DYNAMIC MODELLING OF USER SATISFACTION: THE CASE OF THE BANGKOK MASS TRANSIT SYSTEM (BTS)

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Abstract

Build-Operate-Transfer (BOT) scheme is a key approach in the Public-Private Partnership transportation infrastructure development concept. The private sector obtains concession to develop public infrastructure projects on behalf of the government to build and operate projects and transfer back to the governments at a pre-specified date. The Bangkok Mass Transit System (BTS) SkyTrain is being operated by the BTS Company Limited under an agreement with the Bangkok Metropolitan Administration. Due to the commercial nature, user satisfaction is a major cause for concern. In order to assess the levels of user satisfaction, it is essential to study the user benefits and gauge their levels of satisfaction. The focus of this paper is on the performance of the project during the operation stage and the implications for management. It is proposed to use System Dynamics modelling and simulation to explore the problem of user satisfaction. This research considers ways in which the satisfaction levels of users may be enhanced. Data were collected through questionnaire surveys and interviews to derive causal loop diagram to be translated into stock and flow diagrams for the simulation. The model will be tested rigorously before being deployed for policy experimentation on user satisfaction.

Keywords
BOT, Mass Transit, Model, User satisfaction, System Dynamics

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Introduction

The private sector is now playing an increasingly crucial role in the financing and provision of services that have been traditionally the domain of the public sector. The reasons for this are multifarious. One of the key reasons is that governments are unable to cope with the ever-increasing demands on their budgets. Most infrastructure expenditure in developing countries has been funded directly from fiscal budgets but several factors such as macroeconomic instability and growing investment requirements have shown that public financing is volatile and, in many countries, rarely meets crucial infrastructure expenditure requirements in a timely and adequate manner (Ferreira and Khatami, 1996).

According to the nineteenth annual survey conducted by Public Works Financing (2010), there have been over 1867 infrastructure concessions with estimated capital costs of over $US 712 billion proposed, awarded, or completed under a variety of forms of Public-Private Partnership (PPP) in over 100 countries around the world since 1985.

Furthermore, infrastructure development is one of the prerequisites for continued and sustainable growth of any country in general. Economic progress of a developing country in particular largely depends on the availability of adequate infrastructure facilities including transportation. In order to accelerate the rate of expansion and to fulfil the increasing of various types of customer demand, the approach of Build Operate Transfer (BOT) has been introduced as a form of concession in some of the new projects in developing countries (Ofori, 2007) especially in Thailand (Tangkitsiri and Ogunlana, 2004).

The BOT is a concept whereby governments invite private sectors involved in particular infrastructure projects to partner with them in order to take advantage from them in the areas of design, construction, finance and the operation of the facility. Eventually, after a concession period, the project will be transferred to the host government (Levy, 1996; and World Bank, 2013).

The focus of this paper is on the performance of the project during the operation stage and the implications for risk management. It is proposed to use System Dynamics (SD) modelling and simulation to determine user satisfaction. Furthermore, this research considers ways in which the satisfaction levels of users may be enhanced. Hence, the SD model addresses the satisfaction of users which is derived from the usage data. The model addresses the drivers of user satisfaction. Data from the BTS case study were collected through questionnaire surveys and interviews to formulate a dynamic hypothesis in the form of causal loop diagrams. The diagram may also be applied to derive stock and flow diagrams for the simulation. The model will be tested rigorously before being deployed for policy experimentation on user satisfaction.

Literature Review

BOT

A Public-Private Partnership (PPP) infrastructure development can be defined as: “the permission private sectors acquire from the host government to provide infrastructure services under specific agreement and conditions of market mechanism” (Walker and Smith, 1995). Currently (2013), the most perceptible type of Public-Private Partnership (PPP)

mechanism in transportation infrastructure development is the Build-Operate-Transfer (BOT) method (Walker and Smith, 1995; Dias and Ioannou, 1996; Malini and Raghavendra, 1996; Ogunlana, 1997; Mohamed-Asem *et al*., 2001; Zhang and Kumaraswamy, 2001; Zhang *et al*., 2002; Ghosh and Jintanapakanont, 2004; Zhang, 2005; Abednego and Ogunlana, 2006; ADB, 2008; and World Bank, 2013).

