

# **MEASUREMENT OF PUBLIC TRANSPORT ACCESSIBILITY CONDITION AT KOTA BANDA ACEH**

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## **ABSTRACT**

*Kota Banda Aceh with 224.233 peoples at 2007 deserved by 1.012 units of public transportation in any type, it means there are 5,1 seats for each 100 peoples of Kota Banda Aceh. Length of road which deserved by public transport is 45,35 Km, it means only 10,92% length of road in Kota Banda Aceh. For Banda Aceh with wide 61,359 Km<sup>2</sup>, the coverage of public transport just 15,9%. Any type these accessibility measurement will give us different means the level of public transport accessibility. Through this accessibility level measuring, we will gets some recomendation for public transport policy of Kota Banda Aceh and its implication, as consideration for Public Transport decision maker.*

**Key words : Public Transportation, Accessibility**

## **Introduction**

### Background of the study

Post tsunami in the year 2004, kota Banda Aceh experiences hard damage to the road infrastructure and urban public transport system. To be able to give service as well as possible to the resident, hence main priority done by the government of kota Banda Aceh is repair of road infrastructure, continued by public transport supply. To provide efficient and effective public transport of Banda Aceh in a short time, we required some information of the public transport performance. One of the measuring instrument for transportation performance is accessibility, as consequences the condition of public transport accessibility performance hardly required by the government of kota Banda Aceh to compile strategic program of the public transport supply for the urban transportation system.

### Purposes and objectives

The objectives of this research is to get drawn the condition of urban public transportation accessibility of Banda Aceh

through various measurement methods of accessibility, by which we can be made compilation of strategic program for public transport supply of kota Banda Aceh in effective and efficient ways to serves their peoples.

### Scope of Study

Location of This study is kota Banda Aceh in Provinsi Nangroe Aceh Darussalam (NAD) with wide 61,359 Km<sup>2</sup>, divided into 9 District (kecamatan) and 89 Sub-district (village). This study scope is: 1) Data of public transportation of kota Banda Aceh and their coverage; 2) Measuring the public transport performance and interpretate their result performance measurement; 3) Gives us some recommendation of strategic program for public transport supply to increase public transport performance at kota Banda Aceh.

## **Literature Review**

Hansen,1959 (in Susan Handy,1992) express, that :

"Accessibility reflects the intensity of the possibility of interaction" (How accessibility shapes land use),

While Makrí & Folkesson (2001) express :

"Accessibility... is a slippery notion... one of those common terms everyone uses until faced with the problem of defining and measuring it."

Access is "property of people" ( Huigen, 1986). Location of residing in central point. Core from accessibility located in location purpose. Geurs & Ritsema van Eck (2001) defines accessibility as:

"The extent to which the land-use/transport system enables (groups of) individuals or goods to reach activities or destinations by means of (a combination of) transport mode(s)."

This definition is result of literature review which is wide and enough representing because dimension input spatial and infrastructure in its (the calculation, and close to definition of accessibility in TDM Encyclopedia which is not differentiates concept "accessibility" and "access", that is as follows :

"Accessibility (or just Access) is the ability to reach desired goods, services, activities and destinations (together called opportunities).

Accessibility is "the ultimate goal" of transportation, except in the case of aimless journey as end of movement of itself. There are some factor influencing the accessibility directly and indirect (TDM Encyclopedia, 2005), that is: (Mobility; Transportation Options; Mobility Substitutes; Land Use Factors; Density, Clustering and Land Use Mix; Roadway Network (Connectivity Index); Demand for Access; Other Accessibility Factors)

The key of accessibility measurement, traditionally is based on "trip-based", what interpreted as one trip by one time (one trip type at a time), for example: work trip without considering schedule (scheduling) or movement chain (trip chaining)

