

# Efficiency and Effectiveness of Integrated Urban Passenger Transportation: A Case Study of Mass Transit System Services in Bangkok

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The purpose of this research was to provide suggestions for improving the efficiency, and effectiveness of the mass transit system services in Bangkok. Using a quantitative research approach, the data was collected from 1,290 users of the Bangkok Mass Transit System (BTS), the Chaloe Ratchamonkhon Line (MRT), and the Suvarnabhumi Airport Rail Link (ARL), and was analysed using factor analysis, and multiple regression. The results found that for each route, the service quality, transfer transit, and integration of the service transit system affected the efficiency, and effectiveness in different ways. Thus, it is suggested that each route should develop the service quality, transfer transit, and integration of the service transit system for the improved efficiency, and effectiveness of the integrated mass transit system services in Bangkok. Moreover, there must be a central government agency which should develop the service quality, transfer, and integration of the service transit system criteria through the co-planning, co-designing, and implementation of the public services with the related agencies.

**Keywords:** *Co-production and public transportation; Co-production and public services.*

## Introduction

Capital cities, and major urban areas are increasingly experiencing traffic congestion, which has a negative impact on economic development. As a result of the dependence on personal cars for travel, the public sector has become aware of, and is attempting to solve urban public

transport problems (Vuchic, 2007). The problems of public transportation include: a lack of attractiveness; most urban dwellers travel diversely; the arduousness of using public transport; the failure of public transport management; and the need for the development of public transportation networks (Butkevicius & Lingaitis, 2005). To implement the policies to increase the use of public transportation, and influence changes in travel patterns, it is necessary to thereby provide service quality (Mulley & Nelson, 2003). The highest delivery of public transport service quality affects travellers' attitudes, and service demand (Barnum et al., 2007). In the past, performance measurement was focussed on the competition in resources allocation by service providers, which was the basis of the service cost measurement, and monitoring tools for service improvements from the perspective of the service providers (Transportation Research Board (1994). As a measure of the efficiency, and effectiveness of transportation services, it was found that efficiency is reflected by service outputs, which were compared to resources investment, while effectiveness is indicated by achieving the service goals consistently (Fielding, 1985). However, a measurement above this was created from the viewpoints of the service providers, and which was not linked to the users' viewpoints (Transportation Research Board, 2003a). In contrast, the viewpoints of the users, including their perceptions and expectations, were obtained from evaluations using the Customer Satisfaction Surveys (CSS) (Transportation Research Board, 2003b). These are an important basis for evaluating the performance of transport services (Eboli & Mazzulla, 2011). Similarly, the concept of public policy implementation focusses on public policy implementation evaluation, in order to use the results for service improvement, service reliability, effectiveness, efficiency, safety, and ease of use (Stufflebeam & Shinkfield, 2007). To improve the efficiency, and effectiveness of public services, it is necessary to push forward co-production, in which the users can participate in the improvement of service quality through the knowledge, and experiences of users or improvement of the effectiveness of service delivery by the service co-production of service users. There are a variety of services in which the service users can also concurrently function as service appraisers (Osborne & Strokosch, 2013).

Thailand has adjusted the working style to have integration, and to be open to public participation, in accordance with the Administrative Regulations Act No. 7 of 2007, in order to prepare and provide public services effectively (Office of the Public Sector Development Commission, online). However, an overview of Thai transport services indicates a number of service problems are caused by inefficiency (Ministry of Transport, 2016).

Thus, the authors are interested in studying the factors that affect the efficiency, and effectiveness of the integration of the mass transit system services in Bangkok, and the development of proposals to be used as a set of guidelines for increasing the efficiency, and effectiveness of the integrated mass transit system services in Bangkok, and in practical terms.