There are several Build-Operate-Transfer (BOT) projects already completed or are currently in progress in developing countries (Ofori, 2007) and a considerable number of them have been carried out in Thailand (Tangkitsiri and Ogunlana, 2004). In order to measure levels of stakeholders' satisfaction, it is necessary to study the real benefits from projects such as the Don Muang Tollway operated by the Don Muang Tollway Public Company Limited (DMT) under a concession granted by the Department of Highways (DOH) and Bangkok Mass Transit System (BTS) SkyTrain operated by Bangkok Mass Transit System Public Company Limited (BTSC) under another concession granted by the Bangkok Metropolitan Administration (BMA) (Ogunlana, 1997; Ghosh and Jintanapakanont, 2004; ADB, 2006; Ofori, 2007; ADB, 2008; MOT, 2013; and World Bank, 2013).

The crucial elements of project management in construction are project planning and monitoring. Project monitoring consists of a tracking process, comparing actual outcome to predicted outcome, analysing impact, and making adjustments as appropriate. This means that studies in general are carried out on the projects before the construction stage as part of the impact assessment study especially in terms of risk management (Li *et al*., 2005). The focus of this research, however, is on the project during the operation stage and its relationship to risk management. The outcomes of projects are strongly influenced by the communities and the risks involved in the system. Thus, project monitoring and tracking tasks are very important to keep the projects in their planned situations and ultimately to accomplish their goals (Chege and Rwelamila, 2000).

The Bangkok Mass Transit System (BTS)

The BTS SkyTrain project is now operational in Bangkok, the capital of Thailand. The concession for the BTS was awarded to the Bangkok Mass Transit System Public Company Limited (BTSC) on the 9th April 1992. The BTSC was permitted to retain all revenue deriving from the system operation for 30 years. The objectives of the project are to assist in alleviating the chronic traffic problems within the city and to provide Bangkok citizens with a fast and efficient means of transportation within the central business district.

According to BTSC (2013), the BTS has changed travelling patterns in Bangkok. Both traffic problems and inability to arrive at passenger destinations on time have either been solved or substantially reduced. This means that BTS benefits are economic and social and meet the needs of customers/users.

Tangkitsiri and Ogunlana (2004) have addressed the problem of satisfaction with the BTS through a survey of stakeholders of the system. The survey of users (757) was conducted using questionnaires and interviews to evaluate the real benefits of the BTS. The study results (Tables 1-3) indicate that BTS users were substantially satisfied with the benefits derived from the project. Users expressed satisfaction with the convenient transportation system which, they claimed, had improved the traffic situation. However, they also expressed the wish to have system improvements.

Table 1: Demographic Profile of Users

	Age in Years						
	Male	Female	< 20	20-30	31-40	41-50	> 50
Thai	198 (32%)	429 (68%)	118 (19%)	399 (64%)	1. 64 2. (10%)	3. 34 4. (5%)	5. 12 6. (2%)
7. Foreigner	8. 65 9. (50%)	10. 65 11. (50%)	12. 7 13. (5%)	14. 68 15. (52%)	16. 40 17. (31%)	18. 13 19. (10%)	20. 2 21. (2%)

Adopted from Tangkitsiri and Ogunlana (2004)

Table 2: Satisfaction of Thai Users

Factor	Result						
	Very dissatisfied	Dissatisfied	Average	Satisfied	Very satisfied	Mean	SD
Services	4 (0.6%)	17 (2.7%)	149 (23.7%)	402 (64%)	55 (9%)	3.78	0.66
Safety	1 (0.2%)	10 (1.6%)	146 (23.2%)	404 (64%)	66 (11%)	3.84	0.62
Operation	4 (0.6%)	30 (4.8%)	177 (28.2%)	377 (60.1%)	39 (6.2%)	3.67	0.69
Others (Life improvement)	1 (0.2%)	18 (2.9%)	198 (31.6%)	337 (53.7%)	73 (11.6%)	3.74	0.70

Adopted from Tangkitsiri and Ogunlana (2004)