**Tabel 1**  
**Sub-divisions of accessibility measures, based on literature**

Accessibility measures			
Geurs & Ritsema van Eck [2001]	Hilbers & Verroen [1993]	Handy & Niemeier [1997]	Makrí & Folkesson
Infrastructure-based accessibility measures  Activity-based accessibility measures  <ul style="list-style-type: none"> <li>• Distance measures</li> <li>• Contour measures</li> <li>• Potential measures</li> <li>• Inverse balancing factors</li> <li>• Time-space geography</li> <li>• Utility-based measures</li> </ul>	<ul style="list-style-type: none"> <li>• Characteristics of access</li> <li>• Position in network</li> <li>• Potential accessibility</li> <li>• Actual accessibility</li> <li>• Actual use and level-of-service quality of a transport system</li> <li>• Accessibility related to activity patterns</li> </ul>	<ul style="list-style-type: none"> <li>• Cumulative opportunities measures</li> <li>• Gravity-based measures</li> <li>• Random utility theory</li> </ul>	Place accessibility measures  <ul style="list-style-type: none"> <li>• Distance measures</li> <li>• Cumulative-opportunity measures</li> <li>• Gravity measures</li> <li>• Utility-based measures</li> <li>• Individual accessibility measures</li> <li>• Space-time measures</li> </ul>

In general accessibility is modeled as follows (Ortuzar & Willumsen, 1994):

$$A_i^n = \sum_j f(E_j^n, C_{ij})$$

$A_i^n$  = a measure of accessibility by person type

$E_j^n$  = a measure of attraction of zone j

$C_{ij}$  = generalised cost of travel between zones i and j

Subdivision of accessibility measurement subdividing according to Geurs & Ritsema van Eck (2001), be as follows:

Infrastructure-based accessibility measures (no spatial component)

Infrastructure-based accessibility measures without including spatial component input becomes very simple. Some example of measurement of this group that is: (Travel Time; Congestion; Speed in the network (travel/route speed); Total length highways; Number of train stations)

Activity-based accessibility measures (also spatial component)

If compared to infrastructure-based measures, Activity-based accessibility measures input has included infrastructure and component spatial. Included in this group measurement is: (Distance measures; Contour measures; Potential measures; Measures based on balancing factors of spatial interaction models; Measures derived from time-space geography)

Utility-based accessibility measures (also spatial component)

Utility-based accessibility measures characteristic by the fact that measure is not defined by accessibility itself. The measuring shows individual of itself value. Main assumption for this utility approach is: (Koenig (1980), Geurs & Ritsema van Eck, (2001)). a) People associate a cardinal utility with each alternative they are facing and choose the alternative associated with the maximum utility to them as individuals; b) As it is not possible to evaluate all factors affecting the utility associated with each alternative by a given individual, this utility can be represented as the sum of a non-random (deterministic) component and a random (stochastic component)

Specification of stochastic utility  $U$  owned by people  $n$  in location  $i$  to opportunity in  $j$  as is follows: ( Geurs & Ritsema van Eck, 2001):

$$U_{ij} = V_{ij} - \beta c_{ij} + \varepsilon_{ij}$$

Where:

- $V_{ij}$  = a utility or value of making the trip  $ij$  for person  $n$ , which is deterministic known
- $c_{ij}$  = costs of trip from  $i$  to  $j$  (travel time, travel costs);
- $\beta$  = a cost sensitivity parameter;
- $\varepsilon_{ij}$  = a random term.

Accessibility people  $n( A_n)$  can be interpreted as benefit and individual who live in area  $I$  as born of opportunity  $D$  which can be reached in  $j$ , with cost ( $c_{ij}$ ). (Geurs & Ritsema van Eck, 2001).

$$A_n = \frac{1}{\beta} \ln \sum_j D_j e^{-\beta c_{ijn}}$$

Where:

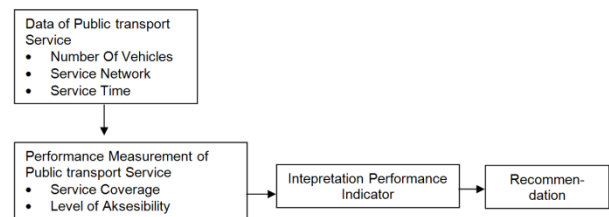
$\beta$  = a travel cost sensitivity parameter.

