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Factors Affecting the Waterway Transport Development of Lat Phrao Canal, Bangkok, Thailand towards Sustainable Urban Mobility

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Abstract:
Presently, urban growth tends to complicate transport operations. Lat Phrao Canal is one of the remarkable canals in Bangkok, which can serve mobility networks in the city by connecting people to the existing mass transit. This article aimed to analyze the residents' understanding of mobility patterns and their attitudes towards boat service connectivity in Bangkok. A quantitative method was used to distribute 1,200 questionnaires along the Lat Phrao Canal. The result highlighted that most respondents agreed that waterway transport development could reduce automobile dependency and travel costs. In terms of using a boat service, there were main key attributes for passengers' consideration, including activity (3.59), connectivity (3.57), canal development (3.20), and navigation system (2.73). The high score of each attribute should be taken into account to determine guidelines and appropriate measures for further development. For future estimation of mobility patterns by the logistic regression model, three significant factors affecting the boat service were quality satisfaction, time of traveling, and shorter travel time on boat services transportation development. These significant factors must be determined in water-based transport management for Lat Phrao Canal development to promote a waterborne transit network in the city. Also, this result is applicable for expanding a capacity waterway network in Bangkok that could alleviate current traffic congestion and encourage sustainable urban mobility solutionS for passengers.

Keywords: boat service, canal, sustainable urban mobility, factor.

影响泰国曼谷叻抛运河水路运输向可持续城市交通发展的因素

摘要:
目前，城市发展趋于使交通运营复杂化。叻抛运河是曼谷著名的运河之一，它可以通过将人们与现有的公共交通连接起来，为城市的交通网络提供服务。本文旨在分析曼谷居民对流动模式的理解及其对船舶服务连通性的态度。使用定量方法沿叻抛运河分发了 1,200 份问卷。结果表明，大多数受访者同意水路运输

的发展可以减少对汽车的依赖和旅行成本。在使用船服务方面，乘客考虑的主要关键属性包括活动（3.59）、连通性（3.57）、运河开发（3.20）和导航系统（2.73）。应考虑每个属性的高分，以确定进一步发展的指导方针和适当的措施。对于未来通过逻辑回归模型估计流动模式，影响船舶服务的三个重要因素是质量满意度、旅行时间和较短的旅行时间对船舶服务交通发展的影响。这些重要因素必须在叻抛运河开发的水上交通管理中确定，以促进城市的水上交通网络。此外，这一结果适用于扩大曼谷的容量水道网络，可以缓解当前的交通拥堵并鼓励为乘客提供可持续的城市交通解决方案。

关键词：船服务，运河，可持续的城市交通，因素.

1. Introduction

Bangkok had been called “Venice of the East” due to its geographic potential of a waterway network with countless important features in supporting urban activities such as a water supply for daily consumption, cultivation, drainage system, fortification, aesthetic layout, and transportation (Hossain & Iamtrakul, 2007). However, the effects of rapid urbanization have been occurring for centuries which demands more land to develop and result in a sprawling (UITP, 2013).

Traditional patterns of the canal network have been abandoned, deteriorated, and dwindled in size and depth over time with the rise of land-based transport. Since the 20th Century, transport development in Bangkok has witnessed a rapid transformation to provide various public transport modes as a varied choice of traveling either by land or water transport is accessible due to the geographical advantages of the Chao Phraya River and canals of Bangkok (Chansiri, 1999).

There are 1,682 canals in Bangkok, totaling 2,604 Km. in length. Saen Saep Canal is a significant thoroughfare in traffic-congested Bangkok’s public transportation network. The city continuously develops a mass rapid transit system (Figure 1) which expands the coverage area of its vicinity (Noichan & Dewancker, 2018).