## **Theoretical Background and Research Framework**

This study has adopted the concept of co-production, which is part of a new public service approach that allows citizens to participate in the services delivery (Denhardt & Denhardt, 2007; 2015). Accordingly, the new public governance concept is well-known in European countries as a tool to evaluate the policy formulation, and implementation of public services. The user participation is focussed on the knowledge, and experiences of users to design elements for service delivery (Denhardt & Denhardt, 2007, 2015; Osborne & Strokosch, 2013). In order to improve public services, it is important to determine the efficiency, and effectiveness of those services (Osborne & Strokosch, 2013). In addition, Doherty and Horne (2002) described that service delivery monitoring must be continuous, and that users have assessed service requirements under the terms of agreement of public service management by finding ways to coordinate all resources, in order to meet the needs of the stakeholders. Therefore, there is an approach of control, quality management, and interest assessment. The public services quality management demonstrates the possibility of evaluation by the experience, and the quality of the services provided. Likewise, Vuchic (2007) explained that modern urbanisation requires modern transportation systems, and efficient transportation services in cities. Thus, the authors have divided the literature review into three parts related to the theoretical aspects of urban passenger transport modes, which is outlined as follows.

### *Service Quality*

The authors used data synthesis on the co-production of public services, as Carlson and Schwarz (1995) presented the types of public service quality that include eight elements, which are: convenience, security, reliability, personal attention, problem-solving, fairness measures, fiscal responsibility, and citizen influence. Potter (1988) suggested that there are five main factors of service development, which include: access, choice, information, redress, and representation. The authors have reviewed the literature of public transport services quality and applied the previous research to this study because the service quality of mass transit systems is nominal. European Commission EN 13816:2002 (2002) determined the criteria for transportation service quality, logistics, and services with eight criteria: availability, accessibility, information, time, user care, comfort, security, and environmental impacts. Pucher (2004) described service quality as consisting of modernity, convenience, comfort, attraction, cleanliness, reliability, vehicle and station safety, speed and fare structures, and ticket options. The Transportation Research Board (1999, 2003a, 2003b) determined that service quality includes five criteria: availability, monitoring, travel time, safety, and security. Vuchic (2007) described the level of service as having nine elements, including: operating speed; reliability; safety; convenience; simplicity of using the system; riding comfort; aesthetics; cleanliness; behaviour of passengers; and price. D'Ovidio et al. (2014) investigated the factors that affect the satisfaction of bus passengers in a local context, and grouped those

factors into seven groups that included: comfort and cleanliness; service; information availability; accessibility; fares; staff behaviour; and inspector behaviour. Eboli and Mazzulla (2011) studied and evaluated the quality of suburban bus services, and grouped the elements into eight groups, which were: route characteristics; service characteristics; service reliability; comfort; cleanliness; fares; information; safety and security; personnel; customer services; and environmental protection. Choocharukul and Sriroongvikrai (2013) analysed the mass rapid transit passenger satisfaction in the case of the MRT and grouped the factors into six groups consisting of: convenience; service and information; access/egress; fare; cleanliness and safety; and facilities. Eboli, Fu, and Mazzulla (2016) evaluated the railway service quality of ten suburban lines, mainly connecting different towns in the hinterland near the city of Milan, which was composed of 26 sub-indicators, and grouped them into seven indicators consisting of: safety; cleanliness; comfort; services; other; information; and personnel. The authors synthesised a total of 36 elements of the public transport service quality, which were consistent with this research.