According to the description which has been submitted is that measurement of accessibility divide in categorizing into 3 (three) category : **infrastructure-based, activity-based and utility-based accessibility measures.**

**Methodologies**

Outline of the methodology

The stage to solve this study follows approach framework as shown at **picture 1.**



Picture 1 Diagram Study Approach Framework

Data required

Data that need to be collected to support this study is: 1) Road network data 2006 and road network plan the year 2016; 2) Demographic data 2004, 2006 and 2016; 3) Number of town public transports Banda Aceh 2004 and 2006; 4) Public transport service route network data; 5) Public transport service time

Analysis method

First, Infrastructure-based accessibility measures is measured with: (Travel Time; Speed in the network (travel/route speed); Total length highways; Number of shelter)

Second, Activity-based accessibility measures is measured with: (Distance measures;

Contour measures; Measures derived from time-space geography)

Thrid, Utility-based accessibility measures is measured with: (Number of passengers per trip; Passenger comments to the public transport performance)

## Result And Intrepretation

### Travel Time

Survey result at route Terminal APK Keudah – Keutapang Dua (2 ways) has shown the average of travel time for this route (CT) is 46 minutes, for 12 Km length. See **Table 2**.

**Table 2**  
**Survey result of Labi - Labi route Terminal APK Keudah - Keutapang Dua (2 ways) Date : 03/09/2007, Time : 11.50 – 12.43**

Location	Distance		Time (hour)	Speed (Km/Hour)
	(m)	(km)		
Terminal APK Keudah	0	0		0.0000
Jl. Inpres Depan Andika Jaya (Toko)	610.3	0.6103		7.3236
Jl.Tgk. Abu Lam U Tamansari	1059.7	1.0597		12.7164
RS Harapan Bunda Teuku Umar	1343.4	1.3434		16.1208
Gerbang Asrama Tentara Zeni Jl. Sudirman	2039.4	2.0394	Average Time each segmen 0.08333 hour = 5 minutes	24.4728
Jl. Utama Perumnas Keutapang (Start)	0.0	0		0.0000
Left side Asrama Tentara Zeni Jl. Sudirman	1818.0	1.818		21.8160
Depan Kuburan Kerkoff	2918.5	2.9185		35.0220
Tk. Nyak Adam Kamil II	1695.1	1.6951		20.3412
BNI Jl. KHA Dahlan	1763.6	1.7636		21.1632
Terminal APK Keudah	386.0	0.386		4.6320
Average distance between shelter 1.200 metre		Length of Way 12 Km		Average 14,87 Km/hour

Location	Time (hour)	Occupancy (passenger)	LF	CT
Terminal APK Keudah		5	0.2941	46 minutes
Jl. Inpres Depan Andika Jaya (Toko)		7	0.4118	
Jl.Tgk. Abu Lam U Tamansari		7	0.4118	
RS Harapan Bunda Teuku Umar		8	0.4706	
Gerbang Asrama Tentara Zeni Jl. Sudirman	Average Time each segmen 0.08333 hour = 5 minutes	7	0.4118	
Jl. Utama Perumnas Keutapang (Start)		3	0.1765	
Left side Asrama Tentara Zeni Jl. Sudirman		1	0.0588	

Location	Time (hour)	Occupancy (passenger)	LF	CT
Depan Kuburan Kerkoff		2	0.1176	
Tk. Nyak Adam Kamil II		2	0.1176	
BNI Jl. KHA Dahlan		1	0.0588	
Terminal APK Keudah		0	0.0000	
		Average pax/ segmen= 4 pax	Occupancy =23%	
<i>LF: Load Factor</i> <i>CT: Cyle Time</i>				

Speed in the network (travel/route speed)

See survey result at Table 4.1, it shown the average speed in the network (travel/route speed) for route APK Keudah-Keutapang Dua is 14,87 Km/jam.

Total length highways

Length of ways which serve by public transportation only 45,35 Km or 10,92% from the length of way in kota Banda Aceh. For city with wide about 61,359 Km2, the public transportation service coverage just only 15,9%.

Number of shelter

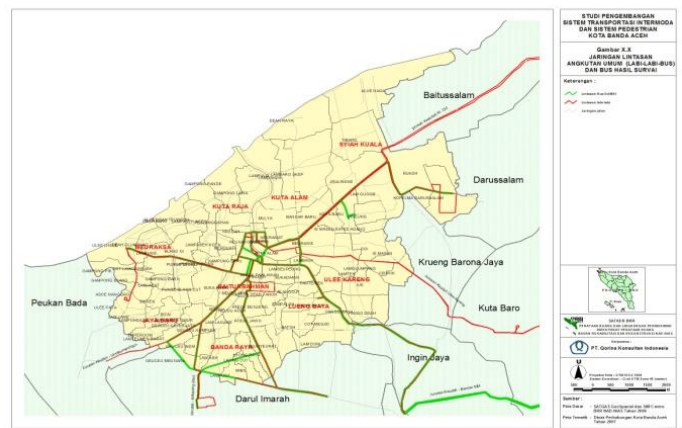
Number of shelter in each route is different, as example for route APK Keudah-Keutapang Dua with length of ways 12 Km, there are 9 shelter for stop point.

