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NODE-PLACE MODEL ANALYSIS ON ATTACHED TRANSIT ORIENTED DEVELOPMENT (TOD) AREAS: THE CASE OF WATES TRAIN AND BUS STATION AREA

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ABSTRACT

Wates Train Station (Wates train station) and Wates Bus Station (Wates bus station) are two transportation nodes located in the Wates District moreover provide a wider area in the scale of the Kulon Progo Regency. These two transport nodes are near to each other and intersect within the radius of the TOD area. The presence of the Yogyakarta International Airport in Temon District was projected to increase the transportation intensity on Wates train station yet Wates bus station as the nodes of the current public transport service. This study was aimed to measure the Node - Place (N - P) index on both TOD areas. The Bertolini's N - P model is a commonly used method on the measurement of TOD performance in terms of the transportation intensity towards land use (activity) intensity. The identifications were based on the TOD theory and the N - P indicators. Measurements were conducted through a weighted multi - criteria analysis. The analysis resulted in the same type of node - place index on both TOD areas, the "unbalanced node". An unbalanced node indicates poor land use development regards a high transportation capability. Wates train station area has the index of node 0,72 and place 0,25 while the Wates bus station has the index of node 0,64 and place 0,16.

Keywords :
Index, Node, Place, TOD, Wates

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1. Introduction

The rise of private vehicle demand in Indonesia keeps growing as the population does, especially in cities and urbanized area. Meanwhile the needs of public transportations were contrary diminishing. Historically in java the public transportation first founded in June 17th1864 as the train Semarang - Vorstenlanden (Solo - Yogyakarta) route was built (PT.KAI, 2018). The legacy continues as other train stations was built across the nation and enhances new cities to grow. The train system was the main back bone for java island to connect the west coast to east coast as well as providing south and north route among the cities of java.

The City of Wates (Wates District urbanized area) is the main capital of Kulon Progo Regency. The south route of java train system has a role in the development of this city. Wates train station (Wates train station) was founded by late 19th century and still active through date (Pratikto, 2018). Wates train station is now known as class 1 train station in DAOP VI Special Region of Yogyakarta. The train a role to connect Kulon Progo suburb area to the main city of Yogyakarta and another city in java. By the year of 2020, Wates train station had its commuter headway around 25 minutes per train.

As well as the city and regional growing, Wates Bus Station was built to provide a wider transportation catchment area internally. Wates bus station was a type B bus station which provide various public vehicle range (Angkudes-minibus sized public transportation, Medium Sized Bus and even Big Bus that transported across island). Yogyakarta's Department of Transportation (2019) registered 10.094 bus arrivals and departures in 2017 also 35.380 Angkudes (arrivals and departures).

Transit oriented development was developed during the growth of public transportation needs in the high populated city. Transit oriented development shaped as urban area development growth which mainly focused on walkable area radius (10 minutes walking), 800 meters (1 / 2 mile) from Train Station (Light Rail Transit, Mass Rapid Transit, Heavy Rail and Commuters) (Steiner and Butler, 2007). The regulation translated to Indonesian in a decreased radius range into 400 meters. Widyastuti (2017) has gathered the transit oriented development theory into 5Ds principles: Density, Diversity, Design for Walkability, Distance to Transit and Destination Accessibility.

The growth of various transit oriented development

areas has led urban designers and planners to developed an assessment model/tools to measure the sustainability / integrastion aspect of transit oriented development. The Bertolini's (1996,1999) node - place model measured the sustainability of transport and land use in balancing between both aspect in transit oriented development area. The basic model in this paper was improved to be applied in urban design at local scale. transit oriented development areas around Wates train station and Wates bus station were the object to be acknowledged. The two had only separated by around 800 meters which caused an overlap area between them. The aim is to measure how the np index and evaluate the factors of causal on each area. If there any difference shown between the two area would likely to be an important factor that reflect the different identity of Train and Bus approaches on land use development around it.

2. Literature Review

The Node - Place model used to be an assessment tool to measure the intensity of transportation movement towards land use development (activity) and finding the balance point between them but only focusing in Railway Train system. Bertolini and Chorus (2011) explained this model as a feedback base model how the land use will reflect the benefit of transportation and vice versa. The development of the model itself has been developing since Bertolini's (1999) first model then applied in Asia (Japan) by Chorus & Bertolini (2011) and then applied in Indonesia (Surabaya) by Nadyla and Nurlaela (2018). Vale et al (2018) and Nadyla and Nurlaela (2018) tried different approach to implement the model into urban design scope.