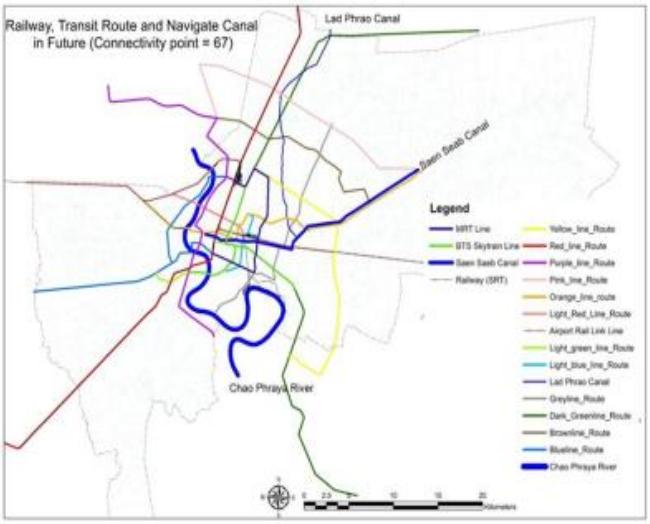

Figure 1. Urban rapid transit routes of Bangkok in future (The Office of Transport and Traffic Policy and Planning (OTP), 2019)

This development is a comprehensive fulfillment public transportation network promoting land and water-based transport in the city. Lat Phrao Canal is one of the most potential canals, connecting the Metro network routes to promote the new mobility choice for Bangkokians (Jittrapirom & Jaensirisak, 2017). Therefore, pursuing the idea of connecting Bangkok canals to the metro transit routes, the first pilot canal using Lat Phrao Canal must be explored and revitalized on how effective water transport development services in the city.

2. Literature Review

Waterways, a necessary condition for water transport, have a significant specificity compared to other modes of transport: their existence and development is not only of transport importance. Any other type of transport takes up space to fulfill its only function: transport people and goods (Wen et al., 2019).

In Stockholm, there is a policy to expand the existing inland waterway network to facilitate increased passenger transport capacity within the city and surrounding districts. The waterway public transportation systems in 23 cities worldwide were analyzed regarding system organization, route structure, schedules, and vessels. Water transport characteristics need integration within the wider public transport network, public perception and feasibility of implementation, land-use implications, and the role of water transport in tourism and leisure travel (Cheemakurthy et al., 2019). Waterway transport was the most efficient, cost-effective, and safe compared to other modes (Sulaiman, 2001).

According to Cheemakurthy (2019), first, it is necessary to explore the key characteristics of water transit systems are route type, scheduling, transit network integration, terminal design, accessibility, comfort and public perception, vessel design, and operating costs. The operational characteristics and safety of operators of water-based transport in Lagos State found that 60% of the operators had spent five years in the business. However, about 90% of the operators were willing to leave the business for a better monetarily rewarding job. The safety of waterway transport has been compromised due to operators’ misbehaviors and government inattention. The effective water transportation in riverine communities of local government found the environmental, economic, boat, and rural market components (Bayode & Ipingbemi, 2016).

The other approach of waterway development could be coordinated with existing public transport systems. To archive sustainable mobility, there are eleven parameters. They are time, security, safety, business

performance, reliability, equity, accessibility, use of resources, environmental impact, price, emission (Leigh, 2016).

Mobility has many dimensions: intellectual, social, professional, or spatial mobility. Spatial mobility comprises temporary relocations, such as trips, and permanent relocations, such as job change or migration. Previous research projects on mobility pattern analysis in Bangkok have been explored to identify mobility factors. According to Punpuing (1993), mobility pattern indicators were demographic, socio-economic, social environment, and commuting patterns. Meanwhile, urban mobility, job accessibility, and travel pattern were investigated by Vichiensan (2007). According to Watchanarat (2000), the pattern and characteristics of passengers along Klong Saen Saeb in Bangkok at 16 major piers during morning and evening rush hours were observed, and found different types of land use, such as commercial, educational, institutional, residential areas to be developed. Most of the trip purpose of passengers was work trip; the second was an educational trip.

The community can also respond to the users' needs. Connectivity with other transport services is likely to be a high priority for those wishing to access the wider urban transport network.