Distance measures

Distance average between shelter is 1.200 metres.

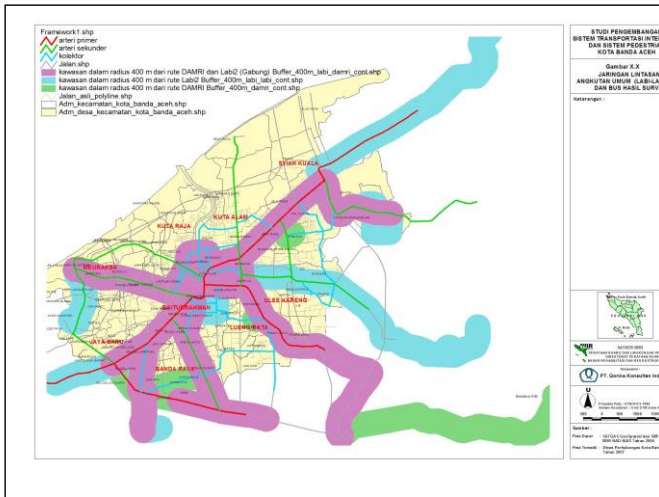
Contour measures

The corridor of public transport which operate in kota Banda Aceh can be seen at **Picture 2**.



Picture 2 Way link of Labi Labi & Damri

Survey result at year 2007, average distance of the willingness to walk on foot the people of kota Banda Aceh till the road where the public transportation route exist is 400 metres. Base on that survey result, we can make service contour as like the coridor of public transportation in kota Banda Aceh as shown at **Picture 3**



Picture 3 Coridor of Labi-labi and Damri in Kota Banda Aceh

Measures derived from time-space geography

The public transport route has not closed all district / sub-district in kota Banda Aceh. Blankness of this transportation filled by pedicab (*becak motor*) and motorcycle (*ojeg*). Blankness occurred because public transport as assume the location doesn't have "demand" adequate, this thing happened because as of settlement goods in town Banda Aceh is a real fragmentation. This public transportation such as labi-labi noted there are 14 routes, but out of the 14 routes only 8 run route, that also only 4 route transportation of matching with route permitted, rest doesn't follow the allowance.

Movement which has not been facility carefully at the moment that is; a) Common movement of transportation passenger from Kecamatan Meuraxa towards Kecamatan Jaya Baru; b) Common movement of transportation passenger from Kecamatan Meuraxa towards Kecamatan Kuta Raja; c) Common movement of transportation passenger from Kecamatan Kuta Raja towards Kecamatan Kuta Alam; d) Common movement of transportation passenger from Kecamatan Kuta Raja towards Kecamatan Syiah Kuala; e) Common movement of transportation passenger from Kecamatan Ulee Kareng towards Kecamatan Syiah Kuala; f) Common movement of transportation passenger from Kecamatan Banda Raya towards Kecamatan Leung Bata; g) Common movement of transportation

passenger from Kecamatan Leung Bata towards Kecamatan Ulee Kareng

To be more clearly about transportation passenger route of public which is not able yet to served in Kota Banda Aceh in the year 2007, hence visible at **Picture 4**.

Number of passengers per trip

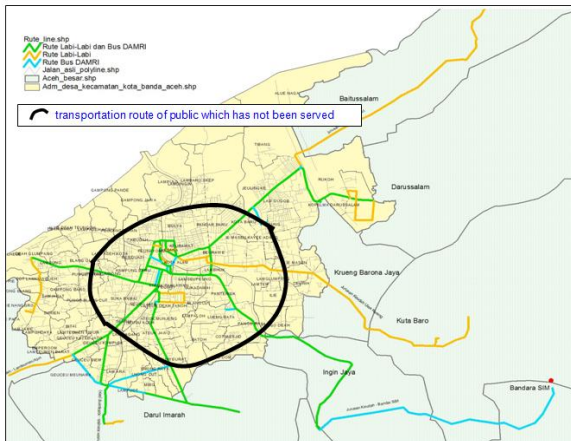
In The year 2007 MAT totals of passenger in Kota Banda Aceh about 18.513 smp/day, where MAT public transport consumer 6.890 smp/day and MAT personal vehicle consumer 10.334 smp/day. MAT Total Kota Banda Aceh estimated will swell 1,5 times more becomes around 27.398 smp/day in the year 2027. From this source, it is known that voyage of passenger from the year 2007 finite of the year 2027 would continuously experience improvement until 48 %. Therefore is required anticipation of supply of transportation facilities and basic facilities in town of Banda Aceh, in order not to invite any problems in the future.

