

Development Of An Electronic Fare Collection System Using Stationary Tap-Out Devices

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Abstract— The peculiar nature of emerging economies means that established technology must be developed with the constraints and limitations of these locations in view. This paper presents the development of an Electronic Fare Collection system using Contactless smart cards. Electronic fare collection systems are commonly integrated with public transit networks such as the bus Rapid Transit (BRT) and Light Rail Transit (LRT) services in major cities worldwide. However, in deploying such systems in an emerging economy like Nigeria, unique consideration has to be given with regards to power management, robustness and availability. The system developed consists of a mobile tap-in device connected to a bus, a stationary tap-out device to be situated at a specific bus stop and a web server on the cloud for coordination and off site monitoring. The stationary tap-out device used consists of a proximity card reader (or an RFID reader) connected to a computing unit linked with a display, outdoor power provision (source) and data transmission capability. A program was developed to capture data from randomly applied proximity cards (or RFID cards) and to transmit same periodically to a remote location for use by the system. The system developed is able to sustain itself for a long period of time from available power supply, it also proves robust enough from a software and hardware perspective. Lastly its availability is proven even when data transmission capability proves erratic.

Keywords—fare, transport, embedded system, tap-in, tap-out (key words)

I. INTRODUCTION

In recent times, mobility and growing congestion levels experienced in urban areas has spurred the need for low-cost mass rapid mode of transportation [1]. A variety of transit technologies are available for public transit, ranging from several bus modes to tram, light rail transit (LRT), commuter rail and metropolitan rail (metro) systems [2]. In Nigeria, there is a great predominance of buses over rail-based technologies in the provision of transit services [3]. Some of this transit technologies are being adopted in some cities across Nigeria. One of such transit models implemented in Lagos, a southwestern city-state in Nigeria is the Bus Rapid Transit (BRT).

Similarly, work commenced on a Light Rail Transit scheme in August 2010 [4]. However, irrespective of transit models implemented, one interesting feature of modern transit systems is the implementation of fare collection processes or systems alongside transit models. The features of such fare collection systems may vary from location to location even within same sovereign territories. There are typical transit scenarios where commuters may utilize singular payment platforms even when journeys require a transfer from one mode or means to another. Also, fares may be differentiated or be flat rates imposed across transit routes. In whatever ways this features may vary, fare collection systems are subject to the context in which they are used.

II. OVERVIEW OF EXISTING TAP-IN TAP-OUT SYSTEM

In implementing a fare collection system for the Lagos BRT lite scheme, BRT buses are fitted with a Tap-In, Tap-out device; this devices are stationed at the bus entrance and expected exit points of the buses. Commuters are expected to Tap-in (Confirm Entry) and Tap-out (Confirm Fare) after each journey. However, this goes against the specified best practices of the BRT Standard, which expects an off-board fare system [5]. The oversight of placing the Tap-out devices may be related to the instability of public power supply and also the ruggedness of the housing and enclosure of Tap-in Tap-out devices which must be protected. Tap-in and Tap-out devices rely on the power supply delivered by the buses.

In suggesting an alternative to an already existing fare payment system, particular attention has been paid to the context of the BRT and the suitability of any suggested arrangement to multiple modes of transit. Also this design will address the following problems experienced with a Tap-in, Tap-out system:

- a. Make fares payment seamless even when transfers (commuter transfer from one bus to another are frequent) occur. Transfers are hard to account for with the current system. Hence, passengers are charged fares for a roundtrip (where flat rates are