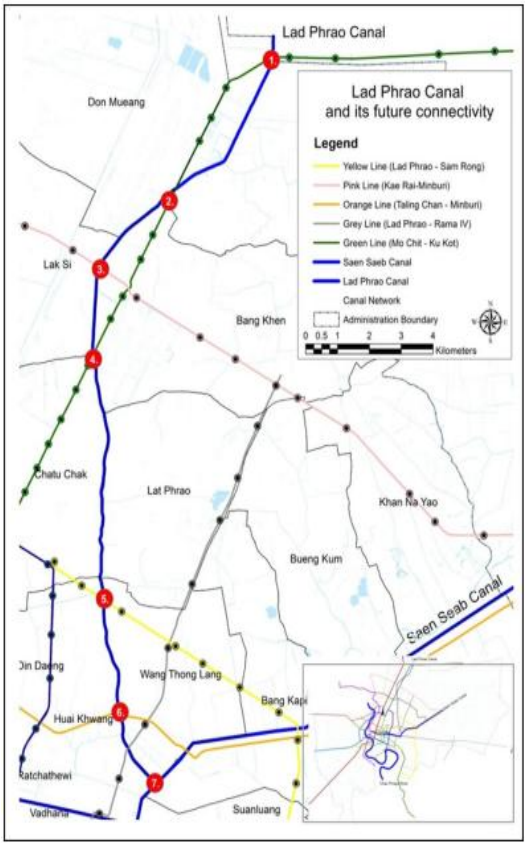

Figure 2. Lat Phrao Canal and mass transit lines in Bangkok

The connected network of canal lines will definitely enhance citywide connectivity on a regional scale and possibly promote a new Central Business District (CBD) in the future (IWTDC, 2015).

From above, the critical parameters through a literature review were the extent to investigate user's configuration as the key characteristics mobility pattern for the future of water transit system of Bangkok by following objectives:

1) To investigate the current mobility pattern as travel behaviors of passengers.

2) To find out the influence factor to contributing a water-based transport development from commuters.

3. Methods

Lat Phrao Canal can serve the transport network by connecting people to existing mass transit; a questionnaire survey was employed for analysis and evaluating travel behaviors of BMR's commuters of 1,200 by focusing on Lat Phrao Canal with the length of 22 km (Figure 2). A random sampling technique was applied for questionnaire distribution. The questionnaire was designed to investigate a mobility pattern in terms of behavior and spatial mobility, which was influenced by two categories of mobility indicators:

1) Demographic and socio-economic factors: personal characteristics of trip makers and commuting behavior.

2) Travel patterns of commuters, including their social environment, urban mobility, job accessibility, and preferences.

Likert scale (1-5) was applied for rating questionnaire answers on particular sections. The respondents were asked to rate the scale of attitudes: (1) very lowly satisfied, (2) lowly satisfied, (3) fairly satisfied, (4) satisfied, (5) very satisfied. Interpreting answers of satisfaction items based on the Likert scale is obtained by equidistant points between each scale element on absolute criteria.

The dependent variable was set up to investigate the significant factors for predicting the variables of using water transport services in Lat Phrao Canal. "Use" or "Do not use" alternatives of boat service were identified as influential factors with respondents' attitudes towards transport development (9 attributes) and features of boat service (29 attributes) of the questionnaire survey. The levels of agreement from a 5-point Likert scale in this analysis were formulated by grouping them into dummy variables. Binary logistic regression was applied to analyze the relationships between variables, as shown in Table 1.

Table 1. Independent variables

	Items	Sub-variables	Dummy value
Dependent Variables	The decision of using boat service	- Use - Do not use	Yes = 1 Otherwise = 0
Independent Variables	Attitudes: Transport development (9 attributes)	- High (3-5) - Low (1-2)	Yes = 1 Otherwise = 0
Independent Variables	Attitudes: Features of boat service (29 attributes)	- High (3-5) - Low (1-2)	Yes = 1 Otherwise = 0

4. Results

4.1. Respondent's Mobility Patterns and Attitudes to Water Transport Development

The majority of respondents' profile was female. The age range was from 10 - 60 years old, in which a group of 25 – 30 years old was indicated as the largest group (37.4%) of respondents. Bachelor's degree education was the highest at 45.9%. In terms of occupation, most respondents were students and private company employees (30.1% and 20.3%, respectively). When examining travel behavior and attitudes of current residents towards water-based transportation development in Lat Phrao Canal, the travel cost was found to be easily estimated for transportation service (60.8%). Meanwhile, travel time (49.4%) and connectivity point (41.7%) were ranked second and third. In terms of environmental concerns, there was only 33% thinking of less pollution to the environment.

