land use integration plans for TOD peri-urban, which usually located in the border area of two cities. Public private partnership collaboration has more roles in terms of promoting and executing the plan into projects, in which local government stakeholders as regulator and controller, and private developers as the executors.

Having compared the two cases, our study found that more involvement of state government and national issues in Bandung TOD have been leading to more complicated institutionalisation process of TOD, and hence, stronger in concept, planning integration, and promotion but still very weak in terms of progress and implementations. Meanwhile, in the second case, active engagements between cross-boundary governments and developers, and keeping the plan only for local issues in Surakarta, and the TOD has been leading to more simple institutionalisation process, which resulted stronger in implementation but still very weak in terms of conception, integration, and plan.

Overall, our study concludes that in terms of the application of ANT logic, there are several analytical aspects of ANT are potential to be used to define stakeholder interactions in TOD peri-urban, such as ‘network’, translation’, ‘key actors’, and ‘blackbox’. These aspects can be used as indicators to measure the strengths and weaknesses of TOD institutions. However, our study suggests further detail researches to explore potential organisation model for TOD peri-urban. Such potential researches should be able to

use resources from this paper to develop various alternatives of organisation structure for TOD peri-urban such as BID (Business Improvement District), enterprise zone, strategic development area, or communicative development forum.

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Exploring distance decay pattern of public transport-induced agglomeration and its impacts on train ridership attraction

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Exploring distance decay pattern of public transport-induced agglomeration and its impacts on train ridership attraction

S Nurlaela[1,2], J (C) Xia[3,4], D Tuladhar[3,4], T (Grace) Lin[3,4] and P Lie[3,4]

[1] Urban and Regional Planning Department, Faculty of Architecture Design and Planning
[2] Institut Teknologi Sepulung Nopember
[3] Department of Spatial Sciences, School of Earth and Planetary Sciences
[4] Curtin University of Technologi, WA, Australia

Email: sitnurlael0@gmail.com; c.xia@curtin.edu.au ; dinesh.tuladhar@postgrad.curtin.edu.au zju.grace@gmail.com; peiyu.li@postgrad.curtin.edu.au

Abstract. Public transport infrastructure creates the effect of agglomeration through transportation externalities. Effective density is an accessibility based agglomeration that was raised as a positive externality from public transportation investments. The aim of this paper is to understand whether public transport facility would induce agglomeration around stations and furthermore induce train ridership. A methodology was developed to reveal the causality of effective density on ridership and reduce the confounding effects from land use-related determinant factor. This was shown by the propensity score matching that tested if effect of a station being in the treatment group (high effective density stations) on train ridership was influenced by land use characteristics of catchment stations. The causality of effective density on ridership was compared between station groups. Findings showed the effect of treatment group was higher in the matched sample compare to the unmatched sample. This difference may be assigned as the true effect of public transport induced agglomeration which was higher after controlling the land use characteristics of stations. Thus, the inclusion of land use variables in the model prediction may has the effect of rendering the influence of effective density variable lower in the model. These findings could guide station catchment area planning to maximise effective density benefits on train ridership.

Keywords: *effective density, propensity score matching, agglomeration, public transport infrastructure, train ridership.*

1. Introduction

The impacts of transportation systems in terms of transportation infrastructure need to be evaluated not only on their aspect of land use but also travel behavior [1]. Further, other factors such as the spatial economic dimension may come into play when transportation system-impacted land use and travel behavior to be examined in a holistic manner.

The extension of the new Perth – Mandurah railway line in the Perth Metropolitan Region (PMR) has been assumed to have made a direct influence on land use and property development, or on economic development. The question of the contribution of stations along the new line to increased train ridership has been considered for more than ten years. Public transport infrastructure creates the effect of agglomeration through transportation externalities. Public transport-induced agglomeration

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economies, which can also be considered to be part of technological externalities, may be defined as the concentration of economic activities and the clustering of offices, shops, entertainment centers, and other land uses that emerge around public transportation stops. The benefits from this clustering are increased efficiency through lower infrastructure costs and reduced labor costs, while more opportunities are created for greater access to specialized labor [2].

Effective density is a specific concept of agglomeration that were raised as a positive externality from public transportation investment ([3], [4]). Transport investments may induce positive productivity benefits by forming clusters of economic activities which are more accessible (effective density) [5]. The improved transport may lower travel time or costs, reduce production cost and help growth a region via effective density. However, it is not clear how to explain the spatial relationship between transport provision and the scale of effective density. In other words, what is the spatial distribution of effective density around transport facilitates, such as train stations? Is closer to a train station, more economic activities or clusters of firms or employees occurred, thus, would be more accessible by train, as such intended by the Transit Oriented Development concept? And what does it imply on travel behavior such as transit demand?

This paper aims to understand whether public transport facility would induce agglomeration around stations and furthermore induce train ridership. This paper explores the spatial pattern or characteristics of effective density attached on public transport induced agglomeration. As agglomeration emerged majorly near a transport facility, i.e. a train station, one may expect its spatial distribution to form a distance decay pattern from a station. Distance decay of the effective density may reflect the interaction of transport supply, such as a train station and land use in the surrounding areas, such as stations' catchment areas; whereas effective density attenuate with distance away from a station [6].

2. Agglomeration measurement

The public transport induced agglomeration concept was initiated by [3] and further developed by ([4]). The study of [3] highlighted the relationship between dense spatial units and the clustering of economic activity with an increase in productivity. Venables' original concept explained the relationship between wages, travel costs, and land rent or housing costs and its impacts on city size. There is a trade-off between land rent or housing costs and commuting costs as: "workers located closer to the CBD face lower commuting costs but higher rents…" [3, p.9]. Venables added an endogenous productivity effect in his model. In Venables' model formulation, transport improvement (such as the development of new railway line and stations) was modelled as a reduction in commuting costs, which derived a further effect on the real income. As workers were able to save more money (a conversion from travel costs savings), workers could afford to live closer to the centre. Transportation externalities therefore create increased urban productivity, which in turn increase the city size since "the city expands up to the point at which these are high enough that a worker is indifferent between locating at the edge of the city and commuting to the CBD, or living (and working) in a non-city location" [3, pp. 3-4].

Graham, after Venables, modelled agglomeration economies using a measure that incorporates both proximity (accessibility) and the scale of economic activity (the size of employment), what so called as the effective density [4]. The total effective density of employment defined in Graham is a measurement of agglomeration. Specifically, agglomeration in terms of effective density was measured in two ways: by using Euclidean distance or network distance [7]. This paper applied the measurement of effective density based on a network travel time.