### *Transfer Transit*

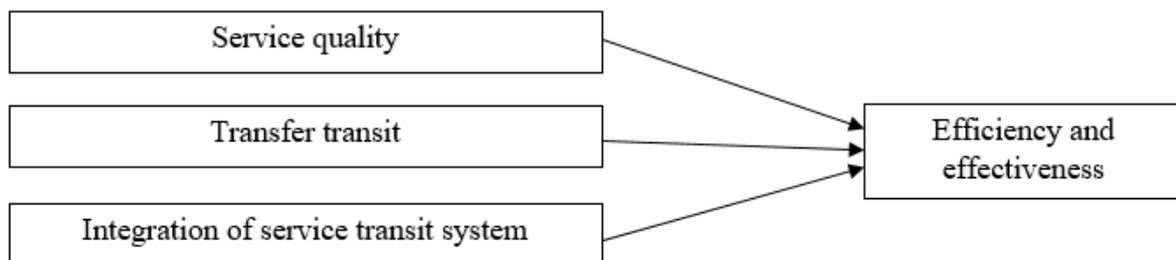
The authors reviewed the data from Transit Cooperative Research Program 165 (TCRP 165), which suggested that transfer transit is an important factor based on the Committee on Intermodal Transfer Facilities, Transport Research Board (1974), which pointed out that the overall effectiveness of transport networks is a consideration of the transfer transit facilities. This was confirmed by Abreu e Silva and Bazrafshan (2013), who explained that when traveling in a city, transfers are very important and affect the smoothness of passenger travel and improve the overall efficiency of the public travel system. Furthermore, they proposed ten indicators for facilitating transfers, namely: transfer signs; access of transfer information; ease to transfer with a personal car; ease of transferring access; ease of access to transfers; security in transfer areas; cleanliness of the transfer; sufficiency of waiting seats; facilities, such as restaurants and beverages; the ticket office; and ticket vending machines; and adequacy of elevators and escalators. Vuchic (2005) explained that the ease of transfer is required to attract passengers to travel. Iseki and Taylor (2009) pointed out that facilitation is important for increasing travel efficiency, and presenting transfer facility attributes, namely: access to transfers; connection and reliability; information; facilities; and security and safety. Ghiasi et al. (2011) found that the urban rail network linkage of the transfer stations which have a parking system at the transfer station encourage private car users to use the city rail transfer; and travel connections. Durning and Townsend (2015) explained that transfers are an effective approach to increase passenger numbers and presented that the transfer factors consist of station accessibility; and increased parking space. The authors of this study synthesised 16 transfer transit elements.

### *Integration of Service Transit Systems*

The authors reviewed the data from Vuchic (2005), who explained that the trend is towards the consolidation, and integration of service transit systems. Currie, Ahern, and Delbosc (2011) pointed out that integrated ticketing implies service effectiveness. In addition, Kamargianni et al. (2016) stated that the future of urban transport will be the integration of transport systems to increase mobility, and presented the indicators to assess the level of integration as ticket and payment integration; mobility package integration; and information communications technology (ICT) integration. SPUNIC (Online) explained that public transport operators must integrate public transport systems appropriately and suggested the use of one ticket for all means of transport; integrative fares for several operators; and synchronised schedules and connections. The authors of this study have synthesised four elements.

These three factors, as outlined above, were merged into the research framework because no previous studies have examined co-production in this context, and few studies have investigated the specific details of these three factors. Thus, this was undertaken in order to understand the factors that affect the efficiency, and effectiveness of the integration of the mass transit system in Bangkok. A multiple regression analysis was used to assess the co-production, as shown in Figure 1.

**Figure 1.** Multiple regression analysis of the co-production



The research hypotheses were:

H1: Service quality factor should has a positive realtionship to efficiency and effectiveness.

H2: Transfer transit factor should has a positive relationship to efficiency and effectiveness.

H3: Integration of service transit system factor should has a positive relationship to efficiency and effectiveness.



## **Research Method**

A quantitative research method was applied in the current study in three cases, including the Bangkok Mass Transit System (BTS), the Chaloem Ratchamongkhon Line (MRT), and the Suvarnabhumi Airport Rail Link (ARL). The procedural design was separated into three steps. In the first step, an exploratory factor analysis was conducted to group the related variables into the same categories and eliminate the variables that cannot be entered in any of the groups. In the second step, a confirmatory factor analysis was conducted to confirm the accuracy of the first step (the grouping of each latent variable that is appropriate for the study). This was achieved by modification of each latent variable to be appropriate, and consistent with the empirical data before the confirmatory factor analysis step. In the third step, multiple regression analysis was conducted.

## **Population and Sample**

The population was calculated as 20 times the number of observed variables (Hair et al., 2014), which in this study includes 58 observed variables. Thus, the sample size was calculated as 1,160 samples by recruiting the users of the BTS, MRT, and ARL, with the number per route being 430 samples (including reserves), resulting in a total of 1,290 samples, using multistage sampling, and convenient sampling with an online questionnaire, in addition to data collection at the connecting points for transit stations.

