Electronic Toll Collection System in Bangladesh: Challenges and Prospects*

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ABSTRACT

Electronic Toll Collection (ETC) system using radio frequency identification (RFID) is a digital technology that allows vehicles to pass through the toll plaza without stopping for toll payment. The most notable advantage of this technology is that it eliminates congestion near the toll booths. Toll operators could also be benefitted from the implementation of ETC. In this study, problems and prospects of introducing ETC in Bangladesh have been assessed with the help of the Questionnaire Survey and Key Informant Interview. A total of nine samples were surveyed. It was revealed from the study that there are both problems and prospects of introducing ETC in Bangladesh. Seventy percent of respondents know about the launching of ETC in Bangladesh. The respondents stalwartly perceive that ETC would help ease traffic jams created by long queues in the manual payment of toll. There are many challenges in introducing ETC in Bangladesh. As this is a new technology, it would take time to overcome the difficulties. Efforts from all corners can move the ETC forward and make excellent use of the modern and digital technology in the payment of toll in line with the viewpoint of Digital Bangladesh.

Keywords: Electronic toll collection (ETC), radio frequency identification (RFID), toll plaza, questionnaire survey, key informant interview

INTRODUCTION

Electronic Toll Collection (ETC) system is a digital technology that allows vehicles to pass through the toll plaza without stopping for toll payment. The most noteworthy advantage of this technology is that it reduces traffic congestion near toll plazas. Toll operators would also be benefitted from the launching of ETC. The benefits of ETC involve fuel savings, time savings in collecting toll, increased highway capacity, shortened waiting time in toll queue, and reduced environmental degradation by reducing vehicle emissions. The electronic toll collection system is getting popular precipitously for travelers to pass through toll gates on national and regional highways. The fact that drivers do not need to bring any money is one of the core motivations

why the electronic toll method has become so accepted worldwide. In developed countries, gone are those days when people used to gather toll fees sitting in booths. The automated toll collection system is a fast and proficient means for the collection of toll charges at the toll plazas. This digital system saves plenty of time as the vehicles leaving through the toll plaza do not need to halt to give a toll, and the payment automatically takes place from the account of the car. ETC system uses Short Message Service (SMS) instead of receipts. It is capable of determining if the vehicle is registered or not, and then informing the authorities of toll payment violations, debits, and participating accounts (Lauren and Mariko, 2007).

The Government of Bangladesh has declared 'Digital Bangladesh' with vision 2021, which emphasizes on optimum use of technology for ensuring the general improvement of the daily lifestyle of all classes of people. This slogan also includes the provision of government services to the people of Bangladesh through the effective and innovative application of technology in various sectors. It is encouraging that the Bangladesh government has taken up all-out efforts for the development of all sectors and seeks to accomplish middle-income status by its 50th birthday. The country needs rigorous growth with mentionable progress in technologies. The government has taken up colossal development works in light of the 'Vision 2021' and 'Vision 2041.' Recently the Government of Bangladesh has commended Bangladesh Delta Plan 2100 (Planning Commission, 2018), which is a long-term plan. Besides, several digitization processes are initiated to provide e-services to all government agencies. Keeping this in mind, the Road Transport and Highways Division of the Ministry of Road Transport and Bridges recently introduced RFID (radio frequency identification) based Electronic Toll Collection (ETC) system at the toll plaza of the Meghna and Gumti bridges on Dhaka-Chattagram highway. The primary purpose of the system is to enhance the convenience of the travelers by enabling cashless payment. It would reduce the traffic congestion at highway toll gates. Indubitably this is a robust system that contributes significantly to the increase in travel safety without requiring vehicles to stop. This study explores the challenges and prospects of implementation of RFID based Electronic Toll Collection (ETC) systems in Bangladesh.

STATEMENT OF THE PROBLEM

The electronic toll collection system (ETC) has various benefits compared to the traditional manual toll collection system. The manual toll collection system requires the collector to receive the toll at a booth stopping each vehicle, which in turn causes, halt in time, severe traffic clogging, more fuel loss, and a long queue of traffic. All these drawbacks are eliminated in an electronic toll collection system. Thus the main problem lies in the manual toll collection system, which can be addressed by introducing the modern automated toll collection system in Bangladesh.

OBJECTIVES

The main objectives of the project are:
i)   To explore the probable benefits of RFID based Electronic Toll Collection.

ii) To find out the challenges in the implementation of ETC in Bangladesh, particularly at the initial stage.

KEY RESEARCH QUESTIONS

What are the significant techno-socio-economic benefits of the RFID based ETC in Bangladesh?

Does RFID based ETC face challenges at the initial stage of implementation?