The formula for effective density calculation was specified as follows [4, p. 327]:

$$ED_{im} = \frac{E_i}{\sqrt{A_i/\pi}} + \sum_{j}^{i \neq j} \frac{E_j}{t d_{ij}^{\alpha}}$$

Where:
ED_{im} = the employment density of ward i for industry in sector m.
E_i = the number of employment of ward i
A_i = the land area of ward i
E_j = the number of employment of ward j
td_{ij}^{α} = the travel distance between ward i and ward j, weighted by the distance decay parameter α.

3. Methodology

Although there is a strong theoretical basis for explaining how better transport infrastructure helps achieve the scale of economies of agglomeration, limited research has been conducted to understand the distance decay patterns of agglomeration around train stations and the factors affecting such patterns [8]. On the other hand, the study of train ridership prediction had not yet paid much attention on the spatial-economic factor, such as effective density or worker/job supply. Nonetheless, how both agglomeration of effective density (the scale or concentration), the proximity, and its decay pattern from stations could increase train ridership was not known in the literature.

In this research, stations were investigated for their effective density pattern, the level of land use development, and train ridership magnitude. A station classification was derived based on these three factors, dividing stations into a control group and a treatment group where the level of land use development were controlled or matched between these two groups.

The model framework is shown in Figure 1. It describes the relationships between a train station (a node) and its catchment area (a place) following a node-place model [9]. To capture a distance decay effect, a larger catchment is necessary as a unit of analysis. The park and rider catchment area was used to test the research hypothesis on public transport induced agglomeration. The black dotted line in Figure 1 illustrates the decrease of effective density with distance away from a train station located at the centre of the diagram.

Two factors were defined in spatial distance decay interaction according to the predecessors' research [10].These factors would define the determinant of train ridership.

- Interaction behaviour factors, represented characteristics in the relationship between suburbs in the catchment area and between a catchment area of a station (park and ride catchment) and its corresponding station. Variables consisted of the decay parameter of effective density, the level of public transport supply index for suburbs in the catchment area, road network travel distance or a centrality of a suburb to all other suburbs that was measured by road network, distance of suburbs in catchment area on average to the corresponding station.
- Spatial structure: refers to the size and configuration of spatial system. It refers to the number of job, land rent, job-housing balance, wage level on average of each suburb included in a catchment area.

To test the extent to which the concentration and/or decay pattern of effective density influence train trip attracted to each station, stations were classified into a quadrant matrix (figure 2). This research assumed stations in quadrant 1 or q1group (negative decay parameter and effective density above mean of Perth Metropolitan region) would have higher train trip attraction than other stations. Less negative decay parameter means less travel friction or higher accessibility between station and its catchment, thus, larger size of catchment station and higher employed resident opportunity. However, a positive decay parameter reflect no or less concentration in the station area, or area other than stations had become a more developed area than that of the station area itself.

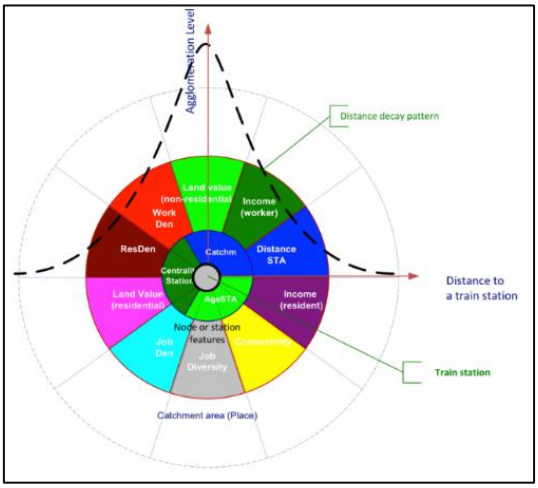

Figure 1. The model framework

Deriving these station categories according to the concentration and distance decay effect, it was necessary to compare how these two factors influence train ridership among different station category. The research was designed to reduce the confounding factor from land use development on the relationship between effective density and train ridership, thus assigning public transport induced agglomeration as a function of proximity or improved accessibility. Propensity score matching (PSM) was used to test only stations in group 1 with similar land use characteristics to station in group 'others' to be compared. Group 1 named as treatment group and other groups (quadrant 2, 3 and 4) named as control group according to the terminology used in the PSM setting.

The methodology developed in this paper was implemented using a case study of Perth, Western Australia.

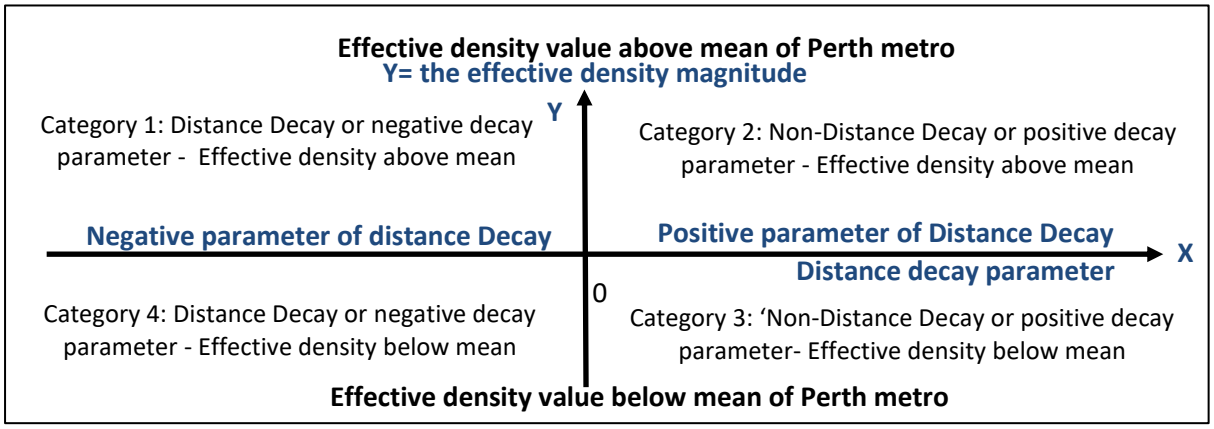

Figure 2. The quadrant matrix of station classification based on distance decay patterns and effective density

4. Method

4.1. Data collection

Most of the data used in this research were collected from various government agencies and Australian Bureau of Statistics (ABS):

- This research used ABS journey to work data as dependent variable in main analysis of train ridership model.
- Transportation information, such as travel time between suburbs, was derived from the 2011 Strategic Transport Evaluation Model (STEM) by the Department of Planning of Western

Australia, consisted of 472 times 472 travel zones in the system in which these travel zones were converted into suburb matrices, consisted of 317 x 317 suburbs. The travel time by park and ride journey was chosen as the best alternative to represent the spatial interaction of the train trips and to sufficiently captured the indication of distance decay pattern.