Table 1. Indicators used by preceding researcher to measure node - place index

Variable	***Chorus & Bertolini (2011); Kamruzzaman et al., (2014); Lyu et al., (2016); Monajem and Nosratian, (2015); Reusser et al., (2008); Vale, (2015); Zemp et al., (2011).***	***Chen & Lin (2015)***	***Nadyla and Nurlaela (2018)***	***Vale et al (2018)***
Node	Number of train connections	Directions served by train Frequency of train services	Bus and train accessibility	Number of directions served by subway
	Number of bus connections	Number of stations within 20 min of travel	Car and Parking Accessibility	Daily frequency of subway services Number of stations within 20 min of travel
	Type of train connections	Number of directions other public transport (bus and tram) Daily frequency other public transport Distance from the closest motorway access Bicycle access	Availability of pedestrian ways	Number of directions served by other public transport (bus, tram, train and ferry)
	Proximity to CBD	Train passenger frequency Type of train services	Pedestrian ways connectivity	Daily frequency of services by other public transport Distance
		Presence of train service	Pedestrian ways amenities	Distance from the closest motorway access Car
		Directions served by train Frequency of train services Number of stations within 20 min of travel Number of directions other public transport (bus and tram) Daily frequency other public transport Distance from the closest motorway access Bicycle access Train passenger frequency Type of train services Presence of train service	Pedestrian ways size	Car parking availability
Design				Pedshed ratio Intersection density Accessible network length Pedshed ratio
Place	Population	Population	Population	Number of residents
	Workforce	Number of workers per economic sectors	Workforce	Number of workers in retail / hotel and catering
	Degree of multifunctionality	Degree of functional mix	Building Coverage Ratio	Number of workers in industry and distribution
		Conference rooms and educational facilities	Floor Area Ratio	Number of workers in education / health / culture
		Distance to town Center	Building Unit Density	Number of workers in administration and services
			Land use percentage	Degree of functional mix
			Degree of multifunctionality	

The indicators of preceding researchers had use have been synthesized for further understanding of each point of view. Indicators were gathered and analyzed the similarity of each other's indicators. The indicators were mainly based from Bertolini's (1999) such as Kamruzzaman et al (2014), Lyu et al (2016), Monajem and Nosratian, (2015), Reusser et al (2008), Vale (2015), Zemp et al (2011). The indicators are shown in table 1.

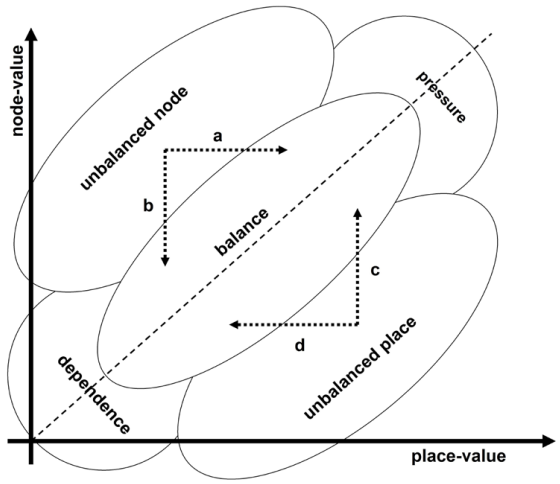

Figure 1. Node - Place Model Position Chart
Source: (Bertolini, 1996)

3. Research Method

3.1. Research Variable

The method used is quantification of the indicators. The data collected by primary survey and secondary sources. Survey methods used are observation and interview. Each indicator sources on previous chapter are synthesized into applicable indicators to be used in sub urban area and inside urban design scope. Some additional standards were gathered from local regulations such as: Keputusan Direktur Jendral Perhubungan Darat Nomor: 272 / HK.105 / DRJD / 96 on the parking standard, the standard was used to quantify the parking need of the area, the used standard for benchmarking was the parking lot size for car. The building density aspect and urban design aspect used Kementrian Agraria dan Tata Ruang's Permen No 16 Tahun 2017 tentang Pedoman Pengembangan Kawasan Berorietasi Transit (Transit Oriented Development Guideline), the standard used as building coverage ratio, floor area ratio standard and multifunctionality standard. The used standard based on sub urban transit oriented development area criteria. SNI (Standar Nasional Indonesia) 03 - 1733 - 2004, Tata Cara Perencanaan Lingkungan Perumahan di Perkotaan (Urbani Neighborhood Planning Guideline Standard) in population density standard.

