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Hierarchical service for integrating multimodal public transport system in Palembang, Indonesia

Erika Buchari [1, a]

[11]Centre of Excellence Multimodal Transportation of Sriwijaya University, Jl. Padang Selasa 524, Palembang 30139, Indonesia

[a]<eribas17@gmail.com>

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Abstract. Palembang, capital city of South Sumatera Province, is developing LRT system for public transport. Yet, the existing old bus, and BRT routes are not compatible with planned LRT route. The aims of this paper are to present the characteristics of multimodal public transport demand, and their potential of shifting from private car or motorcycles to LRT, and to plan the hierarchical service for integrating multimodal public transport system. Method of Analysis is descriptive Analysis, Cross tabulation, matrices analysis and multimodal analysis. The result of this study is (1) demand for multimodal transport is still low (21.66%), with 43.38% travel time is less and equal to 15 minutes and 38.18% travel time is between 16 to 30 minutes (2) the hierarchical services are LRT and BRT is a main modes which share the Road Sudirman in different level and get high speed, the feeder route is Old Buses and Oplets routes, which need to be replanned and readjusted in integrating multimodal public transport.

1. Introduction

Palembang, capital city of South Sumatera Province, is developing LRT system for public transport. Now, Bus Rapid Transit called Trans Musi is in service and functioned as semi BRT because there is no dedicated lane, so that the speed and schedule is uncertain. In addition to that further improvement is being implemented. Light Rail Transit is being constructed and to be operated in year 2018. Currently, in the absence of hierarchical services, the main mode is overlapped on its functions between buses and oplets, which shows Bus users 27,258 (34,40%) and oplet users 23,442 (29,59%) [1]. Yet, the existing old bus, and BRT routes are not compatible with planned LRT route.

Problem Formulation is to know

1) How are the characteristics of multimodal public transport demand and their potential of shifting from private car or motorcycles to LRT
2) How is the hierarchical service for integrating multimodal public transport system in Palembang.

The aims of this paper are to

1) Present the characteristics of multimodal public transport demand, and their potential of shifting from private car or motorcycles to LRT, and
2) Plan the hierarchical service for integrating multimodal public transport system..

2. State of the Arts

Multi modal public transport (MMPT) is defined as a chain of public transport trips which using two or more transport modes, which have combined and interconnected transfer points [3][4]. It is expected by combining and synchronizing the public transport modes, time for changing modes can be saved, and changing modes can be more convenient and easy. The developments of public transport services have been advanced lately, but researches on multimodal transportation have just started recently.

The current characteristics of multimodal trips in developing countries are different with those of developed countries. The connecting and interconnectivity between modes are available in a discontinuous form. Some countries have excessive number of s waiting for passengers; some cases have irregular distribution of bus services. The characteristics of multimodal trips are studied and presented by Krygsman [5]. Erika Buchari [2][6] stated six elements of multimodal public transport for developing countries, for case studies in several cities in Indonesia. Those elements are (1) Connecting modes; (2) Main Modes ; (3) Multimodal Network (Main route, Feeder Route); (4) Transfer Point is a facility that allow the combination of modes; (5) Intermodal terminal (River/Road, other system and infrastructure mode); and (6) Counter Measures. Counter Measures of public transport performance are in the form of regulation, policy, organization (Legal aspect and administration). The most important and negligible part of developing multimodal public transport system in many developing cities are the Transfer Point and Intermodal Transfer Point. Among other things, Potential Development of Park and Ride system has been studied [1]. It was found from the previous research and study that integrating multimodal public transport system is not as simple as building the transport infrastructure, such as Terminal, Station and Bus Stops. Beyond that the hierarchy of services is very important factor to succeed in integrating all the modes. Therefore, this study is trying to analyze and discuss this aspect.

3. Method

The question is then raised on how the research on hierarchical services will be accomplished. What are the tools? What are the key parameters? Raw data from 4000 samples of Households are analyzed and further investigated. Method of Analysis is descriptive Analysis, Cross tabulation, matrices analysis and multimodal analysis. The data from previous study was used to analyze the hierarchy of services of existing public transport.

The steps of analysis is:

1) Define the main modes. First of all, the function of modes should be clarified. Which one is functioned as the main modes, feeder modes,
2) Define the main network and feeder network.
3) Define the easiness of travel, by using matrix Travel time and number of modes used. After demand pattern are detected, then the importance of travel time of each respondents are considered in order to know if the time is prime importance for the travelers or not.
4) Consolidate the trip chain need of public transport users by delineating the existing public transport routes, draw the available public transport modes, predict the future need and shift of public transport mode by deducting Private Vehicle Users-PT Users as a potential shift.