- Job data was retrieved from the ABS website, sourced from 990 DZN or destination zones in the Perth Metropolitan region that also were converted into suburb unit. Employed resident data was sourced from the ABS censuses based on suburb database.

4.2. Study area

This research used the suburb or the state suburb (SSC) as an administrative boundary of the study area. The SSC was not part of the ABS structure. Instead, the areas were aligned closely with the Statistical Areas level 2 (SA2), where the SA2 are an aggregation of statistical area level 1 (SA1). Both SA1 and SA2 are defined in the ABS structure (2011 Census Dictionary, p. 183 and p. 189).

Perth Metropolitan Area (PMA) has five train lines: Fremantle, Midland, Armadale, Mandurah and Joondalup lines and 70 train stations. Study area consisted of the stations as nodes and the catchment area in terms of suburbs as places.

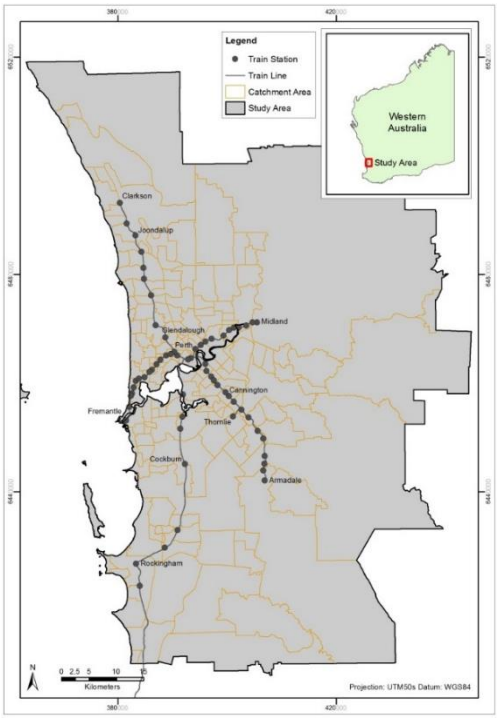

Figure 3. The map of study area

4.3. Data analysis

To form a station classification, an exponential distance decay model was performed. According to figure 1, the exponential distance decay model depicted the relationship between the magnitude of effective density and the distance of the catchment area to the station. A set of significant decay parameters was derived. Only 45 stations had significant parameters. These 45 stations were allocated into the quadrant according to its decay parameter value and its effective density value.

Propensity score matching (PSM) was used to investigate whether the research hypothesis that a station being in the treatment group or q1group (has distance decay pattern of agglomeration with high value of effective density) was a predictor of train ridership, when controlling for land use variables. These land use data were generated at the catchment station level by using data manipulation in GIS. There were 68 stations being research in the study area from total 70, two were removed due to

outliers in the employment data. The distance decay model resulted in 45 stations had a significant parameter of exponential distance decay, thus, 45 stations being sampled in the PSM. Two stations with the outlier distance decay parameter were removed, resulted in 43 stations for the final analysis. The quadrant matrix divided these 43 stations into treatment and control group according to the criteria of value of distance decay parameter (negative or positive) and the value of employed resident effective density (above mean or below mean). The quadrant matrix derived 15 stations in the q1group and 28 stations in other groups for train trip attraction model. As the matching variables, this research choose land use variables such as the number of job and land (property) value. The rationale for choosing those matching variables was that the number of job and land rent may increase due to both the urbanization (population development) and the improved accessibility. Land use development could be indicator of indirect productivity, a proxy for agglomeration effect and urbanization. The area with more intensive land use development was assumed to has higher activities, denser, more expensive land or property prices, and higher wage offered, thus, had higher agglomeration and/or urbanization. Controlling these two variables resulted in assigning the public transport induced agglomeration as only a function of proximity or improved accessibility post the railway line extension, therefore it being modelled by adding the q1group as a dummy variable in the regression of train ridership model. By matching on those variables, the goal was to reduce the confounding influence of land use variables on the effect of public transport induced agglomeration on train ridership. As two regressions for train ridership model were imposed (before and after PSM), how much the regression model improved after the PSM could be assessed. The improved regression model after the PSM may reflect the true influence of public transport induced agglomeration on train ridership.

5. Results and discussion

5.1. Exponential decay model and station classification

Exponential distance decay model was performed to classify station based on hypothetical relationship between effective density and train ridership. To perform this model, *first*, the relationship between station and its catchment area was constructed in a fishnet structure to derive many observations than otherwise if only suburbs were used as observations. *Secondly*, an exponential distance decay model was performed between the effective density and the distance of catchment area to the station for each fishnet unit. An example of the exponential distance decay model from 5 stations was displayed in table 1 (completed data consisted of overall 45 stations with significant value of decay parameters).

Table 1. Exponential distance decay model between effective employed resident density and distance of the area of catchment on average to its corresponding station

Station	Beta*1000	Beta_edertt	R sq	P value	Constant	Number of fishnets
Armadale Stn	2	0.002	0.398	0	7.806	158
Cannington Stn	1	0.001	0.365	0	12.986	60
East Guildford Stn	-0.54	-0.00054	0.297	0	9.988	541
Grant Street Stn	9	0.009	0.742	0	10.42	27
Stirling Stn	-2	-0.002	0.464	0	16.613	151

Overall, the negative decay parameter ranged from -0.00055 to < 0 and the positive parameter ranged from > 0 to +0.004. Claisebrook station and Grant street station were excluded from further analysis due to outlier in the beta parameter, i.e. 0.015 and 0.09 respectively. This has resulted in 43 stations in total being used in the PSM model. Negative decay parameter means the number of effective employed density reduced for every one kilometre increase in the distance of catchment to the station. For example, for the catchment area in Stirling station, an area 1 km closer to the station had 0.2% more effective employed resident density. On the other hand, an area 1 km closer to the

Warnbro station had 0.1% less effective employed resident density, means the core of development was not emerged in the Warnbro station catchment, but on other area farther away.

The result of the exponential model being combined with the information on the magnitude of effective employed resident density constructed a station classification (figure 2). The number of station ridership in terms of the proportion of train trip attraction was added into the graph in the form of bubble size. It was worth noting that some of the stations with the highest train trip attraction did locate in the quadrant 1 (the treatment group), indicating the research hypothesis that a chance for a station being in the q1group may have higher influence on train trip attraction, may be in evidence. The result is shown in figure 4. To understand the true impact of public transport induced agglomeration on train ridership, i.e. indicated by the probability of a station being in the q1 group, there was a need to control for the level of development in each station, such as represented by the number of job and land rent. At this stage, PSM analysis was used.

