

DETERMINATION AND ASSESSMENT OF ADDITIONAL ROUTES FOR PUBLIC UTILITY VEHICLES IN BUTUAN CITY USING GIS-BASED NETWORK ANALYSIS

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ABSTRACT: The country depends heavily in the road networks and its designated routes to accommodate all Public Utility Vehicles. Butuan City, a highly urbanized city has been facing problems in traffic congestion since then due to the increasing number of PUV's traveling across the City. This research performed an analysis of efficiency of the existing routes and shortest route determination with the aim of evaluating the efficiency of the existing routes and finding additional routes that provide additional capacity to service. Using Network Analysis, the system was able to evaluate the efficiency of existing routes and determine the shortest path. Moreover, additional routes were determined and its efficiency was assessed through questionnaire based survey. The result suggests that the identified additional routes were efficient and convenient to the commuters since it allows them to reach easily their destination with less time consumption and at low cost.

1. INTRODUCTION

Land routes are important in creating the link between every part of the country or every part of the cities. These are used for transportation mainly road transportation essential for reaching one place to another via land transportation [1]. In the Philippines, there are various modes of land transportation, the most common are multicab, jeepneys, buses, taxis, trains, vans for hire, motorcycles with passenger compartment, motorcycle taxis or the "Habal-habal" for the hinterland and mountainous barangays, bicycles with sidecar or pedicab or trisikad but not all of these are existing in all the cities and provinces of the Philippines. In the case of Butuan City, a highly urbanized city in the country, the different local public transports are only multicab, jeepneys, buses, motorcycles with passenger compartment or tricycle, pedicab, habal-habal and vans for hire. In general, they are called Public Utility Vehicles or PUV's [2]. PUV's are vehicles that carry passengers or cargo for a fee offering services to the public. The presence of these various modes of land transportation provides a wide array of choices for commuters based in its specified routes. Each of the PUV's has specific routes called PUV routes that are established based on the need and through transportation planning of the government specifically the Department of Transportation [3]. PUV routes serve as the pathway for all public land transportations which supply the need of the daily commuters given that PUV's are their daily mode of transportation to reach their desired destination. The country depends heavily in the road networks and its designated routes to accommodate all the PUV's. The number of PUV's in this city is increasing and there is no enough routes to accommodate all the PUV's and which resulted to traffic congestion that gives discomfort to the commuters. However there are new and improved existing roads and bridges that are constructed in the said city and had been merged in the old roads [4] [5]. For that reasons, a growing demand of improving PUV routes by finding an additional PUV routes is suggested. It is believed that an additional PUV route provides additional capacity to service. Nowadays, there are already technologies and software that can be used in planning and establishing PUV routes, one of these is GIS also known as Geographic Information System. GIS is a suitable tool to accomplish complex task such as establishing routes and finding the shortest route using network analysis [6]. In these paper, the researcher uses network analysis for solving for solving route.