4. Results and Discussions

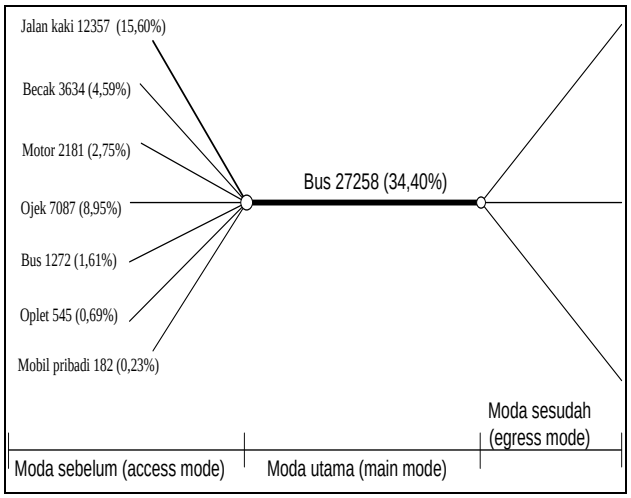
From the results of the home interview survey, which questionnaires is presented in the attachment, then the characteristics of Multimodal Public Transport Services in Palembang are diagnosed as the following table 1.

Table 1: Population Trip Matrix of Mode 1 – Mode 2

MODE 1 (people) \ MODE 2 (people)	1	2	3	4	5	6	7	8	9	10	11	12	13	∑M1
1	0	182	1817	2362	0	3816	12357	18717	0	0	545	0	0	39797
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1272	0	545	0	0	0	3634	3453	0	0	0	0	0	8904
5	7451	0	0	0	0	0	2181	0	0	0	363	0	3271	13266
6	182	0	0	0	0	0	7087	727	0	0	182	0	2362	10540
7	545	0	0	0	0	363	1272	0	0	0	0	0	0	2181
8	1636	0	0	545	0	182	545	363	0	0	182	0	0	3453
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	363	0	0	0	0	0	182	0	0	0	0	0	0	545
11	363	0	0	0	0	0	0	182	0	0	0	0	0	545
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
∑M2	11812	182	2362	2908	0	4361	27258	23442	0	0	1272	0	5633	79231

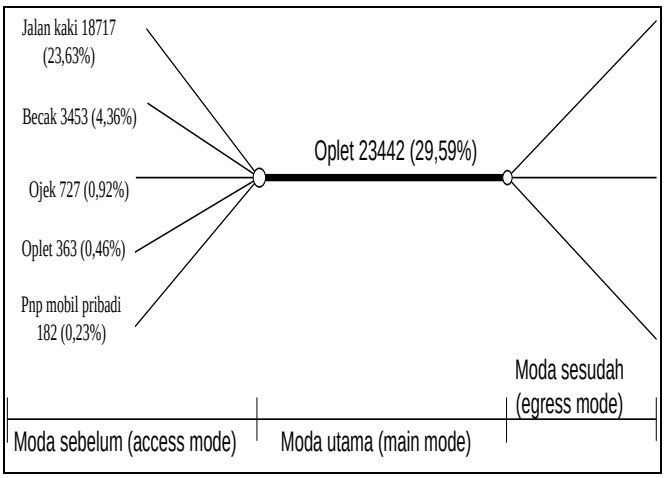
Source: Analysis Data, 2011 (Erika Buchari, 2015)

From the question that was asked, it was revealed the combination of access modes and the second mode for bus and oplet as it is presented in Fig.1 and Fig.2. Then, from the answer of respondets, the function of modes is defined and the main mode can be detected. It was found that Bus and Oplet has overlapping function as main modes. Those are in services as the main mode on the main network.



Source: [1]

Fig.1.Multimodal Analysis of Bus modes



Source: [1]

Fig.2. Multimodal Analysis of Oplet Modes

Level of Multimodality

Level of multimodality is used to analyze the dependency of one mode towards other modes and it is presented in the following table.

Table 2: Level of Multimodality of Palembang Trips, 2011

Modes	All trips	Unimodal Trips	Multimodal Trips	Percentage of Multimodal Trips
Walking	16,47%	9,59%	6,88%	41,78%
Bicycle	2,67%	2,60%	0,06%	2,28%
Boat	0,56%	0,39%	0,17%	30,91%
Becak (tricycle)	4,01%	2,66%	1,36%	33,84%
Motorcycle	43,09%	41,17%	1,92%	4,45%
Motorcycle passengers	7,03%	5,43%	1,60%	22,77%
Bus passengers	6,71%	1,66%	5,05%	75,23%
Oplet passengers	6,02%	2,52%	3,50%	58,08%
Taxi passengers	0,03%	0,01%	0,02%	66,67%
Car	10,92%	10,74%	0,17%	1,58%
Car passengers	1,66%	1,41%	0,25%	15,24%
Truck passengers	0,04%	0,00%	0,04%	100,00%
Others	0,79%	0,15%	0,64%	80,77%
TOTAL	100%	78,34%	21,66%	

Source: [1]

From the above table, it can be seen that there is high multimodality for bus (75.26 %) and Oplet (58,14%), which means they have high dependencies to other modes. These dependencies were captured by Ojek (motorcycle passenger), Becak, and other modes. On the other hand, private vehicle users like motorcycles and cars, have very little combination to other modes. It can be seen from the lowest multimodality as 4.46% for motorcycles and 1.65% for cars.