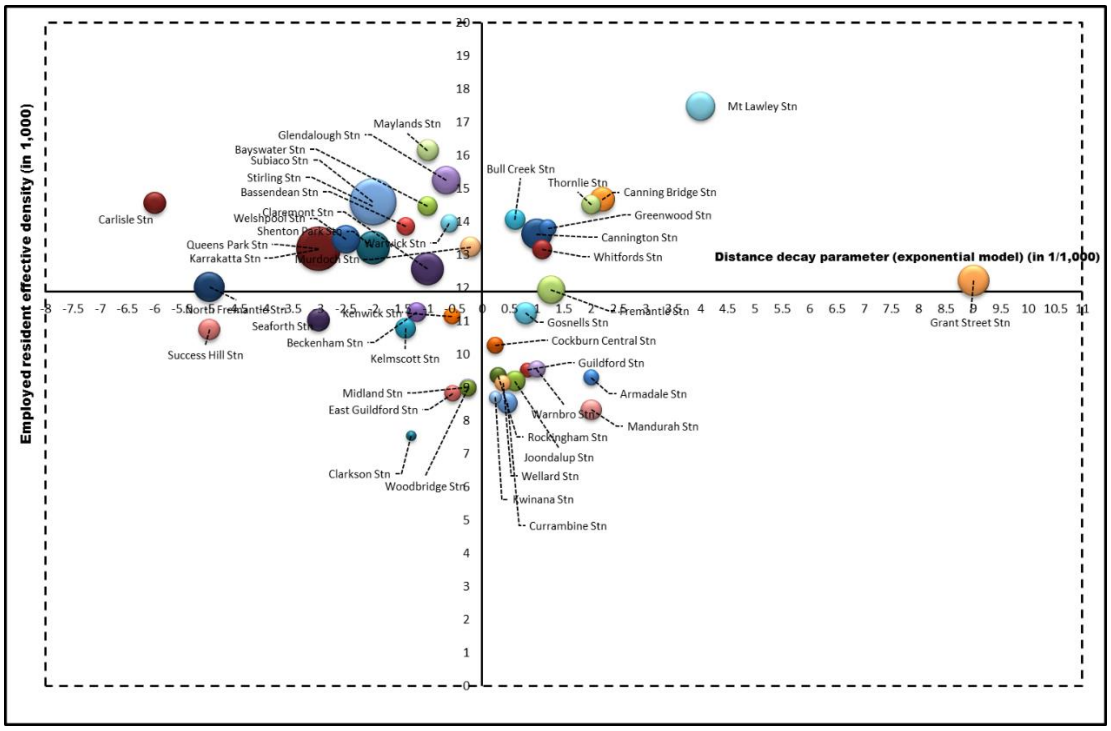

Figure 4. Station classification in a quadrant matrix based on three variables: effective employed density (the y axis), distance decay parameter (the x axis), and the train trip attraction (the bubble size).

5.2. Propensity score matching

The question of interest was whether the station classified in the group of negative distance decay – effective density above mean of Perth (group 1 or treatment group) compared to other station categories (control group) as displayed in the quadrant matrix in fig.4 has any higher impact on the proportion of train trip attraction assessed post the Perth-Mandurah railway line extension. Observed differences in the proportion of train ridership attraction may be due to land use characteristics that has been presented before the extension. If the land use differences had been existed prior the railway extension, then the estimation of the true causal effect of effective density on train ridership will be biased due to confounding. That is, the public transport induced agglomeration as assumed at the first place, may not be hold. Thus, controlling for the similar level of land use development between the treatment group (group 1) and the control group (group 2) means assigning the influence of public transport induced agglomeration on train ridership as a function of improved accessibility post the railway extension that lowering commuting costs.

A propensity score matching analysis was used to control for these confounding influences. The tasks were conducted in the SPSS software with extension packages. In a first step the propensity score, i.e. the probability of a station to fall into the group 1 was estimated using logistic regression. All covariates from land use variables were used. After the estimation of the propensity score, the stations were matched using a 1 to 3 nearest neighbor matching. In order to exclude bad matches, a caliper of 0.2 was imposed. After matching, the balance of all observed covariates was examined. There was no covariate exhibits a large imbalance at d>0.25. The covariate balance was improved in the matched sample. The actual propensity score distributions of both groups (treatment and control) before and after matching overlaid with a kernel density estimate. The t-test analyses were carried out to test the differences in the standardized mean value of variable of job number and land rent out of the treatment and control group. It showed that after the PSM, the adjusted estimate of the mean differences in job number and land rent between the two samples were insignificant statistically. This means the PSM has successfully balance the covariates of those two variables in the two samples. Thus, stations in the treatment and control group have similar land use development or land use characteristics according to the number of job and land rent.

5.3. Train trip attraction model

Regression model before and after the PSM were discussed to understand if controlling land use variables could inform the true impact of public transport induced agglomeration, i.e. the commuting cost reduction due to travel time improvement (post the Perth-Mandurah railway extension) in the system may influence decision of more workers to use train as mode of journey to work travel.

The comparison of the model was assessed based on several t-tests. These comprised of the assessment of the mean proportion of train trip attraction before and after matching and the effect of dummy variable q1group in the model (group 1: a station being in a group of quadrant 1: negative distance decay and high effective density). The model improvement was compared based on the adjusted R-square.

The model before and after the propensity score matching was compared (table 2 and 3). The variables of interests were the dummy variable q1group, the distance of catchment from station, the magnitude of effective density, and the interaction variable between effective employed resident density and the station distance.

Table 2 .Train trip attraction model before the PSM

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.774[a]	.599	.489	.04682

a. Predictors: (Constant), dtedertt, wage_b, job3, q1group, stri, lvr, edertt3, pti, dist
b. Dependent Variable: ptrainw

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.437	.179		2.442	.020**
	q1group (dummy variable of treatment group)	**.053**	**.024**	**.391**	**2.187**	**.036****
	wage_b (hourly wage level)	-.011	.006	-.276	-1.707	.097*
	Lvr (land rent per sq meter)	4.252E-5	.000	.541	2.316	.027**
	Job (the number of job)	1.032E-5	.000	.204	1.084	.286
	Dist (distance to the nearest station)	.027	.019	1.112	1.413	.167
	Stri (road network accessibility)	-8.861E-6	.000	-.428	-1.263	.216
	Pti (public transport accessibility)	-2.613E-8	.000	-.322	-1.055	.299
	Edertt (employed resident effective density)	-.012	.009	-.305	-1.266	.214
	Dtedertt (the interaction between distance and effective density)	-.003	.002	-.968	-1.921	.063*

a. Dependent Variable: ptrainw

***) Significant at 99% level of confidence
**) Significant at 95% of confidence
*) Significant at 90% level of confidence