## **Research Instrument**

A questionnaire was used as the research instrument. The four elements of the latent variables, and the 58 experimental variables were addressed by the questions. A rating scale using five levels was used for the opinion-based questions. The quality of the content was verified and validated by three experts. Cronbach's alpha was employed to evaluate, and corroborate the reliability of the values, and the range of reliability fluctuated between 0.878 and 0.973.

## **Data Collection**

Prior approval for the data collection was obtained from the Research Ethics Committee of Mahidol University, in February 2019. The data were collected and studied from March to September of 2019. The online, and the self-conducted questionnaires were then distributed, and a total of 1,263 were completed and returned.

## Data Analysis

The quantitative data analysis process included an analysis of the descriptive statistics, and the exploratory factors using the statistical program, the Statistical Package for the Social Sciences for Windows (SPSS), to describe the general information, and the exploratory factor analysis to reduce the number of factors by grouping related variables into one group. Subsequently, the factor models were verified in accordance with the empirical data, with confirmatory factor analysis, and empirical data. Finally, a multiple regression analysis verified that the empirical data aligned with the hypotheses (Aungsuchot, Wichitwanna & Pinyophanuwat, 2014) by using the AMOS program.

## Results and Discussion

### *General Information*

The survey showed that the majority of the BTS users consisted of women, at a rate of 93.46 per cent of the sample or 413 respondents; 36.56 per cent were aged years 31-40; 58.35 per cent had completed a bachelor's degree level of education; 44.31 per cent were company employees; 23.73 per cent earn more than 50,000 baht per month; 28.91 per cent travel for the purpose of personal business; 56.66 per cent travel on weekdays; 29.30 per cent travel less than once a month; 23.97 per cent travel during 6.01–9.00pm; 36.56 per cent travel a first trip; 28.57 per cent have a travel pattern from the origin to the station which are by various traveling; and 41.16 per cent have a travel pattern from the station to the destination which is by walking.

The majority of the MRT users consisted of women, at a rate of 96.93 per cent of the sample or 424 respondents; 38.38 per cent were aged 41-50; 61.32 per cent had completed a bachelor's degree level of education; 47.64 per cent were company employees; 21.70 per cent earn 10,001-20,000 baht per month; 27.12 per cent travel for the purpose of personal business; 58.02 per cent travel on weekdays; 34.91 per cent travel less than once a month; 25 per cent travel during 6.01–9.00pm; 40.33 per cent travel a first trip; 31.60 per cent have a travel pattern from the origin to the station which are by various traveling; and 43.63 per cent have a travel pattern from the station to the destination which is by walking.

The majority of the ARL users also consisted of women, at a rate of 94.60 per cent of the sample or 426 respondents; 36.62 per cent were aged 41-50; 59.15 per cent had completed a bachelor's degree level of education; 42.72 per cent were company employees; 24.41 per cent earn more than 50,000 baht per month; 27.53 per cent travel for the purpose of personal business; 56.34 per cent travel on weekdays; 41.55 per cent travel less than once a month; 22.53 per cent travel during 9.00–6.01pm; 48.59 per cent travel a first trip; 33.10 per cent have a travel pattern from the origin to the station which are by various traveling; and 38.97 per cent have a travel pattern from the station to the destination which is by walking.

### ***Exploratory Factor Analysis (EFA)***

The Kaiser-Meyer-Olkin value (KMO), and the Barlett's test value were used to assess the appropriateness of the data to analyse the overall attributes of the BTS, the MRT, and the ARL. The KMO were 0.950, 0.969, and 0.963, respectively, and at the significance value of 0.000, which is statistically significant. The variables are related, and the attributes can be analysed for which values are approaching 1.000, and are higher than the level 0.500, from which it is considered that the relationship between the variables is large and suitable for factor analysis (Hair et al., 2014). Following the exploratory factor analysis stage, the elements that were weighted less than 0.500 were eliminated, and the reliability was calculated for consistency using Cronbach's alpha. The reliability should not be lower than 0.80 (Silpcharu, 2017), which has an alpha value of 0.882–0.972. Thus, the elements obtained from the exploratory factor analysis have no effect on the content validity.