Table 3: Satisfaction of Foreign Users

Factor	Result						
	Very dissatisfied	Dissatisfied	Average	Satisfied	Very satisfied	Mean	SD
Services	0 (0.0%)	0 (0.0%)	14 (10.8%)	98 (75.4%)	18 (13.8%)	4.03	0.50
Safety	0 (0.0%)	1 (0.8%)	8 (6.2%)	94 (72.3%)	27 (20.8%)	4.13	0.53
Operation	0 (0.0%)	0 (0.0%)	14 (10.8%)	97 (74.6%)	19 (14.6%)	4.04	0.50
Others (Life improvement)	0 (0.0%)	0 (0.0%)	15 (11.5%)	85 (65.4%)	30 (23.1%)	4.12	0.58

Adopted from Tangkitsiri and Ogunlana (2004)

System Dynamics Modelling

In this work, we attempt a System Dynamics (SD) concept that addresses the problem of user satisfaction with the system with the view of formulating viable policies to improve the system. The way to implement an integration of a System Dynamics (SD) model and the project management theory, this is able to be used to solve some of these problems and to analyse the results as well as the approach of operations and maintenance (O&M) management by employing clear strategic policies. This is essential in order to ensure smooth O&M from the basis of the designers' concept. In particular, the experience from O&M and SD should positively influence decision making design to ensure stakeholders' satisfaction (Sterman, 2000).

Customer Satisfaction

The definition of "customer satisfaction" has been widely debated as organisations increasingly attempt to measure it. Customer satisfaction can be experienced in a variety of situations connected to both goods and services. It is a highly subjective response which is greatly affected by customer expectations. Satisfaction also is based on the customer's experience of both contacts with the organisation, the "moment of truth" as it is called in business literature and personal outcomes. Some researchers define a satisfied customer within the private sector as "one who receives significant added value" to his/her bottom line—a definition that may apply just as well to public services. Customer satisfaction differs depending on the situation and the product or service (Oliver, 2010).

Instead of asking whether customers are satisfied, companies may be encouraged to determine how loyal customers hold them accountable. In the public sector, the definition of customer satisfaction is often linked to both the personal interaction with the service provider and the outcomes experienced by service users (Grenci and Watts, 2007).

According to ISO 9000:2005, "Customer Satisfaction" is defined as "the customer's perception of the degree to which the customer's requirement have been fulfilled".

In this work, customer/user satisfaction is represented by the following equation:

$$Customer\ Satisfaction = Services - Expectations$$

Thus, customer satisfaction begins when the customers' services expectations are met i.e. when the level of service provided by the service provider (the BTSC) meets the expectations of the users. Why is customer satisfaction important in a BOT project? Many citizens in the developing world are used to bad services. Many may not complain because there are no avenues to express their grievances or because they have never experienced better services. However, as the pace of globalisation increases and many citizens of the developing world travel out of their own countries, they have become more and more desirous to have service standards similar to what is being enjoyed in the developed world. As such, governments can no longer continue business as usual when providing services for their citizens. In addition, one motivating factor in inviting private sector partners to deliver services that have been delivered by the public sector is the assumption that the private sector can be more efficient in service delivery than the public sector. If citizens are now being expected to pay for services they have been delivered free-of-charge in the past, they should have the right to expect better quality services.

Modelling Satisfaction Using System Dynamics

As discussed earlier, an SD model of the project can be used as an effective tool for risk monitoring and control. The model can be used to identify early signs of risk appearance. The implementation of risks and their consequences can be monitored by analysing the aspects of the project causing concern to both the system management and users. Effectiveness may also be evaluated through SD models (Ogunlana *et al*., 2003). In addition, the dynamic nature of the project can be managed better than in other projects which did not benefit from modelling. It is essential for the various levels of managers to make the right decision at the correct time. Thus, some form of supplementary analyses has to be

undertaken to identify the risk conditions of the project. In order to do this, all information must be integrated by modelling.

Customer satisfaction has been modelled by Che *et al*. (2010). The conceptualised quality of service as the major driver of customer satisfaction in telecoms services supply. Our work addresses customer satisfaction at the O&M stages of a BOT transportation project. We define customer as the users of the BTS. Our goal is to find ways and means to improve customer satisfaction through services improvement on BTS. The research context sets this work apart from that already done by Che *et al*.

The causal loop diagram which will form the basis for the BOT model has been developed from an earlier survey of customer satisfaction on the BTS Tangkitsiri and Ogunlana (2004). The Causal loop diagram is represented in Figure 1 while the causes tree is depicted in the Figure 2. The major loops are built around the major drivers of satisfaction with the system, viz: (i) efficiency of BTS operation; (ii) level of safety; (iii) level of services provided; (iv) physical/psychological health; (v) city traffic problems; (vi) travel cost; and (vii) travel time.