Table 3. Train trip attraction model after the PSM

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.814[a]	.663	.529	.04799
a. Predictors: (Constant), dtedertt, q1group, wage_b, Propensity Score, stri, pti, edertt3, dist				
b. Dependent Variable: ptrainw				

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.562	.227		2.479	.022**
	q1group	**.072**	**.023**	**.501**	**3.079**	**.006*** **
	Propensity Score	.095	.057	.343	1.661	.112
	wage_b	-.009	.008	-.207	-1.092	.288
	Dist	.043	.028	1.460	1.544	.138
	Stri	-1.268E-5	.000	-.585	-1.489	.152
	Pti	-3.189E-8	.000	-.317	-.923	.367
	edertt3	-.009	.013	-.226	-.720	.480
	Dtedertt	-.006	.002	-1.380	-2.545	.019**
a. Dependent Variable: ptrainw						

***) Significant at 99% level of confidence
**) Significant at 95% of confidence
*) Significant at 90% level of confidence

The effect of public transport induced agglomeration in the regression model was represented by dummy variable q1group. T-test analysis conducted before the PSM showed the unadjusted estimate of the effect of public transport induced agglomeration as measured by the q1group was statistically significant ($t(43)=2.187, p<0.05$). Increasing one standard score on the chance of a station of being in the q1group would increase the proportion of train trip attracted to this station by 0.391 of its standard score. Stations that classified in the q1group attracted higher proportion of train trip attraction (ptrainw= 13.3%) than stations in other groups (ptrainw=6.04%) and the standardized mean difference was d= 7.25%. This estimated effect was not necessarily representing the true causal effect of public transport induced agglomeration. There may be many covariates act as potential confounders that can bias the estimated effect of effective density on train ridership.

Further, the regression model after the PSM was conducted, now included a total of 21 stations in the matched sample. The stations were almost evenly distributed in the two groups (10 stations for the treated and 11 stations for the control) or 29 stations according to the paired sample with ratio 1:3 matching scheme. The adjusted estimate of the effect of q1group on train trip attraction in the matching sample was still significant ($t = 3.079$, $p=0.006$ or <0.01). Increasing the chance of a station for being in the q1 group by one standard score, would increase the proportion of train ridership attraction to this station by 0.501 of its standard score. The t-test in the differences on the proportion of train trip attraction for stations in the matched sample calculated for group 1 and group 2. Finding showed that stations in the matched sample classified in the q1group had significantly higher proportion of train trip attraction (ptrainw=12.39%) than that of stations in other groups (ptrainw=6.8%) at $p=0.019$. The standardized mean difference in the two samples was 5.5%.

There has been an improvement in terms of R-square increases, or of prediction capability of approximately 10.68% relatively (from 59.9% to 66.3%) in the regression after PSM. The adjusted R-square in the model post PSM indicated 52.9% of the variation in the proportion of train trip attraction may be explained by the model, when incorporating the adjustments of the number of independent variables and the sample sizes. Both the dummy variable q1group and the interaction variable between effective density and distance to station in the model after the PSM were significant. These two variables informed the effect of public transport induced agglomeration on train ridership and how much this effect changed as a decay from a station.

Increasing the chance of a station of being in the q1group (has distance decay pattern and high effective density) by one standard deviation increased the proportion of train trip attraction by 0.501 of

its standard score. The effect of q1group variable was higher in the matched sample compare to the unmatched sample. The effect of q1group in the unmatched sample (43 stations) was 0.391. The effect of 0.501 may be assigned as the true effect of public transport induced agglomeration which was higher after controlling the land use characteristics of stations. More details on the modeling results can be requested from the authors.

6. Conclusion

This paper was expected to shed light on any important interrelationship between transportation, land use, and agglomeration in terms of effective density for the case of train ridership modelling. Understanding to what extent effective density influence train ridership and that this impact is differentiated from the influence of land use related determinant factor of ridership would give different implications for transportation policies. These results inform the significant and important aspect of accessibility based agglomeration measurement in the policy analysis to optimizing the benefits of public transport externalities to residents, businesses and communities.

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Land resource availability and climate change disasters in the rural coastal of Central Java – Indonesia

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Land resource availability and climate change disasters in the rural coastal of Central Java – Indonesia

I Rudiarto[1,2], W Handayani[1,2], H B Wijaya[1,2] and T D Insani[1,2]

[1] Department of Urban and Regional Planning
[2] Universitas Diponegoro, Semarang, Indonesia

Email: iwan.rudiarto@undip.ac.id

Abstract. This paper describes the land resource availability and climate change disaster events in three rural coastal area ofthe Central Java Province, Indonesia, i.e.; Wonokerto sub district – Pemalang Regency, Sayung sub district – Demak Regency, and Lasem sub district – Rembang Regency. Land resourceavailability was assessed into land use cover change from the Landsat Image from three periods (1990, 2000, and 2015). Those images data then were combined with the climate change disasters that mostly occurs in the coastalarea as the impact of the sea level rise. The results show that most of the land use in the coastal area was convertedto fishpond from agricultural land and it happens periodically since 1990 as the disasters frequently found which also transform the occupation of community living in the area. From the assessment, it is also shown that the increasing of water body in specific period has a direct impact to the decreasing of rice field. This indicated that tidal flood as an impact of climate change has contributed in changing the availability of land resource in the study area.

Keywords: *land resource, land use cover, climate change disaster*

1. Introduction

The availability of land resources is a prerequisite for a sustainable livelihood in rural area since most people is very much depend on the agricultural activities.Agriculture has played an important role in the development of human civilization and it is the most important sector for considerable changes towards a sustainable resources balance in the future. The exploitation of the resources is considered as a key to solve the problem of food while the availability and quality of resources are closely linked to the economic efficiency of resources that directly effecting living standards of the people [1]. Efficient management and the availability of land resources are most important factors for socio-economic development in rural area including coastal area [2]. Research on socioeconomic development in rural area were mostly found that rural land resource has been degraded periodically due to the extensive utilization and exploitation [3, 4, 5]. Therefore, rural people has always tried to find the way to improve and to sustain their land resource as the main resource in family's livelihood.

Farmland as the main resource for the agricultural productivity should be considered from the shortage and hence its existence need to be preserved and conserved. According to Knaap and Chakraborty, farmland preservation and conservation have a subtle meaning where preservation is to maintain the farmland while to conserve means to use sparingly [6]. However, to preserve and to conserve farmland are depend on the actual condition of the environment as well as the policy from

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the related authorities. Sometimes, and mostly occurs in coastal area, the sustainability of farmland is threatened due to the impact of climate change disasters such as tidal flood from the sea level rise. Disasters have become the biggest threat to the livelihood of coastal communities and the sustainability of their socio-economy activities in many coastal areas [7, 8]. For long term activities, climate change phenomena will certainly be devastatingly negative and the impact is varied in regional and local scale [9]. As for example, most of the rural coastal area in Demak Regency, Central Java Province has been experiencing with climate change disaster such as flood and tidal flood where forced the farmer to convert their farms and into fishponds to continue their livelihood [2, 10].