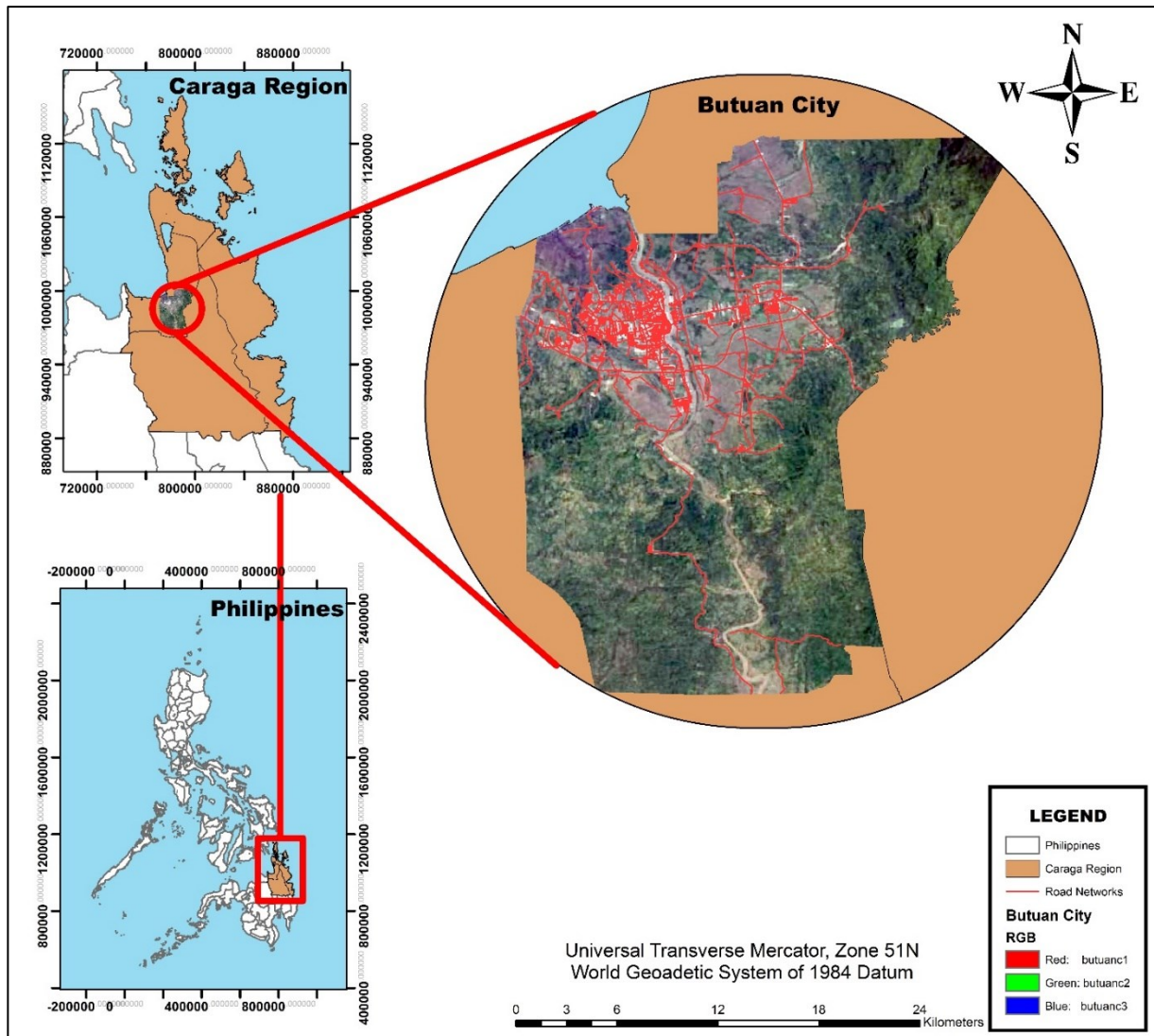


Figure 1. The Road Networks of Butuan City, Agusan Del Norte

2. METHODOLOGY

2.1 Evaluation of Efficiency of PUV Routes

The existing routes of Butuan City is recognized and evaluated to know what route is the most efficient. The criteria of efficiency will be the least time travel, number of passengers per hour given the number of registered PUJs, and the number passenger per hour in a single PUJ, the population along the route and closest to the obtained shortest route. The time travel was obtained using network analysis and the population along route was based on population of barangay in which the route was located and only the barangay within the area of 300 meter radius from the target route was used. The route with least time travel and the greatest number of commuter served and greatest population along the route will be given a value of one (1), other routes will be assigned relatively. The shortest route obtained is compared to the existing route.

2.2 Identification of Additional PUV Routes

In this activity, network analysis was repeated. The starting and ending points, and other variables were put on areas where there are no routes. The obtained shortest route generated by the network analyst were the additional route. The potential routes are shown in table 1 with a distance does not exceed in 15 km and does not have 60 percent overlapped with the existing routes [1].

Table Error! No text of specified style in document..1. List of Potential Routes

POTENTIAL ROUTE NO.	POTENTIAL ROUTES
1	Ambago Libertad Road – Ambago to Langihan Road -Salvador Calo Street – North Montilla Boulevard – JC Aquino –And Vice Versa
2	Ambago Libertad Road – Ambago to Langihan Road -Salvador Calo Street – North Montilla Boulevard – JC Aquino – Ampayon and vice versa
3	Tagabaca Road - Pigdaulan – By-Pass Road- Lemon –Ampayon – Antongalon - Ampayon to Antongalon Road
4	Villa Kanangga to San Vicente Road – Butuan By pass road (Macapagal Bridge) – Lemon Road - Ampayon
5	Tagabaca –Pigdaulan – By pass Road – Villa Kanangga –South Montilla Blvd. – JC Aquino Avenue

2.3 Assessment of Additional Routes

In this activity, the obtained Additional Route was evaluated by estimating the number of commuters that originally will be using the existing routes but will now use the additional routes. To do so, survey questionnaire was made by the researcher related to the Additional Routes; it was then distributed to the chosen respondents and obtained their perceptions by answering the survey questionnaire. The estimation of number of commuters was based on the number of allowed PUV times its allowable load. The answered survey questionnaire was then analyzed using descriptive statistics, to describe and interpret the data [20].