The respondents' travel purposes were working (58.8%), studying (16.8%), visiting (11.8%), shopping (6.8%), transport mode (3.6%), business (1.3%) and leisure (.9%). Significantly, the most common time for trips to work, study, and travel was found to be from 05.00 a.m. to 12.00 p.m.

The respondents were asked about attitudes towards water-based transportation development of Lat Phrao Canal, as illustrated in Table 2. It was found that the majority of respondents (84.8%) agreed upon water-based transportation development in the study area. The top three reasons were reducing automobile dependency (32.8%), travel costs (23.6%), and travel time (9.6%). However, the respondent opinioned that the development of waterway transport might not be applicable and useful in reducing traffic congestion as expected.

Table 2. Attitudes of respondents towards the waterway transport development

Agree 1,018 (84.8%)			**Do not agree 182 (15.2%)**		
Reasons	**Frequency**	**%**	**Reasons**	**Frequency**	**%**
Not specified	182	15.2	Traffic jam as usual	50	4.2
Reduce automobile dependency	393	32.8	Travel cost is not different	31	2.6
Reduce travel cost	283	23.6	Current transport network is not good	28	2.3
Connecting transportation network	100	8.3	Poor access to a pier	35	2.9
Determined travel time	115	9.6	Waterway transport is not fast	19	1.6
Accessibility	95	7.9	Lots of accidents	18	1.5
Travel safety	15	1.3	Effect on the environment and living	1	0.1
Pleasant journey	17	1.4			

As for the preferred travel time of respondents, it was found that they chose the boat service as a main travel route in the morning, at 07.00 a.m. – 09.00 a.m. and evening rush hour, at 4.00 p.m. - 7.00 p.m. on weekdays. Aside from the rush hour period, respondents (49.2%) would choose boat service as optional on weekend mornings and as a connectivity mode of travel during off-peak hours. This finding should be considered regarding facilitating passengers during rush hour towards effective management of boat service. Chi-square was applied to test a relationship between two variables; respondents' attitudes (use or not use in case of boat service development) and preference for using boat service route on weekdays and weekends. The p-value showed significant statistics of relationships between respondents' attitudes and boat service routes on weekdays/weekends at 0.005 (Table 3).

Table 3. Preference of using boat services route after development

Weekday			**P-value (<0.05)**	**Weekend**			**P-value (<0.05)**
(07:00-09:00)				**(07:00-09:00)**			
	No.	**%**			**No.**	**%**	
Not sure	3	.3	.000	Not sure	5	.4	.000
Main route trip	657	54.8		Main route trip	323	26.9	
Optional trip	337	28.1		Optional trip	612	51.0	
Pass by trip	203	16.9		Pass by trip	260	21.7	
Total	1200	100.0		Total	1200	100.0	
Off-peak hours			**P-value**	**Off-peak hours**			**P-value**
	No.	**%**			**No.**	**%**	
Not sure	14	1.2	.000	Not sure	8	.7	.000
Main route trip	312	26.0		Main route trip	357	29.8	
Optional trip	590	49.2		Optional trip	397	33.1	
Pass by trip	284	23.7		Pass by trip	438	36.5	
Total	1200	100.0		Total	1200	100.0	
(16:00-19:00)			**P-value**	**(16:00-19:00)**			**P-value**
	No.	**%**			**No.**	**%**	
Not sure	5	.4	.000	Not sure	6	.5	.689
Main route trip	554	46.2		Main route trip	342	28.5	
Optional trip	452	37.7		Optional trip	319	26.6	
Pass by trip	189	15.8		Pass by trip	533	44.4	
Total	1200	100.0		Total	1200	100.0	

Using a public boat service is related to various factors. Five factors were determined to identify respondents' attitudes: connectivity, activity, navigation system, canal corridor development, and local economic development. The activity showed the highest average score (3.59), followed by connectivity (3.57), canal development (3.20), and navigation system (2.73) (Table 3). The result complied with The Inland Waterways Advisory Council (IWAC) (2010) that engaging activities were the main factors influencing people's waterway paths identified through the online stakeholder questionnaire. Engaging activity associated with the waterway path was in itself a key draw. Even though some waterway paths and corridors may not immediately be considered 'attractive', their relative attractiveness compared to the surrounding environment may be high and often provides a welcome contrast. Thus, the high score of each attribute should be taken into account to determine guidelines and appropriate measures for further development.