### ***Confirmatory Factor Analysis (CFA)***

The modifications of each element were adjusted to be completely in accordance with the empirical data. The criteria for the determination of the model's consistency, and the empirical data were: the Chi-square test ( $X^2$ -test) value, which was  $p > 0.05$ ; the  $X^2/df$  value  $< 2.00$ ; Goodness of Fit index (GFI) value  $\geq 0.90$ ; Adjusted Goodness of Fit Index (AGFI) value  $\geq 0.90$ ; and Root Mean Square Error of Approximation (RMSEA) value  $< 0.05$  (Bollen, 1989; Diamantopoulos & Siguaaw, 2000; Hair et al., 2014). These results were divided into three parts, as follows:

#### **Part 1: Results of the service quality confirmatory factor analysis**

The results of the service quality confirmatory factor analysis of the BTS consist of five groups, and eighteen sub-elements. First, is 'availability', which includes ticket sales are available, fares are appropriate, passengers have channels to comment on services, providers offer equality in services, and train cars are available. The loading factors were 0.72–0.91, and the coefficient of determination values ( $R^2$ ) were 0.53–0.82. Second, is 'safety', which includes trains are clean and protect the environment, travelling by train is safe, and staff are willing to provide services. The loading factors were 0.78–0.80, and the  $R^2$  were 0.56–0.67. Third, is 'reliability', which includes punctual service, consistent service, and service frequency that corresponds to the time period. The loading factors were 0.74–0.85, and the  $R^2$  were 0.56–0.73. Fourth, is 'accessibility', which includes easy access to the stations, ease of use, and walking inside the stations is convenient. The loading factors were 0.75–0.85, and the  $R^2$  were 0.54–0.72. Fifth, is 'comfortable', which includes the temperature inside the trains is appropriate, the temperature inside the stations is appropriate, and the passengers feel comfortable when

travelling. The loading factors were 0.65-0.80, and the  $R^2$  were 0.42-0.64. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 124.848$ ,  $df = 103$ ,  $p = 0.071$ ,  $X^2/DF = 1.212$ ,  $GFI = 0.968$ ,  $AGFI = 0.947$ , and  $RMSEA = 0.023$ , based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

The results of the service quality confirmatory factor analysis of the MRT consist of four groups, and nineteen sub-elements. First, is 'safety', which includes that the stations and inside the trains are clean, travelling by train and the stations are safe, the announcement system on the trains can be used, mass transit reduces environmental impacts, and staff are attentive to services. The loading factors were 0.67-0.85, and the  $R^2$  were 0.45-0.72. Second, is 'availability', which includes staff are willing to provide services, travel is comfortable, the fares are appropriate, facilities for the disabled elderly are available, travelling by train has security to prevent crime on the trains, and train cars are available. The loading factors were 0.72-0.90, and the  $R^2$  were 0.51-0.82. Third, is 'reliability', which includes punctual services, consistent services, service frequency corresponds to the time period, and passengers can predict travel time. The loading factors were 0.82-0.92, and the  $R^2$  were 0.67-0.85. Fourth, is 'accessibility', which includes ease of use, the technology of ticket sales is appropriate, the ticket technology is appropriate, and ease of access to the trains. The loading factors were 0.75-0.87, and the  $R^2$  were 0.57-0.75. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 145.546$ ,  $df = 120$ ,  $p = 0.056$ ,  $X^2/DF = 1.213$ ,  $GFI = 0.966$ ,  $AGFI = 0.946$ , and  $RMSEA = 0.022$ , based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