3. RESULTS AND DISCUSSION

3.1 Evaluation of Efficiency of PUV Routes

Table 2 and 3 show the efficiency of PUV routes. Route efficiency was analyzed using network analysis. Using the least travel time, route that has highest number of population along the route, highest number of passenger per hour per direction and closest to the obtained shortest route is considered as most efficient and will be given a score of one [1]. Others will be rated relatively. By using network analysis tools, shortest route was created between two different points, which is more efficient in terms of distance which is also least cost consumed. The result obtained in network analysis is shown in Table 2 and 3. The route having the highest distance is route 8 as well as the highest travel time. The route having the least distance is Route 2 as well also the least travel time. As shown in the table 2, most of the routes in the shortest route results, decrease its distance and travel time except for Route 7 and 8. This is because the network analyst found another path that is longer since the one way restriction prohibits the shorter path. The route that does not have difference in the obtained shortest route are Route 2 and Route 10, which implies that Route 2 and Route 10 are efficient based on the shortest route. The route having the biggest difference when it comes to distance and travel time from the existing route to the obtained shortest route is route 6. As shown in table 3, Route 10 has the lowest efficiency based on the travel time, number of commuters served per hour, population along the route and number of passenger per hour in a single PUV criteria. Despite of having large population along the route and large number of registered PUJ, the Route 10’s overall evaluation was the lowest, but Route 10 was the closest compared to the shortest route obtained. Route 5 and 6 are considered to be low efficient since there are no registered multicabs that are using the said routes, thus it doesn’t have a number of commuter served. Route 3 is the second least efficient since it only have one registered PUJ.

Table 2. List of Existing routes and Obtained shortest routes

ROUTE NO.	EXISTING ROUTES	DISTANCE (Meters)	TIME (Minutes)	SHORTEST ROUTE	DISTANCE (Meters)	TIME (Minutes)
1	Bancasi-Libertad-J.C Aquino Avenue-A.D Curato- F.Durano St.- Montilla Blvd.- J.C Aquino Avenue and vice versa	10477.6	22	Bancasi-Libertad-J.C Aquino Avenue-A.D Curato- F.Durano St.-R. Calo Street- Montilla Blvd.- J.C Aquino Avenue and vice versa	9238.2	19
2	Bancasi – Libertad - J.C Aquino Avenue- Montilla Blvd.- T. Calo St.- E. Luna - J.C	9956.7	19	Bancasi – Libertad - J.C Aquino Avenue-Montilla Blvd.- T. Calo St.- E.	9956.7	19