Table 4. Attributes for consideration using a boat service of Lat Phrao Canal

Connectivity	**Min.**	**Max.**	**Mean**	**Rank**
Quality improvement of surrounding community's transport	3.18	4.83	3.78	3.57* (2)
Distance of pier and public transport	2.50	4.50	3.62	
Common ticket	3.00	4.50	3.60	
Frequency of mass transit services	2.87	4.67	3.54	
Parking lot	2.85	4.57	3.52	
Pier signboard and schedule	2.75	4.83	3.49	
Connected with other public transport modes	2.62	4.65	3.48	
Activity	**Min**	**Max**	**Mean**	
More attraction areas or activities in the community	3.09	4.75	3.70	3.59* (1)
Providing more facility services in business aspects	2.86	4.62	3.62	
Develop nearby community area to be a travel route for tourism	2.78	4.78	3.59	
Providing more facility services	3.06	4.50	3.54	
Increase recreational area in the community	2.88	4.67	3.54	
Navigation System	**Min**	**Max**	**Mean**	
Engine eco boat or hybrid for environment friendly	2.94	4.67	3.72	2.73* (4)
Efficient navigation system	2.50	4.75	3.64	
Operation period of boat service	3.00	4.75	3.62	
Monitoring a boat service standard	3.19	4.75	3.61	
Modernized boat development	2.88	4.67	3.54	
Frequency of service	2.60	4.83	3.50	
Comfortable journey and not too crowded	2.73	4.88	3.48	
Boat safety	2.78	4.75	3.45	
Fare rate and ticket system	2.31	4.71	3.41	
Canal Corridor Development	**Min**	**Max**	**Mean**	
Landscape for an aesthetic journey	3.09	4.75	3.79	3.20* (3)
Cleaning	3.14	4.75	3.74	
More density approach for the route development	3.12	4.71	3.70	
Adding connectivity with the public transport system	3.09	4.83	3.70	
A walking path along the canal	3.07	4.71	3.69	
Guardhouse and safety monitoring in the community	2.50	4.75	3.68	
Green area along the canal	2.89	4.67	3.64	
Lighting setup	2.83	4.75	3.51	

Notes: *Agreed level: 1.00 – 1.50 = Highly Disagreed, 1.51- 2.50 = Disagreed, 2.51- 3.50 = Fairly Agreed, 3.51 – 4.50 = Agreed, 4.51 - 5.00 = Strongly Agreed

Furthermore, the respondents highly agreed that providing a community place for the local or handmade market (3.66) was an essential aspect of local economic development (Table 5).

Table 5. A degree of respondents' attitudes on local economic development

Local Economic Development	**Min.**	**Max.**	**Mean**
A place of community for the local market or handmade market	3.00	4.67	3.66
Advertising screens or vinyl to prevent water splash	3.08	4.75	3.62
Development of learning center in the community	3.00	4.67	3.59
A variety of community activities	2.88	4.75	3.51

*Agreed level: 1.00 – 1.50 = Highly Disagreed, 1.51- 2.50 = Disagreed, 2.51- 3.50 = Fairly Agreed, 3.51 – 4.50 = Agreed, 4.51 -5.00 = Strongly Agreed

4.2. The Possibility of Using Boat Service in Lat Phrao Canal in the Future

A logistic regression model provided coefficients (Omnibus tests) of a model at < .05 (see Table 6). This indicated that the significant predictor variables affected the dependent variables. The result found that R values (Nagelkerke's) in the possibility of using Lat Phrao Canal boat service showed the relationship at 8.3%. Quality satisfaction during a journey (F1) was a significant, predictable factor with a p-value of .000 and a positive value of 1.270. Meanwhile, an estimated time of traveling (F6) and shorter travel time (F7) were significantly influenced with p-values of .014 and .023, respectively (Table 6). Therefore, attention to water-based transport development needs to be taken towards these variables and a highly expected attitude of service.