Table 2. Research Variable

Variable	Indicator	Parameter
Node / Transportation	Number of service routes Train / Bus	Scoring by gap to 4 services standards
	Number of Departure	Scoring by numbers of departure, 1 departure every 20 minutes standard
	Availability of transit point in 20 minutes mileage	Scoring analysis, 2 transit point standard
	Proximity to highway	Arterial : 1; collector : 0,5
	Parking availability	3,5 Parking Lot Unit / 100m^2 nonresidential area
	Pedestrian ways availability	Percentage of Pedestrian ways availability each block
Place / Land use	Population Density	200 resident / ha
	Public service workforce Density	200 worker / ha
	Retail / Hotel / Restaurant workforce Density	200 worker / ha
	Education, health and cultural worker Density	200 worker / ha
	Building Coverage Ratio	70% as optimum standard
	Floor Area Ratio	2.0 as optimum standard
	Degree of multifunctionality	1. 16 hours minimum activity; 2. 60 : 40 – 30 : 70 % (housing : non housing)

3.2. Research Area

The research area was limited to 400 meters radius area from Wates train station and Wates bus station with regarding the natural edges that can't be passed through. Each area was identified separately to gain various strategies for future development.

Figure 2. Research Area Map
Source: Writer's archive

3.2. Data Analysis Method

Weighted multi - criteria analysis was used in this research to gain the standard on the benchmarking process. The empirical result was benchmarked and quantified on the scale of 0 to 1. The analysis was proceeded by the parameter weight table below.

Table 3. Parameter Weight

Indicator	Parameter	Weight
Number of service routes Train / Bus	Scoring by gap to 4 services standards	1
Number of Departure	Scoring by numbers of departure, 1 departure every 20 minutes standard	1

Indicator	Parameter	Weight
Availability of transit point in 20 minutes mileage	Scoring analysis, 2 transit point standard	0,8
Proximity to highway	Arterial : 1; collector : 0,5	1
Parking availability	3,5 Parking Lot Unit / 100m^2 nonresidential area	0,5
Pedestrian ways availability	Percentage of Pedestrian ways availability each block	1
Population	200 resident / ha	1
Public service workforce	200 worker / ha	1
Retail / Hotel / Restaurant workforce	200 worker / ha	1
Education, health and cultural worker	200 worker / ha	1
Building Coverage Ratio	70% as optimum standard	0,33
Floor Area Ratio	2.0 as optimum standard	0,33
Degree of multifunctionality	1. 16 hours minimum activity; 2. 60 : 40 – 30 : 70 % (housing : non housing)	1

4. Results and Discussions

4.1 Node - Place Index of Wates Train Station Transit Oriented Development Area

The node aspect in Wates train station has been quite optimized in term of commuter services. The additional of Yogyakarta International Airport train service enhanced the commuter activity that departed and arrived in this station. It added 23 more arrivals and departure per day on Wates train station. Totally there are 4 types of commuter serviced by date, even the heavy weight train service can accommodate through Jakarta and Surabaya. The commuter services were having approximately 20 minutes headway per train. The positioning of the station was between Tugu Station of Yogyakarta City (25 minutes far), Wojo and Jenar Train Station of Purworejo Regency (20 minutes far).