The results of the service quality confirmatory factor analysis of the ARL consist of five groups, and eighteen sub-elements. First, is 'availability', which includes fares are appropriate, tickets sales are available, the ticket technology and tickets sales are appropriate, and train cars are available. The loading factors were 0.78-0.92, and the  $R^2$  were 0.62-0.84. Second, is 'safety', which includes that the stations and inside the trains are clean, travelling by train is safe, the announcement system on the trains can be used, and mass transit reduces environmental impacts. The loading factors were 0.56-0.87, and the  $R^2$  were 0.32-0.76. Third, is 'reliability', which consists of punctual services, passengers can predict travel time, services are consistent, and service frequency corresponds to the time period. The loading factors were 0.77-0.88, and the  $R^2$  were 0.59-0.77. Fourth, is 'comfort', which includes the temperature inside the trains is appropriate, passengers feel comfortable when travelling, and the temperature inside the stations is appropriate. The loading factors were 0.72-0.85, and the  $R^2$  were 0.52-0.73. Fifth, is 'accessibility', which includes ease of use, easy access to the trains, and passengers can easily buy the tickets. The loading factors were 0.82-0.86, and the  $R^2$  were 0.68-0.73. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 122.568$ ,  $df = 101$ ,  $p = 0.071$ ,  $X^2/DF = 1.214$ ,  $GFI = 0.970$ ,  $AGFI = 0.950$ , and  $RMSEA$

= 0.022 based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

It was found that all three routes — the BTS, the MRT, and the ARL — have major elements, and sub-elements which are consistent with Carlson and Schwarz (1995), Choocharukul and Sriroongvikrai (2013), d'Ovidio et al. (2014), Eboli, Fu and Mazzulla (2016), Eboli and Mazzulla (2011), the European Committee for Standardization (2002), Mesa, Ona and Ona (2016), Ona et al. (2015), Potter (1988), Pucher (2004), Transport Research Board (1999, 2003a, 2003b), and Vuchic (2007). However, the major elements, and sub-elements of service quality, the loading factors, and the coefficient of determination values are different, in that the viewpoints of the passengers on the service quality of the mass transit for each route differ.

## **Part 2: Results of the transfer transit confirmatory factor analysis**

The results of the transfer transit confirmatory factor analysis of the BTS consist of three groups, and eleven sub-elements. First, is 'transfer information', which includes the pathway and facilitation of transfers, transfer information and signs are clear, security during transfers and waiting areas are appropriate, emergency exits are appropriate, and ease of access to transfer. The loading factors were 0.78-0.87, and the  $R^2$  were 0.61-0.76. Second, is 'facilities', which includes the park and ride is adequate, vending machines are adequate, seats in the transfer areas are adequate, and elevators and escalators in the transfer areas are adequate. The loading factors were 0.72-0.83, and the  $R^2$  were 0.52-0.69. Third, is 'shops', which includes the shops are adequate, and the coffee shops and restaurants are adequate. The loading factors were 0.95-0.96, and the  $R^2$  were 0.91-0.92. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 42.513$ ,  $df = 31$ ,  $p = 0.082$ ,  $X^2/DF = 1.371$ ,  $GFI = 0.982$ ,  $AGFI = 0.962$ , and  $RMSEA = 0.030$ , based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

The results of the transfer transit confirmatory factor analysis of the MRT consist of two groups, and seven sub-elements. First, is 'transfer information', which includes the transfer information and signs are clear, security in the transfer areas are appropriate, the pathway and facilitation of transfers, and ease of access to transfer. The loading factors were 0.82-0.91, and the  $R^2$  were 0.67-0.83. Second, is 'facilities', which includes shops are adequate, coffee shops and restaurants are adequate, and transfer facilities are adequate. The loading factors were 0.65-0.97, and the  $R^2$  were 0.43-0.94. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 10.859$ ,  $df = 8$ ,  $p = 0.210$ ,  $X^2/DF = 1.357$ ,  $GFI = 0.993$ ,  $AGFI = 0.975$ , and  $RMSEA = 0.029$  based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

The results of the transfer transit confirmatory factor analysis of the ARL consist of two groups, and eight sub-elements. First, is 'transfer information', which includes the transfer signs are clear, transfer security and transfer areas are appropriate, the distance and facilitation of transfer areas are appropriate, and passengers can easily transfer. The loading factors were 0.79-0.97, and the  $R^2$  were 0.63-0.94. Second, is 'shops and facilities', which include the shops are adequate, coffee shops and restaurants are adequate, vending machines are adequate, and park and ride and seats in transfer areas are adequate. The loading factors were 0.53-0.96, and the  $R^2$  were 0.28-0.91. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 18.101$ ,  $df = 10$ ,  $p = 0.053$ ,  $X^2/DF = 1.810$ ,  $GFI = 0.989$ ,  $AGFI = 0.962$ , and  $RMSEA = 0.044$  based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

It was found that all three routes — the BTS, the MRT, and the ARL — have major elements, and sub-elements which are consistent with Silva and Bazrafshan (2013), Durning and Townsend (2015), Ghiasi et al. (2011), Hernandez and Manzon (2016), Iseki and Taylor (2009), and Vuchic (2005). However, the major elements, and sub-elements of transfer, the loading factors, and the coefficient of determination values are different, in that the viewpoints of passengers on the transfer transit of the mass transit for each route differ.