Table 6. Significant factor of possibility using boat service of Lat Phrao Canal

The decision of Using Boat Service based on Transport Development Attitudes (9 attributes)			
Independents Variables	**β**	**Sig.**	**Exp (β)**
- Quality satisfaction during a journey (F1)	1.270	.000	3.562
- Quality satisfaction of a good transport route (F2)	.455	.112	1.577
- Adjustable transport modes when facing traffic congestion (F3)	-.238	.438	.788
- Convenience of traveling (F4)	.407	.068	1.502
- Route safety (F5)	.351	.078	1.421
- Estimated time of traveling (F6)	.641	.014	1.898
- Shorter travel time (F7)	-.719	.023	.487
- Shorter distance of traveling (F8)	.211	.378	1.235
- Several attraction areas; retail shop, coffee shop for relaxation during the trip (F9)	-.273	.461	.761
Constant	-1.092	.021	11.990
Omnibus tests of Model Coefficients = 72.311/df 9/sig .000			
Hosmer and Lemeshow = 11.676, df =3, sig. = .009			
-2 Log likelihood = 1413.838, Cox & Snell R2 =.059, Nagellkerke R^2 =.083 (8.3%)			
Prediction percentage correct 81.0%			

Moreover, the decision of using a boat service can also be predicted based on four aspects of boat service and management attitudes; the result found that R values (Nagelkerke's) showed the relationship at 9.2%. Seven significant predictor variables affect the decision: quality improvement of surrounding community's transport, and parking lots increase a recreational area in the community, frequency of service, comfortable journey and not too crowded, fare rate and ticket system and lighting setup with a p-value < .000 as shown in Table 7.

According to the model analysis of boat service, significant factors mentioned above must be addressed to initiate and develop effective plans or policies. Most importantly, the involvement of local associations is required to lead to successful and effective boat service development.

Table 7. Significant factor of possibility using boat service of Lat Phrao Canal

Decision of Using Boat Service based on Four Aspects of Boat Service and Management Attitudes (29 attributes)			
Independent Variables (Connectivity)	**β**	**Sig.**	**Exp (β)**
- Quality improvement of surrounding community's transport (F1)	-.804	.013	.447
- Distance of pier and public transport (F2)	.083	.803	1.086
- Common ticket (F3)	-.285	.228	.752
- Frequency of mass transit services (F4)	1.193	.378	3.296
- Parking lot (F5)	.497	.054	1.644
- Pier signboard and schedule (F6)	.736	.184	2.088
- Connected with other public transport modes (F7)	-.162	.661	.851
Independent Variables (Activity)	**β**	**Sig.**	**Exp (β)**
- More attraction areas or activities in the community (F8)	.424	.159	1.528
- Providing more facility services in business aspects (F9)	.188	.568	1.207
- Develop nearby community area to be a travel route for tourism (F10)	.097	.687	1.102
- Providing more facility services			

(F11)	-.198	.485	.802
- Increase a recreational area in the community (F12)	.483	.050	1.621
Independent Variables (Navigation system)	**β**	**Sig.**	**Exp (β)**
- Engine eco boat or hybrid for environmentally-friendly (F13)	-.084	.651	.920
- Efficient navigation system (F14)	-.057	.762	.945
- Operation period of boat service (F15)	.315	.145	1.370
- Monitoring a boat service standard (F16)	.046	.848	1.047
- Development of modern boat (F17)	.305	.363	1.356
- Frequency of service (F18)	.988	.000	2.685
- Comfortable journey and not too crowded (F19)	.567	.008	1.762
- Boat safety (F20)	-.074	.757	.929
- Fare rate and ticket system (F21)	-.560	.038	.571
Independent Variables (Canal corridor development)	**β**	**Sig.**	**Exp (β)**
– Landscape for the aesthetic journey (F22)	-.575	.179	.563
– Cleaning (F23)	.349	.256	1.417
– More density approach for the area development (F24)	-.154	.563	.858
– Adding connectivity with public transport system (F25)	.161	.404	1.175
– A walking path along the canal (F26)	-.441	.187	.644
– Guardhouse and safety monitoring in the community (F27)	.417	.159	1.518
– Green area along the canal (F28)	.145	.619	1.156
– Lighting setup (F29)	1.796	.000	1.023
Constant	-4.418	.012	.012
Omnibus tests of Model Coefficients = 79.601/df 9/sig .000			
Hosmer and Lemeshow = 3.444, df =7, sig. = .041			
-2 Log likelihood = 1387.440, Cox & Snell R2 =.066, Nagellkerke R^2 =.092 (9.2%)			
Prediction percentage correct 70%			