	Aquino Avenue and vice versa.			Luna - J.C Aquino Avenue and vice versa.		
3	Bancasi- Libertad- JC Aquino- AD Curato ST.- Del Pilar ST.- M. Calo ST.- G. Flores Avenue- Rosales ST.- Montilla BLVD.- T. Calo ST.- J. Rosales Avenue- JC Aquino Avenue and Vice versa.	11936.5	24	Bancasi - Libertad- JC Aquino- M. Calo Street.- G. Flores Avenue – Villanueva Street Montilla Blvd.- Villanueva Extension.- Ochoa Ave. - T. Calo ST.- J. Rosales Avenue - JC Aquino Avenue and Vice versa.	10732.6	20
4	Bancasi-Libertad -J.C Aquino Avenue-A.D Curato ST- T. Sanchez St.- M. Calo St. – G. Florez Avenue – Rosales ST. - Montilla Blvd. – S. Calo Venue – Andaya Road- Butuan City Terminal Langihan Road – J. Satorre ST. – City Hall – J. Rosales St. - J.C Aquino Avenue and vice versa.	15408.6	31	Bancasi-Libertad -J.C Aquino Avenue-A.D Curato ST- Noli Me Tangere St.- M. Calo St. – Lopez Jaena St.- G. Florez Avenue – Villanueva St.. - Montilla Blvd. – Ong Yiu Road – G. Domingo Street— J. Rosales St. - J.C Aquino Avenue and vice versa.	14104.2	28
5	Bancasi- Libertad- JC Aquino Avenue- Capitol Avenue-Capitol Drive- Pizarro ST. –Durano ST. –AD Curato ST.- T. Sanchez ST.- M. Calo ST.- Burgos St. –JC Aquino Avenue and Vice versa.	11773.6	23	Bancasi- Libertad- JC Aquino Avenue- Hidalgo Village Road - Capitol Bonbon Road -Capitol Drive- Guingona Sr. Avenue – Tindalo Road – Santol Road - Pizarro ST. – F. Durano ST. –R. Calo ST.- T. Sanchez St.- M. Calo St.–JC Aquino Avenue and Vice versa.	10628.3	19
6	Bancasi- Libertad- JC Aquino Avenue- J. Rosales Avenue –City Hall- J. Satorre ST.- Langihan Road- T. Calo St.- Montilla Blvd.- JC Aquino Avenue- AD Curato St.- T. Sanchez St.- Montilla Blvd.-JC Aquino Ave.	16231.1	28	Bancasi- Libertad- JC Aquino Avenue- J. Rosales Avenue –City Hall- G. Domingo ST.- E. Ochoa Avenue - T. Calo Extension St.- T. Calo St.- G. Flores St.- Lopez Jaena St. –AD Curato St. –F. Durano St.- R. Calo St. –Noli Me Tangere St.– Montilla Blvd.	12939	24
7	De Oro - Taligaman – Ampayon - J.C Aquino Avenue – R. Calo St.- T. Calo St. – G. Flores Avenue– Montilla Blvd. – Andaya road – Langihan Public Market- J. Satorre St. –City Hall – J. Rosales St – J.C Aquino Avenue and vice Versa	18602.2	31	De Oro - Taligaman – Ampayon - J.C Aquino Avenue – Montilla Blvd.- Rosales St. – Montilla Blvd. – T. Calo Street – Ochoa Ave.- G. Domingo St. – J. Rosales St – J.C Aquino Avenue and vice Versa	19625.8	31
8	JC Aquino Avenue – DBP – GOV. Rosales Ave. –City Hall Rotonda – J. Satorre ST. Langihan Circumferential Road – Montilla Blvd. JC. Aquino Ave. –	22941.5	41	JC Aquino Avenue – DBP – GOV. Rosales Ave. –City Hall Rotonda – Holy Redeemer Road – Salvador Calo St.- J.P Laurel Street –Andaya St. – Montilla Blvd. – Rosales St. –G Flores St.	23028.7	40

	Ampayon – Sumilihon – Los Angeles - Brgy. Sto. Niño			–Lopez Jaene St. – AD Curato Street – JC Aquino Ave.- Ampayon – Sumilihon – Los Angeles – Brgy. Sto. Niño		
10	Bancasi – Ampayon via Butuan City Medical Center and vice versa	18293.3	33	Bancasi – Ampayon via Butuan City Medical Center and vice versa	18293.3	33

Table 3. Efficiency Evaluation of Existing Routes

ROUTE NO.	TIME TRAVEL (%)	NUMBER OF COMMUTER SERVED PER HOUR (%)	POPULATION ALONG THE ROUTE (%)	NUMBER OF PASSENGER PER HOUR IN A SINGLE PUJ PER DIRECTION (%)	OVERALL EVALUATION (%)
1	86.36	41.61	84.80	86.36	74.79
2	100	100	19.93	100	79.98
3	79.17	0	23.87	79.17	45.55
4	61.29	82.57	54.48	61.29	64.91
5	82.61	0	27.03	82.60	48.06
6	67.86	0.35	55.56	67.86	47.90
7	61.29	53.35	100	61.29	68.98
8	46.34	24.49	83.37	46.34	50.14
10	57.57	24.46	40	57.58	44.90

3.2 Identification of Additional Routes

The obtained additional routes are shown in Table 4. In these areas, there were no existing routes. Additional Route having the longest distance and travel time is Additional Route 2 which has a distance of 14, 672.4 meters and a travel time of 27 minutes, and Additional Route having the least distance and travel time was Additional Route 4 which has a distance of 12,113.2 and a time travel of 19 minutes.