Passenger response at public transport performance

Result of survey Home Interview which shown usage of labi-labi only 0,98%. So service of public transport in this Banda Aceh town of course not popular, so the existence in coming needs defended or doesn't become separate problems. Ironically from survey HI also shown that 60% responder still wishing existence of public transport is having schedule is immanent to serve them

Availability ratio of public transport chair

Town Banda Aceh with number of residents 224.233 people in the year 2007 served by 1.012 public transport units from various types, is meaning there are 5,1 carriage chairs of public for every 100 town Banda Aceh



Picture 4 Transportation Route of Public Which Has Not Been Served Town Banda Aceh in Year 2007

Existing Condition of Public Transport in order of Respondent

The valuing of the existing condition of public transportation in Kota Banda Aceh vaued by comfortability, safety and fare. If we look from comfortability factor, 45,69% repondent say that public transportation condition is uncomfortable, meanwhile for safety factor, 46,70% respondent say unsafety, especially using that public transport in the nighth time. From 197 responden, 51,78% say that the fare of public transport is expensive, while 41,62% respondent say that the fare is fair. The different of people perception on fare shown the buying power of people. They fare propose shown their financial condition. Clearly the public transportation services condition can see at **Table 3**.

**Table 3**  
**Responden Express the Public Transport Services Existing Condition In Kota Banda Aceh , at 2007**

No	Condition	Number of Respondent	%
<b>1</b>	<b>Safety</b>	<b>197</b>	<b>100</b>
	Fair	62	31,47
	Safe	32	16,24
	Unsafe	92	46,70
	Very unsafe	11	5,58
<b>2</b>	<b>Comfort</b>	<b>197</b>	<b>100</b>
	Comfort	21	10,66
	Less	78	39,59

No	Condition	Number of Respondent	%
	Uncomfort	90	45,69
	Very uncomfort	8	4,06
<b>3</b>	<b>Fare</b>	<b>197</b>	<b>100</b>
	Cheap	3	1,52
	Fair	82	41,62
	Expensive	102	51,78
	<b>Very Expensive</b>	<b>10</b>	<b>5,08</b>

Source :Primary Survey, 2007

People sugestion for Fare

For public transportation fare in Kota Banda Aceh, 44,67% respondent most likely choose fare base on distance (Km). While 26,40% respondent most likely fare base on staging distance. Clearly see at **Table 4**.

**Table 4**  
**Respondent sugestion for public transport fare in Kota Banda Aceh, at 2007**

No	Public Transport fare	Number of respondent	%
<b>1</b>	Flat fare	45	22,84
<b>2</b>	Base on distance	88	44,67
<b>3</b>	Base on staging distance fare	52	26,40
<b>4</b>	Base on zone distance	12	6,09
<b>Total</b>		<b>197</b>	<b>100</b>

Source :Primary Survey, 2007

**Conclusion**

Kota Banda Aceh with number of residents 224.233 people in the year 2007 served by 1.012 public transport units from various types, is meaning there are 5,1 carriage chairs of public for every 100 townies Banda Aceh. Street length served by public transport has just reached 45,35 km or around 10,92% from the street length in town Banda Aceh. For town with a width of 61,359 km<sup>2</sup>, service inclusion of this public transport has just reached only 15,9%.