5. Discussion

When studying current mobility patterns, it was found that the major respondents' travel purposes were working, studying, visiting, shopping, transport mode, business, and leisure. The working trip is passengers' basic trip between home and work place that can be generally found of urban daily travel pattern (Liu et al., 2020).

Estimating sustainable mobility in Bangkok by water-based transport development, the respondents' attitudes were high on the agreed level (3.51–4.50), including 1) quality satisfaction during a journey, 2) quality satisfaction of a good transport route, 3) adjustable transport modes when facing traffic congestion, 4) convenience of traveling, 5) route safety, 6) estimated time for traveling, and 7) short distance of travel time must be taken on water-based development. This result is in line with the study of travel satisfaction in public transport using a configurational approach (Sukhov, 2021) that satisfaction with multiple service quality attributes interplay and jointly contribute to high overall travel satisfaction. Sukhov (2021) found that safety was the only necessary condition associated with high overall travel satisfaction, which means increasing users' public transportation experiences.

Especially after predictions with logistic regression model highlighted that to promote the boat service of Lat Phrao Canal and increase water-based transport demand, these variables: quality satisfaction during a journey, estimated travel time, and shorter travel time were significant factors (Figure 3). It must be taken into consideration for future transport development.

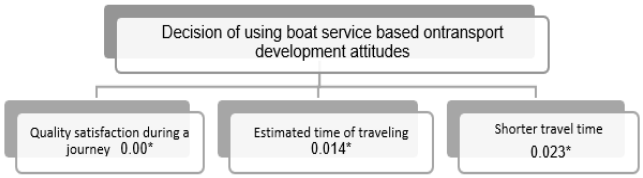

Figure 3. Factors of decision using boat service of Lat Phrao Canal

Furthermore, passenger facilities to serve commuters should focus on service and management aspects: quality improvement of surrounding community transport, parking lots, recreational areas in the community, frequency of service, comfort boat capacity, fare rate, ticket system, and lighting setup (Figure 4).

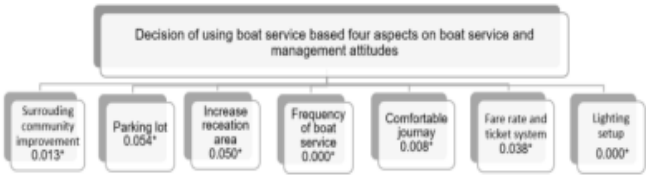

Figure 4. Factors of decision using boat service of Lat Phrao Canal based on management

These results of factor analysis of this study have highlighted and explain how to shift passengers of using boat service by fulfillment of previous studies; Punpuing (1993), Vichiensan (2007), and Watchanarat (2000) on waterway travel patterns in Bangkok.

Therefore, the above results of respondents' mobility and attitudes will be used in preparing for the future of water transport by shifting commuters to public water transportation service in Bangkok by:

1) The respondents agreed that providing an efficient and applicable boat service might lessen the rate of automobile dependency. Improving and expanding public transportation could be both affordable and accessible to everybody and is fundamental to the idea of boat service. The study indicated that a boat service provided along Lat Phrao Canal must run on time, and passengers should have access to information that is useful and reliable for their journeys. Moreover, other facilities provided at the pier area: waiting and sitting areas, food and refreshment facilities, comfortable seats, and the opportunity for other activities along the canal must be fulfilled and acted upon. The surrounding ambiance could be improved and revived by applying visuals such as architectural arts or designs, creative painting, lively sitting areas, cleanliness, and neatness for passengers to enhance a pleasant experience and physical comfort (Leigh, 2016). Finally, the people would not change from road to water transport unless the operation is easy and cheap (reasonably priced) for them (Jurkovic et al., 2021).