### **Part 3: Results of the integration of the service transit system confirmatory factor analysis**

The results of the integration of the service transit system confirmatory factor analysis of the BTS consist of four elements: single ticket travel on the mass transit system; the payment for use of the mass transit system; access to coordinated travel information from different systems is easy; and train operations are harmonised, and connected. The loading factors were 0.60–.096, and the  $R^2$  were 0.36–0.91. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 0.350$ ,  $df = 1$ ,  $p = 0.554$ ,  $X^2/DF = 0.350$ ,  $GFI = 1.000$ ,  $AGFI = 0.996$ , and  $RMSEA = 0.000$ , based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

The results of the integration of the service transit system confirmatory factor analysis of the MRT consist of four elements: single ticket travel on the mass transit system; the payment for use of the mass transit system; access to coordinated travel information from different systems is easy; and train operations are harmonised, and connected. The loading factors were 0.56–0.95, and the  $R^2$  were 0.32–0.91. The confirmatory factor model is consistent with the empirical data, which has an index value of  $X^2 = 2.809$ ,  $df = 1$ ,  $p = 0.094$ ,  $X^2/DF = 2.809$ ,  $GFI = 0.997$ ,  $AGFI = 0.967$ , and  $RMSEA = 0.065$ , based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

The results of the integration of the service transit system confirmatory factor analysis of the ARL consist of four elements: single ticket travel on the mass transit system; the payment for use of the mass transit system; access to coordinated travel information from different systems is easy; and train operations are harmonised, and connected. The loading factors were 0.61–0.94, and the  $R^2$  were 0.37–0.88. The confirmatory factor model is consistent with the empirical data, which has an index value of  $\chi^2 = 3.613$ ,  $df = 1$ ,  $p = 0.057$ ,  $\chi^2/DF = 3.613$ , GFI = 0.996, AGFI = 0.957, and RMSEA = 0.078, based on the criteria of Bollen (1989), Diamantopoulos and Siguaw (2000), and Hair et al. (2014).

It was found that all three routes — the BTS, the MRT, and the ARL — have a similar integration of service transit system elements, which are consistent with Kamargianni et al. (2016), SPUNIC (2009), and Vuchic (2005). However, the loading factors, and the coefficient of determination values are different, in that the viewpoints of passengers on the transfer transit of the mass transit in each route differ.

### ***Multiple Regression Analysis***

Hair et al. (2014) explained that the importance of interpreting the variance of regression is the relationship between the independent variables. In general, a relationship higher than 0.90, is the first indicator of multicollinearity. The correlation coefficient between the independent variables of the BTS, the MRT, and the ARL were 0.864-0.498, which did not indicate multicollinearity. Subsequently, the authors analysed the factors that affected the efficiency, and effectiveness of the integrated urban passenger transportation with multiple regression analysis by the stepwise approach. The results are shown in Table 1.

**Table 1: Comparison of Multiple regression analysis by stepwise method of the BTS, MRT and ARL**

Independent variables	Beta Standardised Coefficients		
	BTS	MRT	ARL
Service quality	***0.494 (9.254)	***0.510 (9.114)	0.327*** (6.012)
Transfer transit	0.225*** (4.309)	0.244*** (4.405)	0.380*** (7.140)
Integration of service transit system	0.144*** (3.952)	0.102* (2.786)	0.168*** (4.651)
R Square	0.608	0.621	0.597
Adjusted R <sup>2</sup>	0.605	0.619	0.594
SEE	0.487	0.516	0.518
F	211.552***	229.768***	208.655***
Sig.	0.000	0.000	0.000
R <sup>2</sup> Change	0.015	0.007	0.021
F Change	15.619	7.760	21.632
Sig. F Change	0.000	0.006	0.000