2. Data and Method

2.1. Study Area

Coastal areas are more prone to climate change effects thus the three rural coastal areas in northern Central Java Province were chosen as the main focus of this research. The study areas were Wonokerto sub district in Pekalongan Regency, Sayung sub district in Demak Regency, and Lasem sub district in Rembang Regency. They were justified as study areas because of their history on climate change disasters. Tidal flood, flood, and drought were some of frequent events on those areas which also contributed to the change of land resource utilization there.

Figure 1. Location of Study Areas.

2.2. Data Needs

Primary data used in this research was satellite image data produced from remote sensing. It served to identify the availability of land resource and to analyse its availability in the study areas. A time series of landsat image data (1990, 2000, and 2015) was applied to provide information on land use cover in study areas. As for identifying climate change disaster events in the study area, report of disaster events was gathered from *PODES* data (village potential data; the formal-secondary data provided by village office and Central Bureau of Statistics). As this research aimed to show kind of climate change disasters within the study area, the data on flood and tidal flood events in 2010 were used.

2.3. Method

Each satellite image used for this research was projected into a map to be able to be processed and analysed. To distinguish different types or classifications of land resource, image interpretation had to be done. A visual on-screen interpretation was selected as the technique to acquire information on landsat images into land use-cover maps. This technique was applied to extract available information in landsat images by a visual analysis through image interpretation. In applying this interpretation technique, a cross-check on past studies done in the area as well as local news and statistical data were conducted prior to as well as during the interpretation process. Statistical data on climate change disaster events are quantitatively described to show the amount and distribution of the events in each study area. Results from the analysis of climate change disaster event distribution was then combined with classification of land use-cover derived from image interpretation. This process would give us information on the change in land resource availability and its relationship with climate change disaster events in the study areas.

3. Results and Discussion

3.1. Land Use-Cover in Rural Coastal Area of Central Java

The dynamics of land use-cover change in rural coastal area has a tendency to be the result of human and environment interaction which mostly related to the socio economic activity [11]. In this first study area, Wonokerto sub district in Pekalongan Regency, the image interpretation showed a very significant increase of fishpond on the northern part near the shoreline (Figure 2). The fishpond has also contributed to the increasing of the waterbody which both could be seen reaching the settlement area on the middle of the sub district. The settlement area has also seen a rise as it grew more apparent from 1990 to 2015 to the south and southwest sides of Wonokerto. Farm field area was also seen growing in accordance to the movement of settlement area.

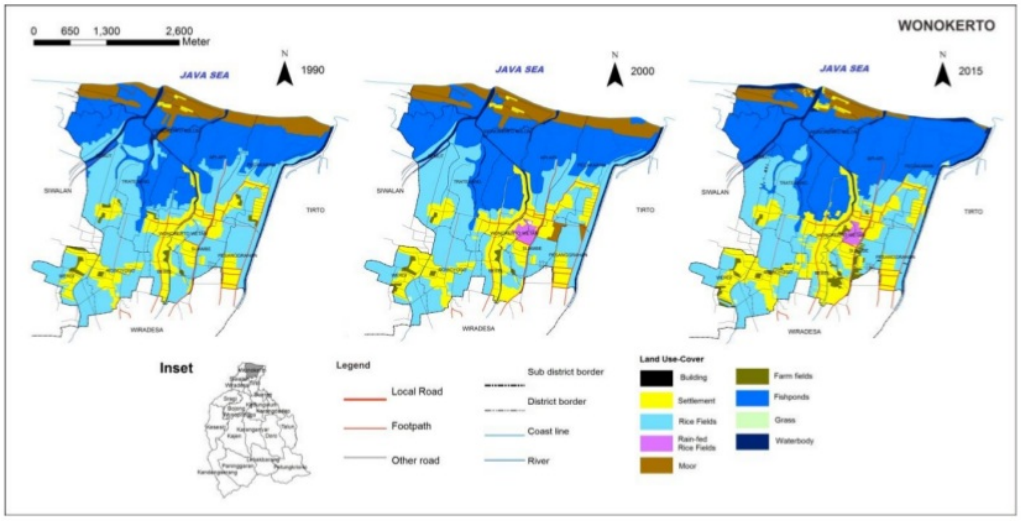

Figure 2. Land Use-Cover of Wonokerto Sub District (Periods: 1990, 2000, 2015).

As shown in Table 1, the change of land use-cover area was detailed into each type. Over the course of 25 years, the most significant increase in term of area was fishpond (199.21 ha) and settlement area (102.53 ha) which both reached more than 30% increase. Meanwhile,at the same period from 1990 to 2015, rice field and moor areas were decreased for more than 256 ha (30%) and 100 ha (53%) respectively. The increasing of fishpond and the development of more settlement area

largely caused the decreasing of rice field area and moor area because of sea level rise as well as land conversion. The decrease of those areas however followed by the increase of farm field area which reached 39%. Although it was not big in term of area, this could indicate the shift of farm-based activityin Wonokerto.

Table 1. Land Use-Cover Change of Wonokerto Sub District in Three Different Periods.

No	Land Use Cover	Area [Ha]			Land Use Cover Change	
		Year 1990	Year 2000	Year 2015	Area [Ha]	[%]
1	Waterbody	66,01	62,85	87,96	21,96	33%
2	Fishponds	641,3	671,49	840,51	199,21	31%
3	Building	-	-	1,25	1,25	100%
4	Farm field	25,84	17,35	35,82	9,97	39%
5	Settlement	330,79	369,07	433,32	102,53	31%
6	Grass	1,47	5,51	6,43	4,96	337%
7	Rice fields	863,91	769,87	607,28	-256,63	-30%
8	Rain-fed rice field	-	20,18	16,85	-3,33	-16%
9	Moor	187,68	200,68	87,58	-100,1	-53%

One of the major causes of land use-cover change in rural coastal area is the increasing of sea level rise as the impact of climate change phenomenon. Land use-cover change in Sayung sub district area was found very significant from 1990 until 2015 where most of rice fields near shoreline were converted into fishponds. Land use change was also identified to grow rapidly into industrial and settlement area from 1990 until 2015. It was especially apparent along the main road of the sub district (Figure 3). As Sayung is also a part of northern Java road network and directly bordered with Semarang City, this area is growing faster than other areas in Demak Regency. From data compilation of land use in Sayung sub district, most of land use cover was changed in term of use and the area. Among those land uses; fishpond, settlement, industrial area, rice field, and waterbody have shown a significant change. The increasing of industrial land use was formed from farm field, settlement, and rice field. Meanwhile, settlement area was improved from the changing of bush, grass, farm field, and rice field. And the waterbody has grown from the shift of fishpond and rice field.