Table 4. Wates Train Station Commuter Schedule

COMMUTER ROUTE	ARRIVAL	DEPARTURE
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	04 : 01	04 : 03
KA. PRAMBANAN EKSPRES	04 : 33	04 : 35
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	04 : 58	05 : 00
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	05 : 36	05 : 38
KA. PRAMBANAN EKSPRES	06 : 05	06 : 07
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	06 : 22	06 : 25
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	06 : 43	06 : 45
KA. PRAMBANAN EKSPRES	06 : 46	06 : 48
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	07 : 19	07 : 21
KA. JOGLOSEMARKERTO	07 : 37	07 : 39
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	07 : 56	07 : 58
KA. PRAMBANAN EKSPRES	08 : 36	08 : 38
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	09 : 02	09 : 05
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	09 : 03	09 : 06
KA. SOLO EKSPRES	10 : 15	10 : 17
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	10 : 36	10 : 38
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	11 : 22	11 : 24
KA. SOLO EKPRES	10 : 43	10 : 45
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	11 : 45	11 : 48
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	12 : 46	12 : 48
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	13 : 16	13 : 18
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	13 : 33	13 : 36
KA. PRAMBANAN EKSPRES	14 : 06	14 : 09
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	15 : 28	15 : 32
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	15 : 33	15 : 36
KA. JOGLOSEMARKERTO	15 : 45	15 : 47
KA. PRAMBANAN EKSPRES	16 : 31	16 : 33
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	17 : 06	17 : 08
KA. SOLO EKSPRES	17 : 17	17 : 19
KA. PRAMBANAN EKSPRES	18 : 01	18 : 03
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	18 : 17	18 : 19
KA. SOLO EKPRES	18 : 53	18 : 57
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	18 : 54	18 : 56
KA. PRAMBANAN EKSPRES	19 : 34	19 : 36
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	19 : 42	19 : 45
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	20 : 28	20 : 30
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	20 : 36	20 : 55
KA. BANDARA YOGYAKARTA INTERNATIONAL AIRPORT	21 : 42	21 : 45

Source: Kereta Api Kita (2020)

In the local scale, the train are positioned on the central of the business district of the city. Placed nearby a collector road and in between government office, *alun-alun* and city's market. The parking availability in the area were low

in percentage to be benchmarked, there was only 6.570 m^2 (525 parking lot units) in this area to be compared by 2.794 parking lot units required parking area. The unavailability of parking lot caused on-street illegal parking on this area. The illegal parking also caused blockade on the pedestrian ways by motorcycle. The last aspect of node was the availability of pedestrian ways. The pedestrian ways on this area were integrated to every local destination. On the residential area the pedestrian ways were not really optimized by the government and spread well on the residential / housing area. Some of the pedestrian ways were in a bad shape and didn't have a similarity in design. Only 44% (6.983 m from 16.000 m total block circumference) of the blocks in this area are connected by pedestrian ways.

The place aspect was quiet low in this area. The residential area was 33,5 ha large. Proxy analysis was applied to quantify the number of residents from Wates village to the Wates train station and Wates bus station area. About 3.414 residents from 14.919 (BPS, 2019) was estimated in this area. The population density was 73 resident per hectare, 25% from the standard used. The workforce was gathered from secondary data (website) and quick interview with the shop / office owners. There were 731 (16 workers / ha) public facility / government office workers, 2.760 (59 workers / ha) retail / shop / restaurant workers and 221 (5 workers / ha) educational / health / cultural workers.

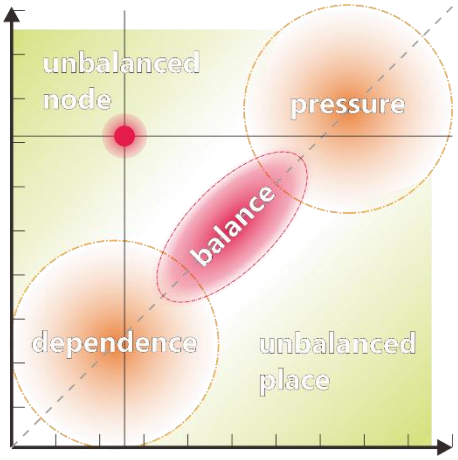

Figure 3. Node - Place Position Wates train station Transit Oriented Development Area

Source: Writer's archive

Building density was urban design node aspect, it had important role in future development strategy. Building density linked to population and workforce density. The Wates train station area averaged 38% in building coverage ratio the area was benchmarked low to the threshold of sub - urban transit oriented development standard (70% building coverage ratio). Floor area ratio also very low on 0,46, only 23% of the threshold. Low density was caused by inadequate development, there was 1,6 ha undeveloped farming area. Most of the building was landed and single owned, the tallest building was 3 stories high.

