Efficiency Management of Public Bike-Sharing System in Bangkok

Pittawat Ueasangkomsate

***Abstract*—**This paper studies the efficiency of public bike-sharing system in Bangkok. The program mainly supports local dweller to participate more in public transportation. This is to relief the problem of traffic and environment in the capital city of Thailand. Public bike-sharing system now provides the coverage area of servicing only in urban area with 50 bike stations. To generate the revenue for driving business, the researcher applies the simulation model to obtain the expected revenue in term of service fee from membership. The study uses Poisson distribution function to represent the number of customer arrival at docked station and then generate average time of dweller's riding on public bike into the business model. The result of research shows consequence of increasing bike capacity into bike-sharing system comparing with residents' traffic at bike station. It presents efficiency improvement of management including higher expected revenue of service and also introduces lower loss opportunity from inadequacy of bike into the system. Moreover, it could help advice providers to realize the benefit and to arrange the plan for capacity management in bike-sharing system regarding local resident's traffic and behavior consequently.

***Keywords*—**Bike-sharing, Public Transportation, City Logistics, Sustainability

I. Introduction

BIKE-sharing system has been introduced to many cities around the world for a long time. This concept was found back to the 1960s' when local dweller tried to initiate bike-sharing program [1]. Whereas, now there have been around 461 bike-sharing systems in 28 countries [2] or more than 500 programs of bike-sharing system with 49 countries [3]. The worldwide bike-rental programs offer at least 250,000 bikes for service providing [4].

The concept of bike-sharing program is that resident could check out a bicycle from one of docked stations and return a bicycle back at another docked station in servicing area. It supports local residents who travel in short distance within city and provides more choices of public transportation [5]. This model can create the shared value in term of reducing carbon-dioxide emissions, maintaining the health, environmental and economic benefits, relieving traffic movement and increasing resident's livability [5-7]. Thus, policy makers in many cities realize these benefits of bike-sharing system certainly.

Bangkok is the capital city of Thailand where there are many problems looking for solving and relieving. To improve quality of dwellers' life is one of policy maker's targets to manage and execute. Due to the number of cars in Bangkok has been increased continuously [8]. It then causes significant problem with many aspects including traffic, pollution, environment, livability etc. Therefore, Bangkok Municipality realizes these concerns and then initiates Public Bike-sharing Program in Bangkok, so-called Pun Pun Project. It has been established since 2012 and provided servicing area within city. This is for local residents to have more choices of travelling in public transportation as well as improve their quality of life in the city.

Fig. 1 Public Bike-sharing in Bangkok

Because the program of public bike-sharing in Bangkok has been recently introduced to Bangkok, so nowadays there are memberships around 20,000. In Fig. 1, it shows the docked station of bike-sharing system in which there are 50 bike-stations in urban area within city. There are 8 parking slots at each station for resident to check out and to return (source: http://www.punpunbikeshare.com/). Service provider now attempts to promote and encourage local residents to participate more in this program via society activities and advertisement including newspaper, social media and others. For this research, it will focus on the efficiency of resource management in term of bike capacity to volume of customer and their behavior with simulation model. This is to help service provider to manage the resource of public bike efficiently and also realize the benefit for revenue management over traffic of customer arrival very well.

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Fig. 2 Servicing Area of Public Bike-sharing Scheme in Bangkok

II. RESEARCH METHODOLOGY

For research methodology, this paper assumes that number of customer arrival to public bike station is Poisson distribution function. It is applied to represent probability of number of customer arrival into docked station. For servicing time, it is now available during 7am - 8pm. The model simulates an average time of dweller's riding on public bike while number of customer arrival in one hour to docked station is randomized as assumption previously. For revenue scheming, the study employs the actual fee of this program in order to calculate the expected annual revenue and annual loss opportunity in TABLE I. To find probability of number of customer arrival into the bike-station, it is expressed the details in (1). Whereas, expected annual revenue which presents income of this project obtained by service fee is demonstrated in (2). For loss opportunity when bike capacity is probably not sufficient with customer demand, it can be shown in (3).