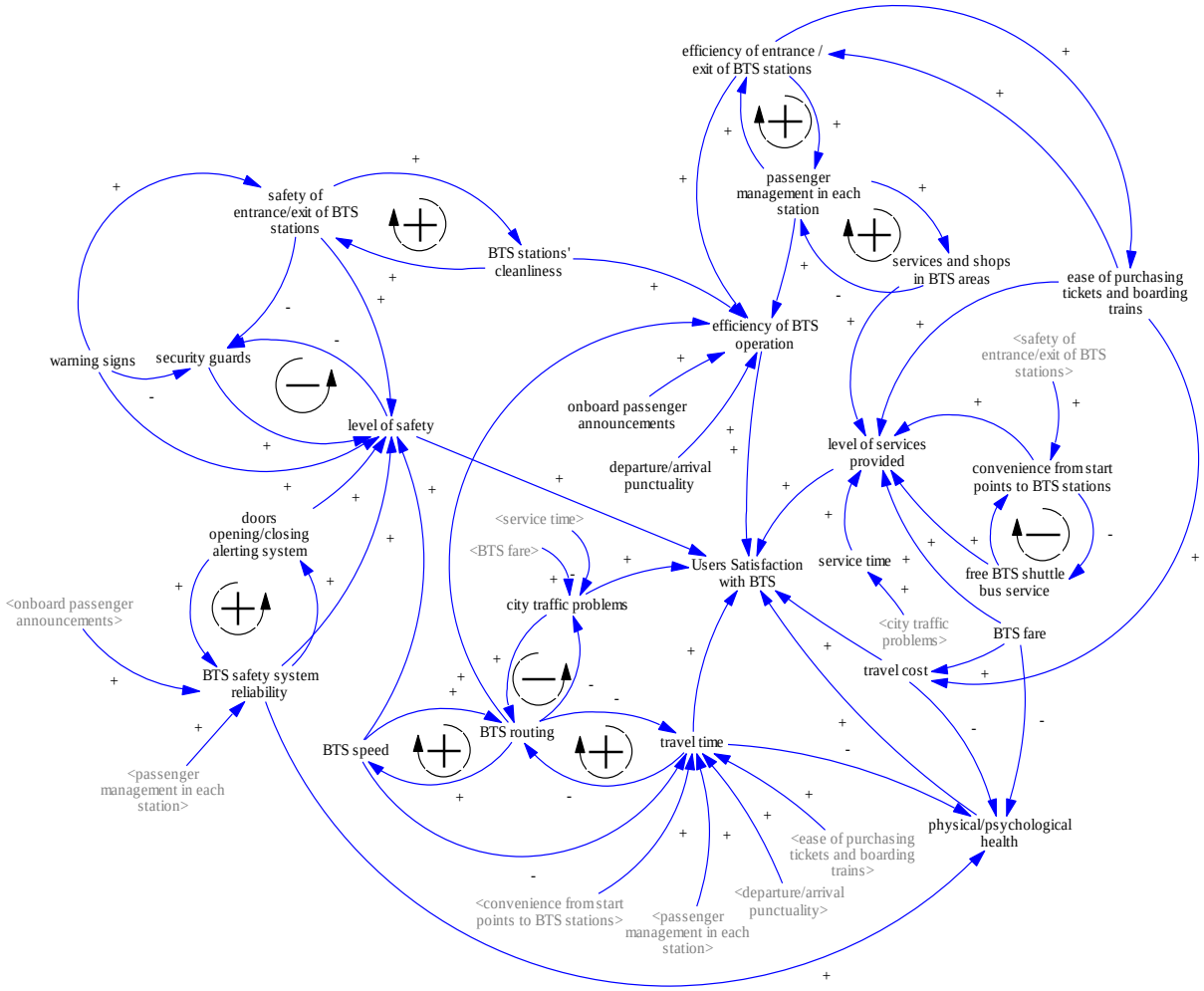

Figure 1: Main feedback Loops of the User Satisfaction

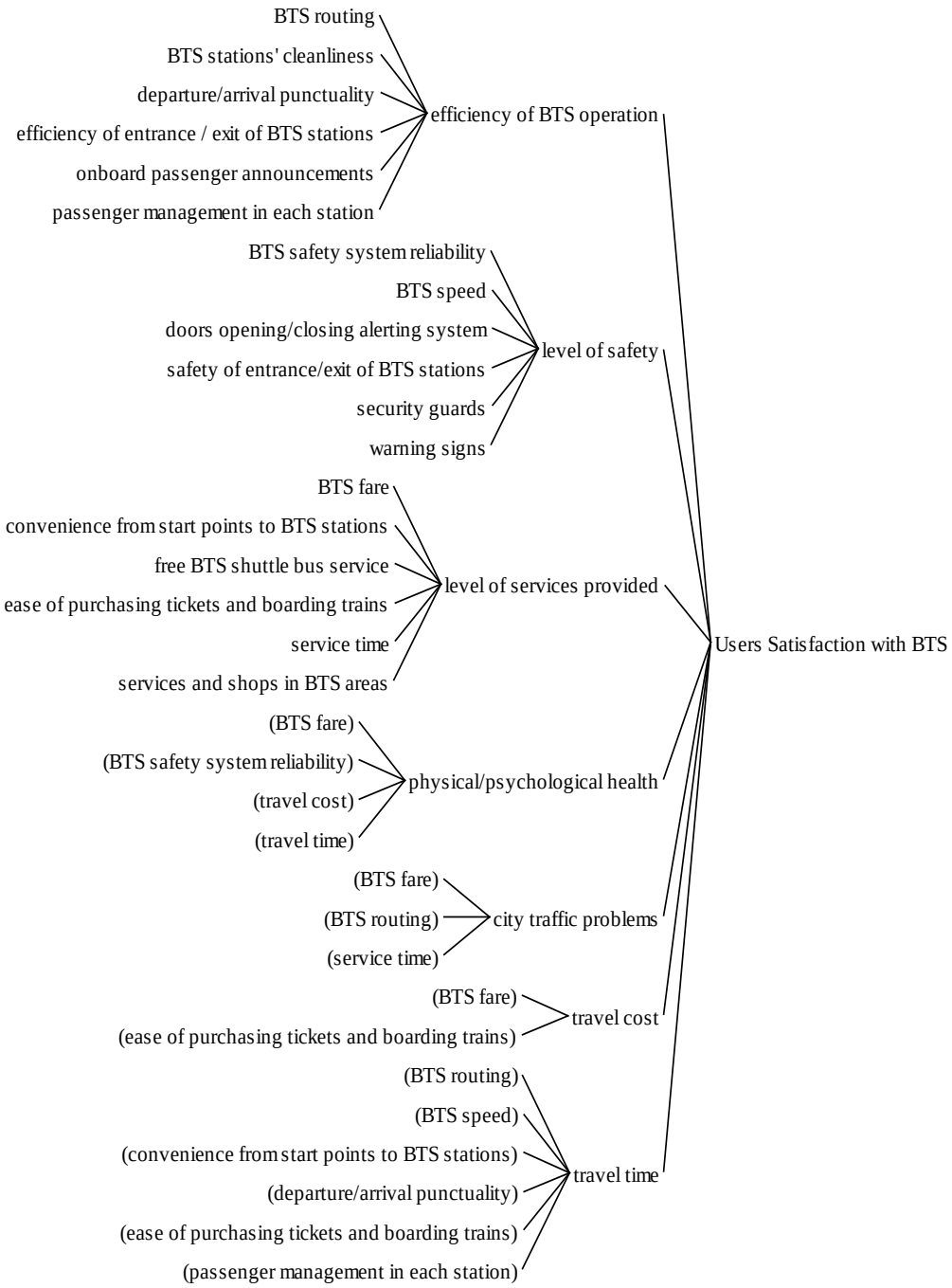

Figure 2 Causes Tree

Further Development

This work is still at an early stage of development. The causal loop diagram will be validated through discussion with the managers of the BTS system before being translated into stock and flow diagrams for simulation purposes. Essentially, there is the need to establish that the causal loop diagrams accords with the mental model of the managers of the system. In the absence of a reference mode in form of time series data, the authors intend to consult the

managers of the BTS to refine the outputs from the system before being used for policy experimentation.

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