THE RATIONALE OF THE STUDY

The electronic toll collection system has an enormous effect on the toll collection business worldwide. Automated tolling techniques would not have been possible without this digital technology. However, Bangladesh is way behind the developed nations in implementing this technology in the toll management system. It is only recently that such technology has been launched in Bangladesh in the Meghna-Gumti toll plaza. Until now, a few studies have discussed the prospects of this technology; nevertheless, there are significant benefits of such technology. The ability to price transportation by the time of day, especially in urban areas, offers many opportunities to improve travel behavior. Assuming that the total time taken by one vehicle to stop and pay toll in manual toll collection system is 60 seconds and around 27000 vehicles pass the toll plaza in a day (Verbal communication, 2019). The time taken by one vehicle with 60 second average stop in a month is equal to 30 x 60 seconds or 1800 seconds. The total time taken in a year equals to 12 x 1800 seconds or 6.0 hours. On an average, each vehicle passing through the toll plaza has to wait 6.0 hours in engine start condition in a year. If, on average, 27000 vehicles pass through the toll plaza each day, then 9855000 vehicles cross through the toll plaza in a year (Verbal communication, 2019). Every year 9855000 vehicles stand still for 6.0 hours in engine start condition, thereby aiding pollution and wasting fuel and money. The study would assist in planning, implementation, and management of ETC in Bangladesh. This study would help achieve the Sustainable Development Goal (SDG) No. 11, which is on Sustainable Cities and Communities.

OVERVIEW OF ELECTRONIC TOLL COLLECTION SYSTEM

The primary electronic toll collection systems presently in use worldwide are automatic number plate recognition (ANPR), dedicated short-range communications technologies (DSRC), radio frequency identification (RFID), global navigation satellite systems (GNSS); tachograph-based tolling and mobile communication (GSM and smartphone) tolling systems.

Automatic Number Plate Recognition (ANPR) is a technology that makes use of optical character identification on images to recognize automobile registration plates to create vehicle location data. ANPR technologies implemented have usually shown high cost-effectiveness (Prud' Homme and Bocarejo, 2005), with yearly net revenues being similar or higher than initial investment costs.

Dedicated short-range communications technologies (DSRC) is one of the most common approaches to implementing ETC. Its applications have been extended to pricing schemes in urban areas and nationwide truck tolling systems (Nowacki et al., 2011). DSRC is often complemented by sensors and cameras for enforcement purposes. DSRC can be used either in toll booths (Pickford and Blythe, 2006) or in multi-lane free-flow schemes (Lee et al., 2008).

Radio Frequency Identification (RFID), the most used toll collection system in the United States and China, relying on radio waves to identify onboard devices. The performance and characteristics of RFID approaches are, at least in practice, very similar to those of DSRC technology (can be less accurate than DSRC), since both are microwave-based approaches (Feng et al., 2010).

Global Navigation Satellite Systems (GNSS) encompasses the vehicle's location data is used to evaluate the usage of the highway to estimate the charge. GNSS-based enforcement is comparable to the DSRC-based method.

Tachograph-based tolling, recording the distance run by the punter through an OBU attached electronically to the automobile's odometer. Evasion rates are below 1%, according to Balmer (2006), but it has less precision than other systems (Engdahl, 2013).

LITERATURE REVIEW

Electronic Toll Collection System is an intelligent transportation system that refers to the effective integrated application of advanced information technology, data communication technology, electronic sensing technology, electronic control, and computer processing technology to the entire transportation management system (Yan et al., 2006). Rahman et al. (2016) studied the RFID based Smart Toll Collection System as a solution to solve the traffic problems and to maintain transparency of the toll collection system. They also carried out an economic analysis of the automatic toll collection system and compared it with the manual ticketing base system. Deek et al. (1997) studied the advances in traffic operations at the electronic toll collection plazas of the Orlando-Orange County Expressway Authority. They found that for the dedicated E-PASS lane, the measured capacity has tripled, the service time has decreased by five seconds per vehicle, the average queuing delay has reduced by one minute per vehicle, the maximum queuing delay has decreased by 2.5-3 minutes per vehicle, and the total queuing backlog has decreased by 8.5-9.5 vehicle-hours per morning peak hour for that lane. 407 Express toll route (ETR) is used in Canada as an ETC system. The close barrier at each end of the stretch is installed in this system (Predko, 1999). Optical cameras are used to record the license plate of the vehicle, which is called Optical Character Recognition (OCR). Taking images and identifying the license plates of the vehicle without transponders are functions of OCR. At the top of the solid infrastructure, laser beams are located to detect the vehicle type. As the system is not cost-effective, the expense of the built infrastructure is recovered from the motorists by enhancing toll fare. Kamarulazizi and Ismail (2010) studied the various types of RFID-based ETC systems. They found that the system significantly improves the efficiency of toll stations and the traffic abilities of the toll road in Malaysia. Satyasrikanth et al. (2016) studied an automatic toll collection system using RFID. They concluded that this system of collecting tolls is ecofriendly and also results in increased toll lane capacity. They also introduced an anti-theft solution system module that prevents the passing of any defaulter

vehicle, thus assuring security on the roadways. Singh et al. (2019) studied the benefits of ETC and found that the electronic toll collection system eliminates manual cash handling, reduces traffic congestion, and helps in lesser fuel utilization. There are other studies carried out to assess the benefits of ETC compared to the manual toll collection system (Andurkar and Ramteke, 2015; Levinson and Chang, 2003; Sharma and Sharma, 2014). While glancing through the literature as mentioned above, it is to be noted that no research specifically covered the area of study under this research. Hence, this issue gets the novelty to be a research agenda.