Table 5. Node Place Index of Wates Train Station Transit Oriented Development Area

Indicator	Result	Criteria	Score	Weight	Index
		Node Variable			
Number of service routes Train / Bus	4 types : Joglosemarkerto, Solo Ekspress, Prambanan Ekspress, Kereta Bandara	4	1	1	1
Number of Departure	1	1	1	1	1
Availability of transit point in 20 minutes mileage	2 (Wojo, Jenar) (Yogyakarta 25 minutes)	2	1	0,8	0,8
Proximity to highway	Collector road (200m)	Arterial : 1; Collector : 0,5	0,5	1	0,5
Parking availability	525 Parking lot units (6.570 m^2)	2.794 Parking lot units	0,19	0,5	0,09
Pedestrian ways availability	6.983 m	16.000 m	0,44	1	0,44
	Node Index				**0,723**
		Place Variable			
Population Density	73	200	0,250	1	0,25
Public service workforce Density	16	200	0,035	1	0,04
Retail / Hotel / Restaurant workforce Density	59	200	0,296	1	0,30
Education, health and cultural worker	5	200	0,024	1	0,02
Building Coverage Ratio	38 %	70%	0,54	0,33	0,18
Floor Area Ratio	0,46	2	0,23	0,33	0,08
Degree of multifunctionality	45 : 55	4 categories 60 : 40 (0,25) 50 : 50 (0,5) 40 : 60 (0,75), 30 : 70 (1)	0,625	1,0	0,6
Area active time	03.30 - 23.00 (20,5)	16 - 24	0,5625		
	Place Index				**0,257**

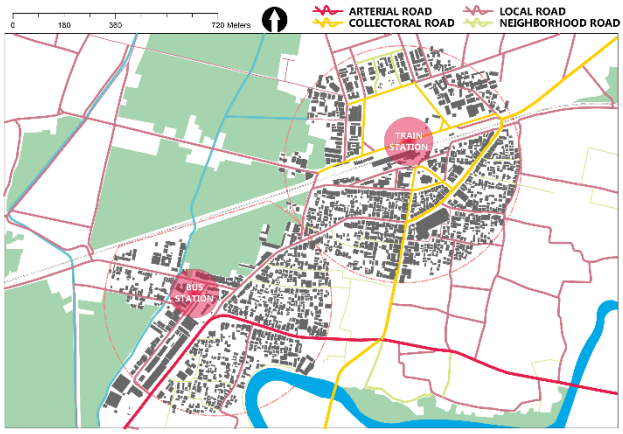

Figure 4. Distance from Node to Highway Road Map

Source: Writer's archive

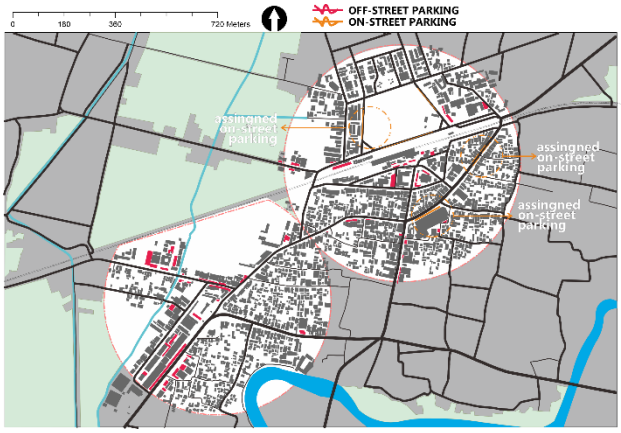

Figure 5. Parking Lot on Transit Oriented Development Area Spreading Locations Map

Source: Writer's archive

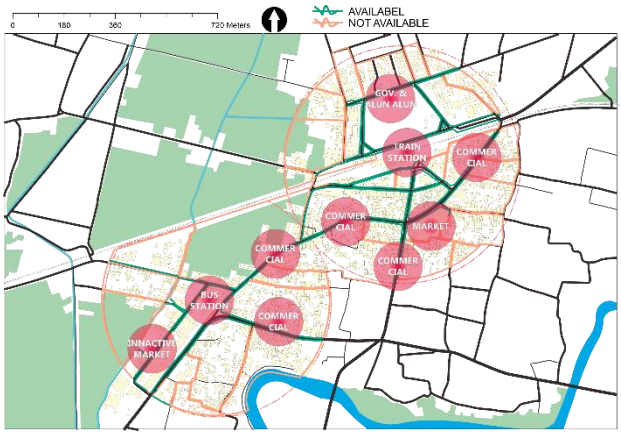

Figure 6. Pedestrian Ways on Transit Oriented Development Area Spreading Map

Source: Writer's archive

Degree of multifunctionality reflected how vibrant the area. The first aspect was resident to non - resident ratio. The ratio reflected various activity that the area provided. Ratio on this area was 45 : 55 (resident : non - resident), the highest ratio was 30 : 70. Bigger non - resident ratio impacted on more activity provided by TOD area which also more transportation attraction to the area. Area active time also responsible in terms of degree of multifunctionality aspect. The longer active time the more vibrant area is. This area active from 03.30 - 23.00 (19 hours). The main factor of early active in this area was the present of Wates