2) The influential factors for successful water-based transport development by logistic regression analysis, the essential factors were quality satisfaction during a journey, estimated time of travel, and shorter travel time. Quality satisfaction during a journey has various quality dimensions. Passengers must positively evaluate the journey in terms of providing comfort and good

traveling experiences (Asian Development Bank, 2016). Service facilities, including shops and cafés along with a service-minded staff, would enhance the journey. According to the five aspects regarding specific predictors of boat service, the lighting setup of the canal corridor indicated a high beta value. However, considering a number of element predictors, the navigation system and connectivity should be firstly addressed for boat service features of Lat Phrao Canal. Another point is that promoting boat service based on mobility prediction factors can benefit local people as community-owned transport. Prioritizing boat service development as a business model would support the decision process on how to use these variables in a development model. Most importantly, the involvement of local associations is required to lead successful and effective boat service development.

The desire to capitalize on this expansion and allow transfers between modes is a key focus going forward for the future of the water transportation system. However, challenges exist, and a coherent dialogue between stakeholders is, as yet, lacking despite calls for integration and even new forms of governance (Tanko & Burke, 2017). Therefore, the promoting sustainable water transport of Lat Phrao Canal stands a better chance of being achieved more quickly if the role of community engagement in mobility planning, decision-making, organization, and delivery.

6. Conclusion

Lat Phrao Canal is one of the remarkable canals of Bangkok, which can serve mobility networks in the city by connecting people to the existing mass transit. This report aims to collate information on existing waterway public transport to provide a resource for cities that may be considering implementing a water transit network.

The questionnaire survey was conducted through 1,200 people living near Lat Phrao Canal to develop a transportation network based on a water transport perspective. Most respondents agreed that waterway transport development could reduce automobile dependency and travel costs. The results of using a boat service, there were main key attributes for passengers' consideration including activity connectivity, canal development, and navigation system. The high score of each attribute should be taken into account to determine guidelines and appropriate measures for further development.

For future mobility patterns by the binary logistic regression model, three significant influence factors affecting the boat service were quality satisfaction, time of traveling, and shorter travel time on boat services transportation development (P-value < 0.05). The study offers concrete factors for promoting boat service to understand and develop the quality of the waterway network service. The recommendation based on these significant factors is to be determined in terms of water-based transport management for Lat Phrao Canal development to promote a waterborne transit network in the city.

Also, this result is applicable for expanding a capacity waterway network in Bangkok that could alleviate current traffic congestion and encourage sustainable urban mobility solutions for passengers. Bangkok is now in the middle of a large rail expansion program at the moment, with plans for seven new rail river crossings. The development of water transport would make canal alignment more potential by recommending the suitable allocation of future pier services to support Bangkok's local connectivity and regional mobility.

7. Limitations and Further Study

The limitations of the study were focused on mobility patterns and attitudes towards boat service as the demand side to explain existing travel behaviors and shifting trends of BMR's commuters. There was no information yet about the supply side of the canal transit system, which would be useful for passengers' behaviors. Therefore, further study should refer to the more exploring supply side of waterborne characteristics to in-depth analysis of mobility patterns. In addition, the multi-stakeholders should explore the potential of the Lat Phrao Canal based on the provision of policymakers, local authorities, and community and compare it to other cases of the canal in Bangkok to promote waterway transportation development.

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Authors' Contributions

Tanaphoom Wongbumru carried out the literature review part, including summarizing relevant publications and documents, statistical analysis and interpreting data and discussing results of this paper.

Pawinee Iamtrakul made a significant contribution to the field survey of questionnaire distribution for samplings. Also, she was in charge of the overall direction as the corresponding author. All authors read, commented, and validated the final version of the manuscript.

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