Fig. 3 Activities of Pun Pun Program

TABLE I
PUBLIC BIKE SERVICE FEE

t (hour)	*f* (THB)
Less 0.25	0
0.25 – 1	10
1 – 3	20
3 – 5	40
5 – 6	60
6 – 8	80
Exceed 8	100

For simulation, the study runs the expected number of customer arrival in one hour (λ) at average time of residents' riding (t). The outcome of simulation can show both expected annual revenue and annual loss opportunity of this program with various mean of λt.

$$P(x) = \frac{(\lambda t)^x . e^{-\lambda t}}{x!} \quad (1)$$

$$R = a.s.h.f \sum_{x=0}^{x} P(x).x \quad (2)$$

$$L = a.s.h.f \sum_{x-k>0}^{x-k} P(x).[x-k] \quad (3)$$

Where:

R = Expected Annual Revenue (THB)
L = Loss Opportunity (THB)
t = Average time of dweller's riding on public bike (hour)
x = Number of customer arrival in t hour
λ = Expected Number of customer arrival in one hour
$P(x)$ = Probability of x customer arrival in t hour into public bike station
f = Service fee (THB)
s = Number of docked station
b = Number of public bike
h = Number of servicing hour (hour)
$k = b/s$
a = 30 days * 12 months

Assumption:

- Use Poisson distribution function to represent the number of customer arrival to each docked station evenly
- Average time of public bike residents' riding = 0.25 to 1 hour; t = (0.25 - 1), f = 10 THB
- Number of docked station = 50 stations; s = 50
- Number of servicing hour = 13 hours; h = 13

III. Results

The simulation shows the result of performance comparing of bike capacity (b) between 250 bikes and 400 bikes with various expected number of customer arrival at t time. In Fig. 4 and Fig. 5, it presents the benefit of revenue management of this project to traffic of dwellers' riding obviously. The results exhibit that this program can gain higher expected annual revenue while annual loss opportunity is decreased by expanding capacity of public bike in case of increase of customer volume. In addition, the efficiency improvement between 250 to 400 public bikes of simulation in Fig. 6 shows the expected revenue increased since 0% to 60% regarding various mean of expected number of customer arrival with t.

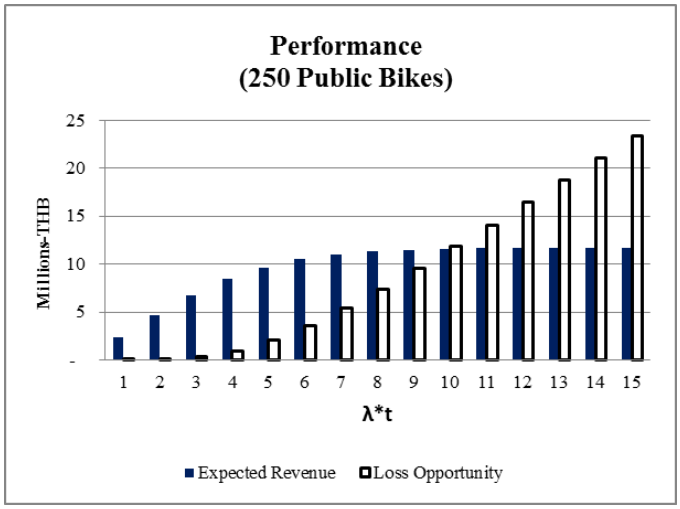

Fig. 4 Simulated Performance of Bike-sharing System (b= 250)

The results of having several numbers of public bikes (b= 250, 400, 800 and 1,000) into the system are shown in Fig. 7 and Fig. 8. It thus presents the expected revenue including loss opportunity from each available resource (b) with expected number of customer arrival with t. This outcome can support management team of this project to manage and arrange the capacity of bike more appropriately. Moreover, this research assists them to apply the results in order to compare the benefit and cost between current bike capacity and new bike capacity into the system. This is for them to evaluate whether this program should expand the number of public bike to serve residents' demand in the future.

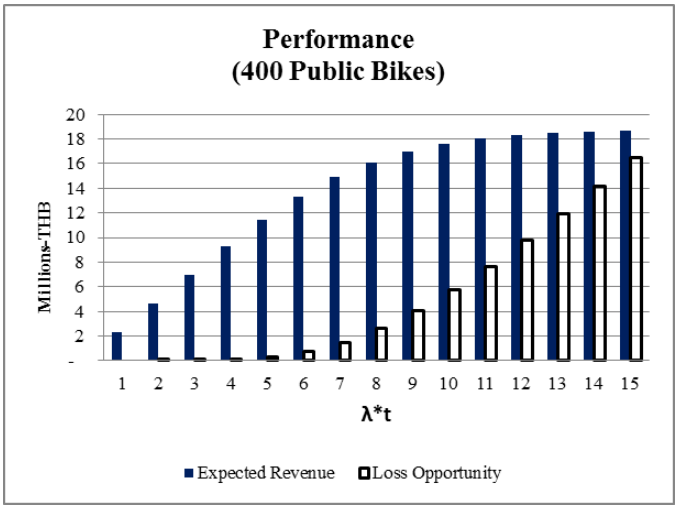

Fig. 5 Simulated Performance of Bike-sharing System (b= 400)