The easiness of travel is analysed by using the following matrix Travel time and number of modes used.

Table 3: Matrix Number of modes used – Travel Time

		Travel Time (minute)							
		1	2	3	4	5	6	7	TOTAL
No of Mode	1	1116	894	140	145	38	14	6	2353
	2	593	548	116	106	40	11	3	1417
	3	81	85	20	28	8	0	2	224
	4	5	0	1	0	0	0	0	6
	5	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
	TOTAL	1795	1527	277	279	86	25	11	4000

Notes :
No of Mode 1 to 6 is coded as the number of mode used by respondents
Travel time Code:

1	**2**	**3**	**4**	**5**	**6**	**7**
≤ 15 min	16-30 min	31- 45 min	46-60 min	61-90 min	91-120min	>120 min

From the above table, it was detected that Private Vehicle is usually only used one mode, in this term the total of Private Vehicle is 2353 (58.82 %). While, the rest 41.82% is captive and optional to public transport. Majority of travel time PV is shorter than PT time, which is shown in above the table, 43.38% travel time is less and equal to 15 minutes and 38.18% travel time is between 16 to 30 minutes. Only 16.95% travel time by private vehicle in urban area takes longer than 1 hour, but 19.48% travel time by public transport take longer than one hour. If the policy is in favors to private vehicles, and the public transport services are not considered and fulfilled then it is almost impossible to switch the mode choice to the public transport. Therefore, the travel time of public transport should be planned as close as possible to private vehicles.

Detecting Travel Demand

In detecting travel demand, the desired line of travel pattern from 4000 sample of respondents is delineated as the following figure 3.

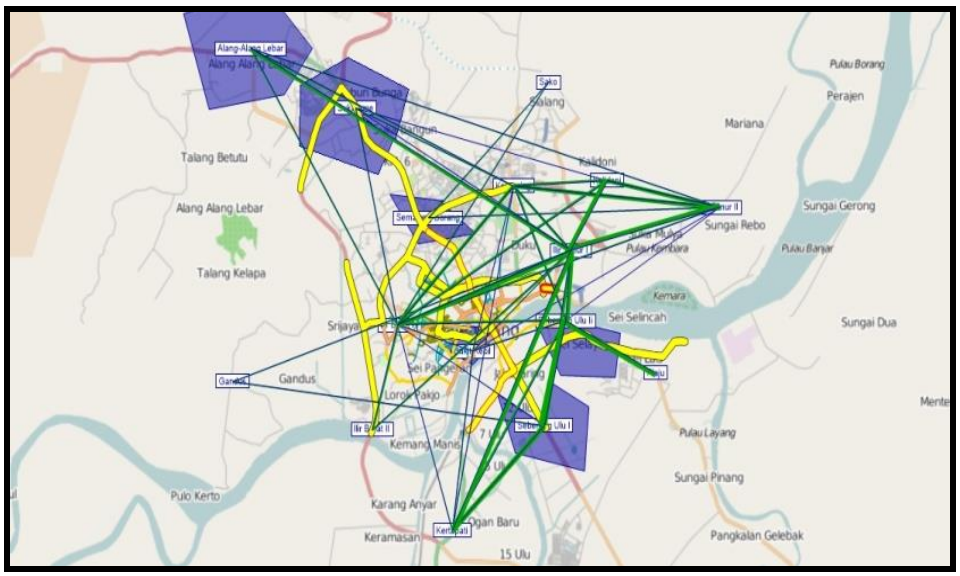


Figure 3: Desired line of travel pattern of PalembangTrips

Potential Shift from Private Vehicle to Public Transport

Referring from the survey results, that was obtained from home interview survey, it can be concluded that, the services which influence passenger's choices are about:

1) Perception before travel: Awareness, Modal Choice, Travel Plan. Need: Information, time n cost, perception and image about services.
2) Walking distance and condition to the public transport
3) Waiting Time for Public Transport. Need: regular and high frequency of bus coming in, safe condition, weather protected, comfort and information/certainty of the service
4) Information about Public Transport, i.e distinctive at long distance, number or color of routes, clear information about route destination
5) Board the public transport; distance to pedestrian, deck or floor level, grab rails, quick payment system
6) On Public Transport; Internal condition such as crowdies, seating and standing facilities, information about estimation of travel time
7) Alighting public transport: Level of the floor, distance to pedestrian
8) Interchange facilities: Informaion about walking distance in interchange facilities, safety.