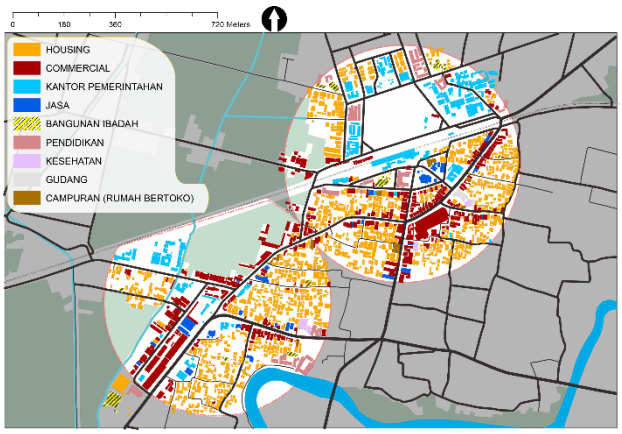

Figure 7. Building Function Map

Source: Writer's archive

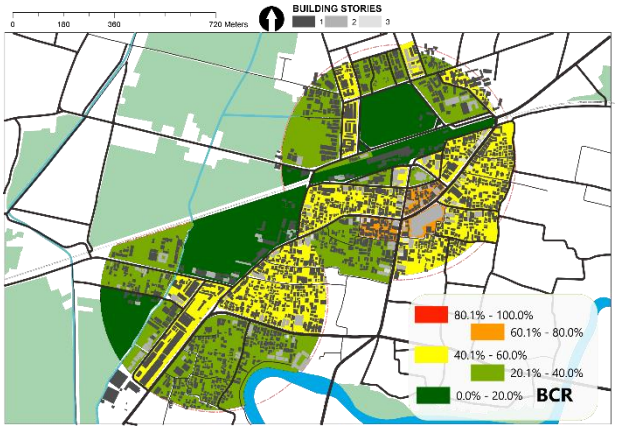

Figure 8. Building Coverage Ratio Map

Source: Writer's archive

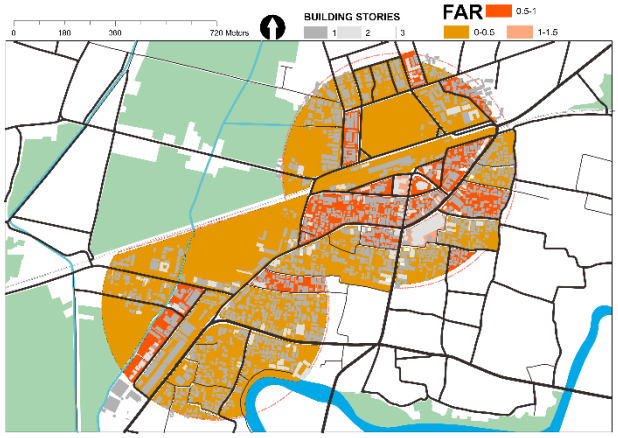

Figure 9. Floor Area Ratio Map

Source: Writer's archive

Market and the Train Station. Economic (formal and informal) activity last long in this area until 23.00 due to some café and street vendors. Street vendors shopping were a common night activity in Java especially in Yogyakarta. The activity caused longer and saver nighttime.

4.2 Node - Place Index of Wates Bus Station Transit Oriented Development Area

Wates bus station served 2 mode of public transportation vehicle, *angkudes* and bus (commuter and long - distance big bus). Wates bus station and commuter bus service in Kulon Progo was very active until late 2015, but due to the lack of improvement in commuter bus service and massive private vehicle demand in this region

decreased the people willingness to use commuter bus. By 2015 there was 3 active transit in Kulon Progo (Ngeplang transit point / Sentolo District, Brosot transit point / Galur District and Jangkaran transit point / Temon District) and also another route that served the District of Kokap, Kulon Progo. In 2020 there was only one active bus transit point (Ngeplang transit point) and only one active route from Wates to Giwangan (Yogyakarta). The Jangkaran route has been inactive and only served by *angkudes*, the Brosot bus transit point has been inactive but the Wates - Galur - Bantul route still active in decreased number. As type B bus station also served long - distance to another region and even island to Sumatra and Bali. The big bus was organized by private sector and needed ticket for the access. There were 2 arrivals and departures per 20 minutes in this bus station on average.