In parentheses are the values of t

\*p ≤ 0.05, \*\*p ≤ 0.01, \*\*\*p ≤ 0.001

The results of the multiple regression analysis showed that the models with the independent variables of service quality, transfer transit, and integration, best described the dependent variable. These models can predict the efficiency, and effectiveness of the BTS, the MRT, and the ARL, which are 60.5 per cent, 61.9 per cent, and 59.4 per cent, respectively, with a statistically significant level of 0.001. The service quality has a positive relationship to efficiency, and effectiveness, which is in accordance with the studies of Mackett and Sucliffe (2003), and Vuchic (2007). The transfer transit has a positive relationship to efficiency, and effectiveness, which is in line with the studies of Silva and Bazrafshan (2013), Polat (2012), Thompson and Brown (2012), Transportation Research Board (1974), and Vuchic (2005). The integration of the service transit system has a positive relationship to efficiency, and effectiveness, which is in accordance with the studies of Currie, Ahern and Delbosc (2011), Kamargianni et al. (2016), and SPUNIC (2009). However, for each route, it was found that the service quality factor, transfer transit factor, and integration of the service transit system factor have a positive relationship to efficiency, and effectiveness at different levels.

Therefore, the opinions of users on the services are reflected. There is the basic importance of the co-production of public services, as mentioned by Osborne and Strokosch (2013), who pointed out that users have a variety of roles in services. Thus, they are both service users, and

service appraisers, at the same time. The service use is a pillar of co-production, and the expectations and experiences of the users will be at the centre of delivering an effective service. Moreover, there are the results of services, which at this point correspond to Needham (2010), who pointed out that participation involves the evaluation of monitoring, and the assessment of the quality, and the output of public services. Additionally, Loeffler (2016) stated that the quality of urban infrastructure, and the local services evaluation, as a co-assessment, can convert user complaints, which is typically seen as an application of citizen feedback into the co-design, and is an especially important activity that contributes in major ways to the effective delivery of services. This is consistent with Denhardt and Denhardt (2015), who stated that users can partner with the Government in services co-production and describe their experiences and opinions of participation. It is also in accordance with Ciasullo, Palumbo and Troisi (2017), who studied the co-production of public services from the different perspectives of needs, and found that citizens can provide the co-planning, and co-designing of local transportation services by critiques to improve service quality. This is also in line with Nunes, Galvao and Cunha (2014), who discovered that when users are involved in public transport services delivery, they will receive a better travel experience. It is also consistent with the policy implementation theory, which includes an emphasis upon policy evaluation that recognises problems (Stufflebeam & Shinkfield, 2007).

### ***Recommendations Related to Mass Transit***

There should be an integration of the co-planning, and co-designing policy in service quality, transfer transit, and the integration of the service transit system among the Government, the private sector, and the people using the services. The service providers and service users have participated in the mass transit system in the Bangkok planning process, and the involvement of these sectors participating in the policy process will encourage the users to participate in providing opinions, and descriptions of the experiences gained from using the mass transit system in Bangkok. This will enable the output of the policy to respond to the needs of users because the users who participate in the service evaluation will reflect the reality, and the appropriate needs of the users.

### ***Recommendations for Further Research***

The factor model from this study should be used to evaluate the mass transit system service in various areas to better understand the efficiency, and effectiveness of the mass transit system in Bangkok. Moreover, it should be used to evaluate other public transportation services, in which an increasing number of users are becoming involved in the service evaluation, and which should be conducted continuously, and across time periods, in an effort to follow the changes that occur over time. Furthermore, it can be used for examining the model in which other factors are increasingly affecting the efficiency, and effectiveness of the integrated mass



transit system services in Bangkok, which will be useful for comprehensive policy formulation. However, the efficiency, and effectiveness criteria evaluation which will be a central standardisation — as the comprehensive criteria, and efficiency, and effectiveness benchmark evaluation of the mass transit system in the future — should be determined.



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