Hierarchical Services

In order to plan the hierarchical services, some steps can be done as the following:

1) Select the speed, the time and the long distance travel that will be a main mode. The resuts are the options of LRT and dedicated lane TransMusi (BRT)
2) Increase other PT travel time, such as old bus and oplet (minibus with 8 or 9 seats, like tuk tuk in Philippine)
3) Make voluntaries agreement among public transport provider to share smart card system
4) Work out in Land Consolidation to create Transit Oriented Development System. Each Transfer point and Intermodal Transfer Point should have integrated and easy access to other transport modes.
5) Make agreement about multimodal network for public transport priority, unlike now which is more to private vehicle priority

5. Conclusion

From the above analysis, it can be concluded that:

1) To present the characteristics of multimodal public transport demand, analysis of multimodality is used. Level of multimodality is 21.66%, which means there is low dependencies to other modes, or in other words there is high tendency of using single mode. The potential of shifting from private car or motorcycles to LRT, can be obtained from matrix Number of modes and Travel times. It is shown that 43.38% respondents' travel time is less and equal to 15 minutes and 38.18% travel time is between 16 to 30 minutes. It means to have a shifting from Private Vehicles (58.82 %) to Public Transport modes need elaborated effort of reducing travel time in public transport. Therefore, the travel time of public transport should be planned as close as possible to private vehicles.
2) For integrating multimodal public transport system, the hierarchical services are planned. LRT and BRT is a main modes which share arterial road, Sudirman Street in different level and get high speed. Then, the feeder route is Old Buses and Oplets routes, which need to be replanned and readjusted in integrating multimodal public transport.

Appendix

HOME INTERVIEW SURVEY INDIVIDUAL TRAVEL IN PALEMBANG, SEPTEMBER 2011

START DATE: TIME: FINISH DATE: TIME: FOLLOWING DAY.
SURVEYOR: SIGNITURE: INTERVIEWEE:

STATUS IN FAMILY 1. FATHER 2. MOTHER 3. CHILD 4. RELATIVES 5. GRAND PARENTS	CURRENT ADDRESS:	PLACE OF WORK/SCHOOL:	GENDER: 1. WOMAN 2. MAN	AGE	JOB STATUS 1.PROFESIONAL 2.MANAGER 3.GOVERNMENT OFFICIAL 4.TRADER 5.FARMER 6.DRIVER 7.LABOUR 8.SECURITY 9.STUDENT 10.HOUSE WIFE 11.UNEMPLOYMENT	NUMBER OF CARS IN FAMILY: 1. ZERO 2. ONE 3. TWO 4.THREE OR MORE	PRIORITY OF USING CARS? 1. YES 2. NO

TRAVEL DIARY DATA IN ONE DAY (1 TRIP TO DESTINATION MAY CONSIST OF VARIOUS MODE, SUCH AS WALKING--BUS-OPLET-BECA)

	TRIP I				TRIP II				TRIP III				TRIP IV			
1. DEPART FROM:																
2. ADDRESS:																
3. DEPARTURE TIME:																
4. DESTINATION TO:																
5. ADDRESS:																
6. ARRIVAL TIME:																
7. TRIP PURPOSE																
8. TRIP MODES: MODE 1. MODE 2. MODE 3. MODE 4. MODE 5.	A. TYPE	B. (TIME)	C.CHANGE	D. (TIME)	A. TYPE	B. (TIME)	C.CHANGE	D. (TIME)	A. TYPE	B. (TIME)	C.CHANGE	D. (TIME)	A. TYPE	B. (TIME)	C.CHANGE	D. (TIME)
9. COST PER MONTHBLN																
10.SALARY/MONTH	1) < Rp 500.000,- 2) Rp 500.000,- -				Rp 1.000.000,- 3) Rp1.000.000,- -				Rp.3.000.000,- 4) Rp 3.000.000,-				- Rp5.000.000,- 5) > Rp 5.000.000,-			
11. COMPLAIN:																

Code:
1 and 4: House (1) working Place (2) School (3) Others (4)
2 and 5: Address: (Surveyor: See the attached table of zone coding and Map
7: Going home (1) Working (2) Study (3) Trade (4) Meeting/Conference (5) Repair Services (6) Farm/forest (7) Shopping (8) Social activities (9) Others (10)
8: A.Type: Walking (1) Bicycle (2) Boat (3) Becak (4) Ride motorcycle (5) Passenger of Motorcycle/Ojek (6) Bus passenger (7) Oplet passenger (8) Taxi (9) Drive own car (10) Car Passenger (11) Truk Passenger (12) Others (13)
B. (T): Travel time per mode type
C.Change: Location of changing mode (i.e: Station, Bus stop, Parking, Street).
D. (T): Waiting time for changing mode

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