In the local scale position of the bus station was prime, place at the arterial road on an organized traffic light. The parking availability in the area were inadequate in percentage to be benchmarked, there was only 8.503m^2 (680 parking lot units) compared to 1.848 parking lot units needed. The unavailability of parking lot also caused on - street parking on this area. The availability of pedestrian ways. The pedestrian ways on this area were integrated to every local destination. On the residential area the pedestrian ways were not really optimized and spread well. The neighborhood road was small in size that even some 4 wheels vehicle can't access. Only 34% (3.780 m from 11.028 m total block circumference) of the blocks in this area are connected by pedestrian ways.

The place aspect was lower than the Wates train station area. The large of residential area was 18,9 ha. Proxy analysis also applied to quantify the number of residents from Wates village to the observed area. About 1.942 residents from 14.919 (BPS, 2019) was estimated in this area. The population density was 49 resident per hectare, 25% from the standard used. On the workforce indicators, there were 267 (7 workers / ha) public facility / government office workers, 1.162 (29 workers / ha) retail / shop / restaurant workers and 157 (4 workers / ha) educational / health / cultural workers.

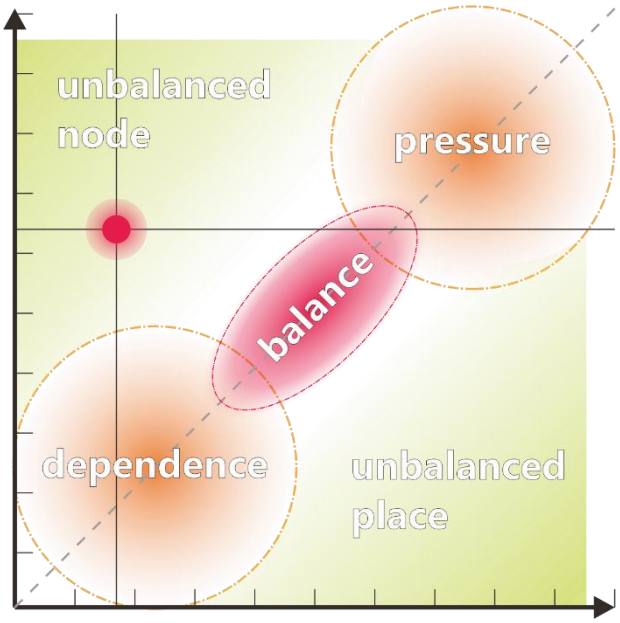

Figure 10. Node - Place Position Wates bus station Transit Oriented Development Area

Source: Writer's archive

The building density was also low in development, buildings averaged 34% in building coverage ratio the area was benchmarked low to the threshold of sub - urban transit oriented development standard (70% building coverage ratio). Floor area ratio also very low on 0,37, only 18% of the threshold. Low density was also caused by inadequate development, there was 9,7 ha undeveloped farming area. Most of the building was landed and single owned, the tallest building was 3 stories high and most of the building parcel were large.

Multifunctionality in Wates bus station area was lower than the train station area. Ratio of resident to non - resident were 50 : 50, indicated lower transportation attractiveness of the area. The unavailability of big market or big commercial place caused low attraction and made the bus station only as a hub not as destination. The bus station area has no large commercial building or even government office. The area active from 05.00 – 20.00 (15 hours) lower than the threshold. Activity was low at the nighttime due to the presence of arterial road, there were informal merchant by the roadside but didn't have much impact to attract people.

Table 6. Node Place Index of Wates Bus Station Transit Oriented Development Area

Indicator	Result	Criteria	Score	Weight	Index
		Node Variable			
Number of service routes Train / Bus	2 Type (Angkudes, Bus)	4	0,5	1	0,5
Number of Departure	2	1	1	1	1
Availability of transit point in 20 minutes mileage	1 Active (Ngeplang) 2 Non - Active (Brosot, Jangkaran)	2	0,5	0,8	0,4
Proximity to highway	Arterial Road	Arterial : 1; Collector : 0,5	1	1	1
Parking availability	680 parking lot units (8.503 m^2)	1.848 parking lot units	0,37	0,5	0,18
Pedestrian ways availability	3.780 m	11.028 m	0,34	1	0,34
		Node Index			**0,647**
		Place Variable			
Population Density	49	200	0,250	1	0,25
Public service workforce Density	7	200	0,035	1	0,04
Retail / Hotel / Restaurant workforce Density	29	200	0,145	1	0,15