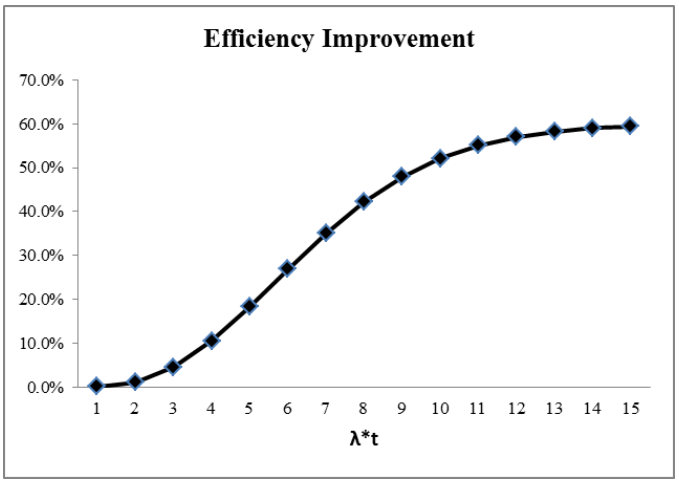

Fig. 6 Efficiency Improvement of Bike-sharing System

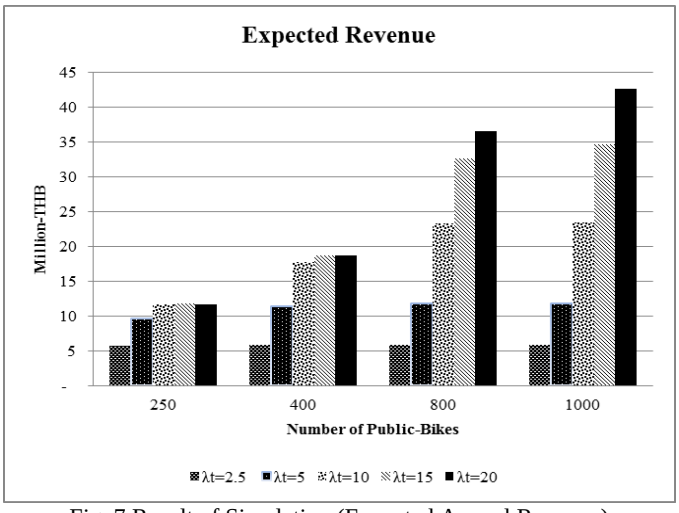

Fig. 7 Result of Simulation (Expected Annual Revenue)

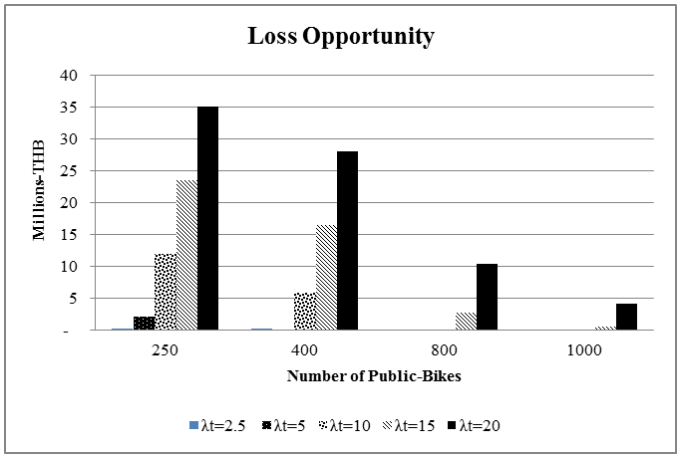

Fig. 8 Result of Simulation (Annual Loss Opportunity)

IV. Conclusion

This paper studies the simulation of revenue management for public bike-sharing program in Bangkok. The project aims to provide more public transportation to local residents so that they could reduce number of private cars and also improve quality of livability and environment within capital city of Thailand. For simulation model, it applies Poisson probability distribution to represent the number of customer arrival into docked station with one period. In addition, it provides various bike capacities into the model during 250 to 1,000 public bikes. This is to analyze the expected revenue and loss opportunity in the public bike sharing program in different bike capacity and customer volume. The cases when bike capacity is not sufficient for residents' demand shows higher loss opportunity in term of earnings. Thus, it enables service provider to realize the efficiency of revenue management to dweller's traffic with various bike capacity. Furthermore, this research could help this project to prepare and arrange the public bike capacity for residents' demand more efficiently.

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