**Sugestion**

First, Urgen to propose mass public transport to anticipate the faster growth of private car

Second, Socialization and education of people to use public transport comparing to private car inline with higher cost of fuel and reducing global warming policy

### **References**

- Bapeda Kota Banda Aceh, 2006, *RTRW Kota Banda Aceh 2006 – 2016*.
- Pemerintah Daerah Kota Banda Aceh, 2006, *Rancangan Qanun Kota Banda Aceh tentang Rencana Tata Ruang Wilayah Kota Banda Aceh*
- Taede Tillema and Bert van Wee, 2002, *Pricing policies: a spatial perspective*, Geographical Sciences, Utrecht University, Utrecht.
- Tamin, Ofyar Z, 1997. *Perencanaan dan Pemodelan Transportasi*, Bandung, Penerbit ITB
- TDM Encyclopedia, May 9, 2005. *Accessibility*, Victoria Transport Policy Institute,
- TDM Encyclopedia, April 4, 2006. *Measuring Transport*, Victoria Transport Policy Institute.



APPENDIX

Table 5 Number of Labi labi operate at 2007 Headway: 2-3 Minutes

No	Route of Labi labi	Hari	H (minute)	AO (labi labi)	KT (Pax/minute)	KL		Pnpg Terangkut	
						Pax – trip/ minute	Pax – km/ minute	Pax – trip/ minute	Pax- km/ minute
1.	Terminal APK Keudah – Darussalam	Senin - Jumat	3	20	5	21	111	7	34
		Sabtu - Minggu	2,4	25	7	53	126	16	39
2	Terminal APK Keudah – Lampineung	Senin - Minggu	3	23	5	32	17	5	3
3	Terminal APK Keudah – Kreung Cut	Senin - Minggu	7	10	2	41	94	9	20
			3	23	5	96	219	20	47
4	Terminal APK Keudah – Ulee Kareng	Senin - Jumat	4	18	4	44	89	18	36
			3	23	5	59	118	24	47
		Sabtu - Minggu	5,5	13	3	32	65	13	26
			3	23	5	59	118	24	47
5	Terminal APK Keudah – Ketapang dua	Senin - Jumat	2,4	19	7	47	91	11	21
			3,7	12	4	30	59	7	14
		Sabtu - Minggu	3,0	15	5	37	73	8	19
6	Terminal APK Keudah – Lamteumen	Senin - Jumat	4,4	16	4	18	51	8	14
			3	23	5	27	75	12	20
		Sabtu - Minggu	6	12	3	13	38	6	10
			3	23	5	27	75	12	20
7	Terminal APK Keudah – Lampeuneurt/Lamlagang	Senin - Jumat	3	38	5	80	192	29	69
		Sabtu - Minggu	3	22	4	80	192	29	69
			4	29	5	60	114	21	51
8	Terminal APK Keudah – Mibo	Senin - Jumat	2,4	19	7	47	91	11	21
		Sabtu - Minggu	3,7	12	4	30	59	7	14
			3,0	15	5	37	73	8	19
9	Terminal APK Keudah – Tanjung/Lambaro	Senin - Minggu	3,0	23	5	59	109	23	43
10	Terminal APK Keudah – Lueng Bata	Senin - Minggu	3,0	23	5	37	43	12	14
11	Terminal APK Keudah – Ulee Lheue	Senin - Jumat	11	6	2	15	21	4	6
			3	23	5	53	76	12	22
		Sabtu - Minggu	8	9	2	20	28	6	8
			3	23	5	53	76	12	22

Keterangan:

- Cycle Time (CT)
- Headway (H)
- Load Factor (LF)
- Number of vehicle operation (AO)
- Point Capacity (KT)
- Route Capacity (KL)

**Table 6 Survey result of Labi Labi at Gate on terminal APK keudah Date, Thursday,1 November 2007 Route Keudah – Ketapang Dua**

No.	Plate No. Car (BL)	Number of Passenger (pax)	Time of arrival (WIB)		Average Headway (minute)
			Clock	Minute	
1	1105	1	7	0	
2	1689 A	3	7	15	
3	1649	1	7	19	
4	1369 AB	0	7	19	
5	1952 AA	2	7	27	
6	1348 AA	3	7	32	
7	1282	1	7	36	
8	1492 A	3	7	37	3.11
9	1125 A	1	7	38	
10	1239	1	7	41	
11	1748 AA	2	7	46	
12	1160	7	7	47	
13	1215	0	7	48	
14	1375 AA	3	7	49	
15	1136	6	7	51	
16	1190	3	7	53	
17	1235 A	3	7	55	
18	1766 A	3	7	58	
19	1399	3	7	59	