Indicator	Result	Criteria	Score	Weight	Index
Education, health and cultural worker Density	4	200	0,020	1	0,02
Building Coverage Ratio	34%	70%	0,5	0,33	0,17
Floor Area Ratio	0,374	2	0,187	0,33	0,06
Degree of multifunctionality	50 : 50	4 categories 60 : 40 (0,25) 50 : 50 (0,5) 40 : 60 (0,75), 30 : 70 (1)	0,5	1,0	0,3
Area active time	05.00 - 20.00 (15)	16 - 24	0		
	Place Index				**0,164**

5. Conclusion

Node - Place Index in Wates train station and Wates bus station area situated at unbalanced node position. Unbalanced node indicated high activity of transportation, but the land use was not equivalently developed. Unbalance node impacted on minor transportation attraction and caused un-sustained economic development. The transportation aspect on both areas were capable of high amount of service. Unfortunately, the development of transportation mode modernity was not applied on both nodes. The bus station was having a diminishing number of user and led the bus owners to withdraw their fleet away. The Wates train station was having opposite situation lately. The presence of Yogyakarta International Airport on Temon District, Kulon Progo enhanced the train activity on this train station. The airport train service added 23 more arrivals and departures from this train station daily, also impacted on faster headway time of the train arrival. The faster headway impacted the availability of commuter chance from Wates to Yogyakarta.

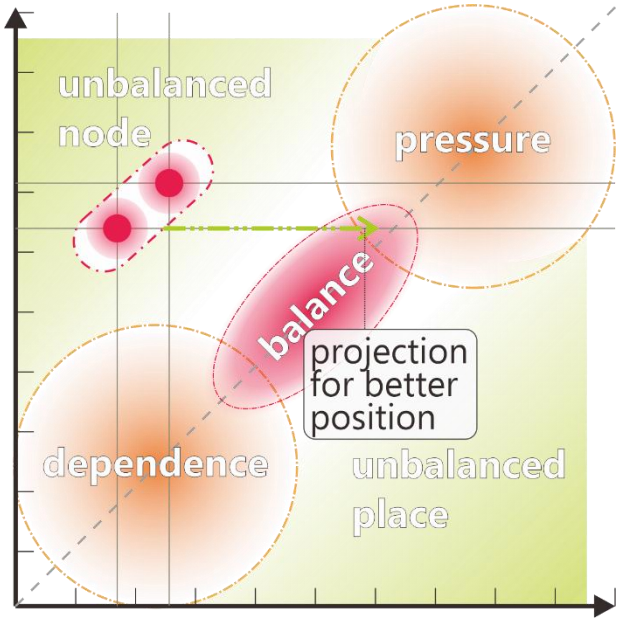

Figure 11. Node - Place Position Both Transit Oriented Development Areas

Source: Writer's archive

The downside of this area was the land use / place factor. The main factor of the low place index was the density. The buildings in this area were mainly singular landed housing and single owned office / retail. Low density development in this area impacted the low population even workforce. The minimal workforce caused minimal transportation attraction into the area. In terms of being an urbanized area the farming area needed to be minimized and transform into a new modern shape of farming. In case of future development into optimal shape of sustainable transit oriented development area and categorize as sub - urban transit oriented development it had to increase the density. The building coverage ratio needed to be at least 70% and having the floor area ratio on number 3. Both transit oriented development areas in Wates District were suitable for being a satellite city for Yogyakarta greater city transit oriented development.

The design aspect needed to fulfill the requirement were concluded into 3 development strategies:

a. increasing residential density by vertical housing development,
b. office intensity by mixed office building development,
c. And retail / services intensity by multi story retail development.

This research shown another perspective on the node place model application. The previous research by Chorus & Bertolini (2011), Chen & Lin (2015), Nadyla and Nurlaela (2018) and Vale et al (2018) were based on urbanized area. Especially on Chorus & Bertolini (2011), Chen & Lin (2015) and Vale et al (2018), those researches were taken on larger metropolitan cities on multiple TOD areas. Meanwhile this research took sub-urban area on a developing country as the object that resulted low place/landuse index compared to the metropolitan cities. But there were some benefits on the long-term planning by how this model was applied on sub-urban area. This model resulted more variable and aspect on how the city can be strategically planned and can be used as a threshold how the city develops.

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