Table 4. Additional Routes

ADDITIONAL ROUTE	ROUTES	DISTANCE (meters)	TRAVEL TIME (minutes)
1	Bancasi – JC Aquino – Ambago Libertad Road – Ambago to Langihan Road -Salvador Calo Street – North Montilla Boulevard – JC Aquino –And Vice Versa	13,988.8	25
2	Libertad – JC Aquino – Ambago Libertad Road – Ambago to Langihan Road -Salvador Calo Street – North Montilla Boulevard – JC Aquino – Ampayon and vice versa	14,672.4	27
3	Tagabaca Road - Pigdaulan – By-Pass Road-Lemon –Ampayon – Antongalon - Ampayon to Antongalon Road	13,956.2	24
4	Villa Kanangga to San Vicenti Road – Butuan By pass road (Macapagal Bridge) – Lemon Road - Ampayon	12,113.2	19
5	Tagabaca –Pigdaulan – By pass Road – Villa Kanangga –South Montilla Blvd. – JC Aquino Avenue	12,316.4	20

3.3 Additional Routes Assessment

The Additional Routes were assessed by asking the perception of the active commuters by disseminating survey questionnaire to a certain number of commuters. The researcher have distributed the questionnaire to 50 people by route, plus 50 people for the commuters that uses other than the routes mentioned. As shown in Figure 2, almost all of the respondents agrees to use these additional routes instead of using the existing routes.

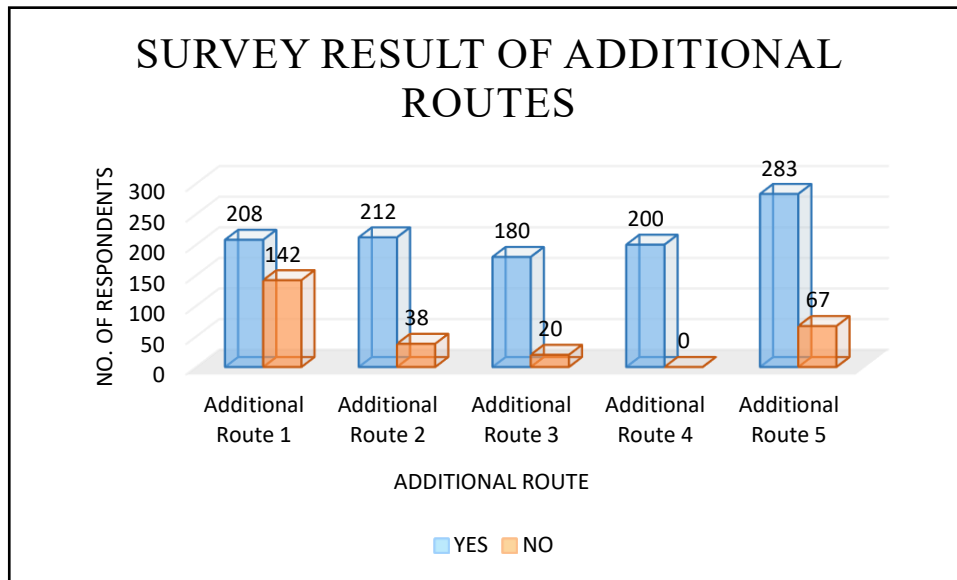


Figure 2. Survey Result Additional Routes

4. CONCLUSION AND RECOMMENDATION

The network analysis tool is very reliable to measure the efficiency in terms of time and distance. It is concluded that the shortest route was the most efficient route. In the study, it was shown that route 2 was the most efficient route, though it has the least population along the route but it has the least distance as well as the least travel time it has the most number of trips and has the most number of passenger per hour per direction and also its obtained shortest route was the one of the closest route and distance compared to its existing route.. The result of evaluation implies that, the existing routes was not efficient in terms of number of passenger and distance, since it does not accommodate all the population of Butuan and some of the distances of the existing routes exceed 15 km, so additional routes are recommended to add service to the public especially to those Barangays that are complicated to ride on. It is concluded that there are additional routes that can be established in Butuan City. These additional routes can be effective based from the impact assessment performed. Almost all of the respondents agrees to use these additional routes instead of using the existing routes. Additional routes will help commuters who is away from the city proper to easily reach their destination with less time consumption and affordable. The use of network analysis helps in analyzing whether the existing route is good or bad in terms of efficiency and it was crucial when it comes to route solving as well as doing a route planning.

For the betterment and improvement of this study it is recommended to add more criteria of efficiency of evaluating existing routes for more accurate results; Consider more factors in determining additional routes, like width of the road and the concentration of commercial establishments or government buildings in planning routes; Include PUV owners and drivers of both tricycles and PUJ's as respondents in the impact assessment of additional routes.; and Validation of the results.

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