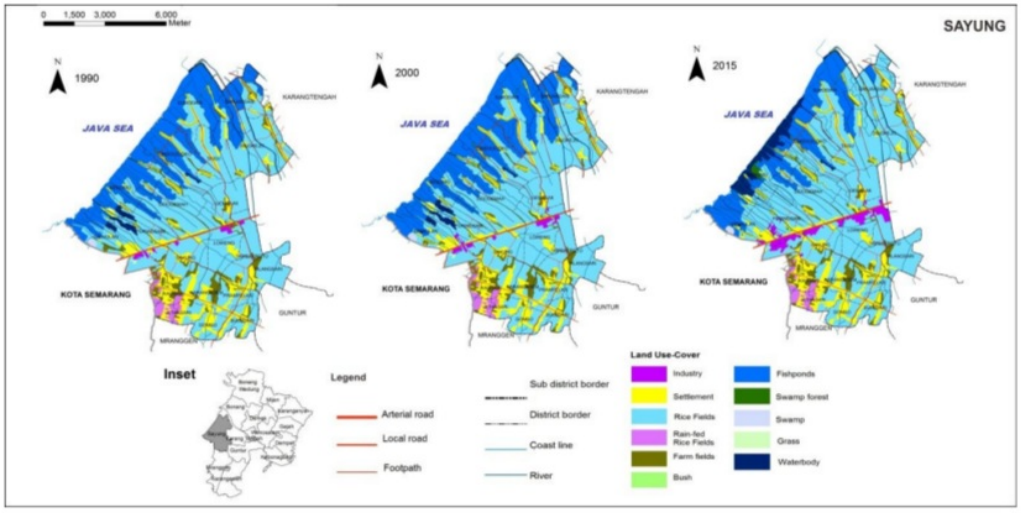

Figure 3. Land Use-Cover of Sayung Sub District (Periods: 1990, 2000, 2015).

Table 2 showed a detailed dynamic of land use cover change on the total area of each land use in 1990, 2000, and 2015. Most of the land in Sayung sub district was dominated by rice field followed by fishpond and settlement area. Rice field and settlement area have increased for about 6 % from 1990 to 2015 while fishpond area decreased up 38% during the same period. Concerning the climate change issue, this area was also experiencing sea level rise which was shown by the increased of waterbody area from 150 ha in 1990 into 379.86 ha in 2015 or equal to 153%. The industrial area also showed a huge surge of 387% over the course of 25 years.

Table 2. Land Use-Cover Change of Sayung Sub District in Three Different Periods.

No	Land Use Cover	Area [Ha]			Land Use Cover Change	
		Year 1990	Year 2000	Year 2015	Area [Ha]	[%]
1	Bush	12,85	12,85	6,62	-6,23	-48%
2	Fishpond	1.940,28	2.073,77	1.206,41	-733,87	-38%
3	Swamp forest	0,7	0,7	24,6	23,91	3432%
4	Industry	48,39	75,33	235,56	187,16	387%
5	Farm fields	447,31	428,5	402,29	-45,02	-10%
6	Settlement	1.064,92	1.077,26	1.132,36	67,44	6%
7	Swamp	24,54	24,54	16,28	-8,26	-34%
8	Grass	26,7	29,57	16,44	-10,26	-38%
9	Rice fields	4.766,57	4.607,92	5.061,97	295,39	6%
10	Rain-fed rice fields	128,23	128,23	128,23	0	0%
11	Waterbody	150,14	151,96	379,86	229,73	153%

In the third study area on the eastern side of Central Java, Lasem sub district in Rembang Regency has gained the most significant increase of settlement area and followed by fishpond as well as farm field area. The rain-fed rice field suffered from decreasing as it could be seen that most of the area was turned to settlement. Similar cause might be affecting the change in moor area as it also could be seen that settlement area were growing into the moor area. On the other hand, the forest area seemed to be conserved well as it did not show significant decrease. Unlike the first two study areas which both showed an increase of waterbody, Lasem had the opposite condition.

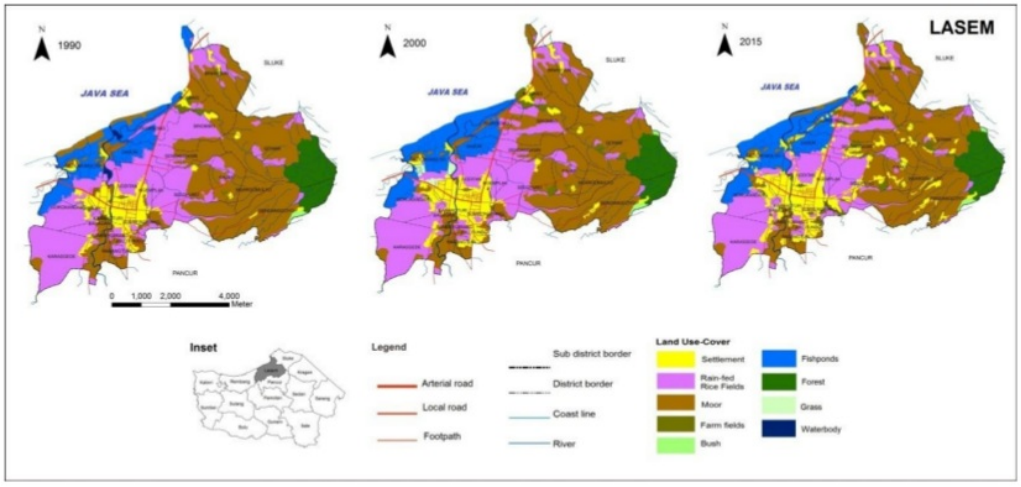

Figure 4. Land Use-Cover of Lasem Sub District (Periods: 1990, 2000, 2015).

The amount of decrease and increase area of land use cover in Lasem could be closely monitored in Table 3. Settlement area increased 290,79 ha from 1990 to 2015 or equal to 88%. This conversion mainly came from rain-fed rice field area which still dominated the total area of Lasem although it showed a decrease of 309,97 ha (21%). The decrease of 117,42 ha of moor area also contributed to the increase of settlement area as it can be seen in the map of 2015 of Figure 4. With the decrease of waterbody by 5,93 ha and the increase of fishpond by 69,96 ha, it was still hard to see how climate change affecting the rural coastal area in Lasem. However, the significant increase of farm field area by 66,81 ha which grew near settlement area could suggest that the rural community still likely depend their livelihood on farm-based activities.

Table 3. Land Use-Cover Change of Lasem Sub District in Three Different Periods.

No	Land Use Cover	Area [Ha]			Land Use Cover Change	
		Year 1990	Year 2000	Year 2015	Area [Ha]	[%]
1	Waterbody	34,08	21,37	28,14	-5,93	-17%
2	Bush	10,61	14,09	14,09	3,48	33%
3	Fishpond	409,78	477,79	479,74	69,96	17%
4	Forest	263,2	258,05	258,05	-5,15	-2%
5	Farm fields	55,44	64,71	122,25	66,81	121%
6	Settlement	329,58	404,74	620,37	290,79	88%
7	Grass	4,93	43,04	12,37	7,44	151%
8	Rain-fed rice field	1.443,33	1.225,04	1.133,36	-309,97	-21%
9	Moor	1.887,23	1.929,35	1.769,81	-117,42	-6%

3.2. Climate Change Disaster Events

Climate change has various impact on human activities. Drought will significantly influence agricultural activities [12]. Tidal flood is very likely to influence people working on fishery sectors. Flood will lead to a broader impact, both physical impact on infrastructure and also socio-economic impact on people daily activities. Flood is also regarded as the most frequent natural disaster in Asia including in Indonesia [13, 14, 15]. According to PODES data, drought was not found in the study areas of this research as most of the drought along the northern side of Central Java happened toward the more inner area of the region. Climate change disaster events that occurred were flood and tidal flood (Table 4). In 2010, Wonokerto faced 5 events of flood and 4 events of tidal flood. Sayung which has a larger area experienced 3 flood events and 6 tidal flood events. Lastly, unlike the two previous study areas, Lasem had seen more flood events than tidal flood. It experienced 6 flood events while there was only a single event of tidal flood.

Table 4. Climate Change Disaster Events in Study Areas.

Sub District	Climate Change Disaster Events	
	Flood	Tidal flood
Wonokerto	5	4
Sayung	3	6
Lasem	6	1

Source: [16]

3.3. Change in Land Resource Availability and Climate Change Disaster Events

Land use-cover analysis showed that there were some changes on the availability of some types of land resources in all three study areas. In Wonokerto and Sayung where an increase of waterbody was seen, tidal flood events were also occurred more. This pattern was followed by the decreasing of rice fields. This indicated that tidal flood as an impact of climate change has contributed in changing the availability of land resource in the study area. In Sayung, not only that the settlement area increased significantly, the industrial area also grew fast in the heart of the sub district. These conditions

answered why land conversion happened from other land use-covers to provide more development to the community. People in the community will need to readjust their activity pattern and type of livelihood while there is other possibility to the exposure to more flood as catchment areas decrease and follows with the raise of the built areas especially into the industrial one.

The land use-cover change in Sayung showed the sub district vulnerability to coastal disaster as well as to unsustainable rural livelihood. Past research in Demak Regency supported this finding as according to socio-economic measures as well as the occurance of climate change disaster events, most villages in coastal areas of Sayung sub district was categorized as most vulnerable. Villages that fell into this category were mostly those exposed by tidal flood or both tidal flood and flood with around 24% to 48% of its people were working infarming and fishery [10]. It can be said that those whose livelihood depended on the availability of land resource affected directly by the climate change disaster events. With the uncertainty that may come from change in land resource availability and possible disaster events in the future, the livelihood of the people in Sayung sub district could further be in a vulnerable state if they do not start to develop resilience as a community.

Meanwhile, the settlement area in Wonokerto that tended to move to south and southwest parts of the sub district, away from the increasing amount of waterbody and fishpond on the northern part, showed that the community tried to settle in the safer areas which are less exposed to climate change impacts such as tidal flood. Lasem on the other hand had showed an opposite trend compared to the other study areas. The decreasing of its waterbody area and its single event of tidal flood showed that the climate change impact happened in coastal area of the sub district was not as severed as Wonokerto and Sayung. This was proved by the growing of some settlement areas near waterbody and fishpond areas in northern part of Lasem.

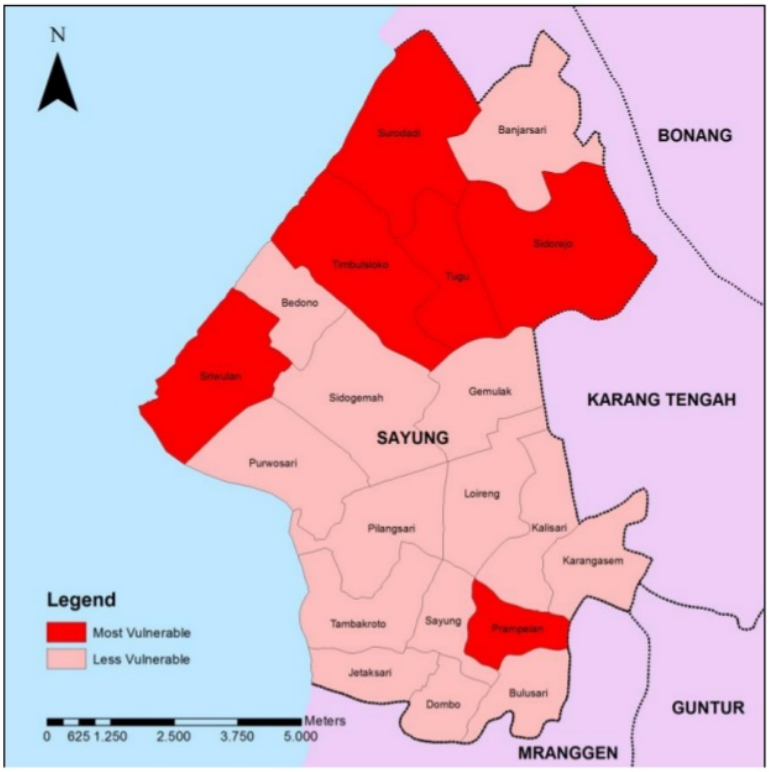

Figure 5. Socio-EconomicVulnerability in Coastal Area of Sayung Sub District

4. Conclusion

The availability of land resource in three study areas through the land use cover change analysis had shown a significant relation to the climate change disasters where the disaster has posed the local community to be adapted to the environment. Most of the agricultural land where previously utilised as the paddy field and other commodities was converted into fishpond as the reaction of local people to keep the livelihood. Since they do not have other alternatives in terms of occupation and source of income, people tend to accept the condition with their limitation.Climate change disasters in the rural coastal area has also been the major factor for the local people to make other decision on how their livelihood should be sustained. This is very possible since human being is the centre as the decision maker in the rural livelihood system.

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PAGE 2

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PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10