CONCEPTUAL FRAMEWORK OF RFID BASED ETC

Radio Frequency Identification (RFID) relies on radio waves to recognize onboard gadgets. The performance and characteristics of RFID methods are very similar to those of DSRC technology (can be less accurate than DSRC) since both are microwave-based approaches (Feng et al., 2010). In this system, RFID tag which stores a unique serial number associated with a user's account, consisting of microchip and antenna is mounted on the windshield of the vehicle. Each tag communicates through radio frequency waves and contains electronically stored information, i.e., a unique vehicle identification number, vehicle registration no., vehicle classification, number of the axle of the vehicle, and allowable weight.

METHODOLOGY

The study is based on both primary and secondary data. The secondary data is collected from literature and relevant reports. The data on traffic volume, congestion, accidents would be collected from the appropriate agencies. The waiting time and its impact on traffic congestion has been assessed. The primary data also collected through Rapid Rural Appraisal (RRA) techniques such as Key Informant Interview and Questionnaire Survey (Creswell, 1998).

The questionnaire survey is a very well-known and widely-used research technique for quickly and efficiently gathering and analyzing data from a population under study. Questionnaire surveys have been used in transport planning, rural development, and many others (Richard and Encinas-Escribano, 2017). The survey technique is steered by rules of statistics from the instant of producing a sample, or a class of persons to characterize a population, up to the time of the study results' examination and explanation. The survey technique is ascertained to be an efficient technique to amass essential information for the progression of science and technology from straightforward polls regarding dogmatic conviction, to views regarding new merchandise against another. The questionnaire survey was carried out in the Meghna -Gumti toll plaza on May 20, 2019. A total of nine samples were surveyed. Besides open survey questions, the survey questionnaire also comprised of three closed questions. One question to the respondents was what ETC is. The other one was whether they know about the launching of ETC in Bangladesh. The third closed question was about the necessity of introducing ETC in Bangladesh. Photos 1 shows the Fast Track (ETC Lane) in the Meghna-Gumti bridge toll plaza.

Photo 1: The Fast Track (ETC Lane) in the Meghna-Gumti Bridge Toll Plaza

In addition to the questionnaire survey, key informant interview was also applied to gather pertinent data on the potential and challenges of ETC in Bangladesh. The Key Informant Interviews engage interviewing individuals who have particularly cognizant outlooks on an aspect of the agenda being appraised. Key informant interviews are qualitative in-depth interviews with relevant stakeholders. Key Informant Interviews resemble a conversation among acquaintances allowing free flows of ideas and information. The purpose of key informant interviews for the current study was to amass data from a wide range of people who have first-hand knowledge about the ETC. Interviewers frame questions continuously, probe for information and take notes, which are expounded on later (USAID, 1996). The questionnaire survey is a well-known and widely used research technique for quickly and efficiently gathering and analyzing data from a population under study (Hewitt et al., 2017).

In total, five Questionnaire Surveys and four Key Informants Interviews were conducted at the toll plaza of the Meghna and Gumti bridges. The key informant interviews were undertaken with the professional at the Ministry of Road Transport and Bridges of the Government of Bangladesh, who are primarily involved in the planning and decision making of the introduction of ETC in Bangladesh. Nine interviews were carried out in the survey. The collected data was analyzed to explore the benefits and challenges of ETC in Bangladesh.

ASSESSMENT OF THE CHALLENGES AND PROSPECTS OF ELECTRONIC TOLL COLLECTION SYSTEM IN BANGLADESH

Assessment of the Awareness about ETC in Bangladesh

Four questions were asked in the questionnaire survey in relation to the awareness of ETC and its usefulness in regarding traffic congestion. It was found that the overwhelming majority of the interviewee is already familiar with ETC (Figure 1). They are also aware of the recent launching of the RFID based ETC in the Meghna-Gumti toll plaza (Figure 2). It appears that the

mainstream media played a pivotal role in disseminating the commencing of ETC in Bangladesh for the first time. They strongly feel that it is utterly essential to introduce ETC in Bangladesh under the backdrop of burgeoning traffic congestion in the busy highways, partly due to prolonged pausing in the manual system of paying the toll (Figure 3). The respondents strongly perceive that ETC would help ease traffic jams (Figure 4). Even though the study employed a limited amount of primary data regarding the assessment of challenges and prospects of the ETC in Bangladesh, nevertheless, the credibility of the study cannot be challenged because of the robust findings; the results are consistent with the findings of other studies (Singh et al. 2019; Kamarulazizi and Ismail, 2010; Satyasrikanth et al., 2016).
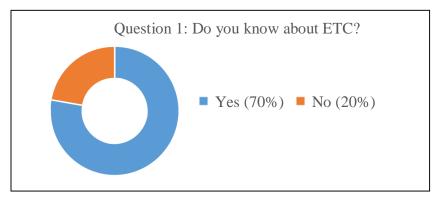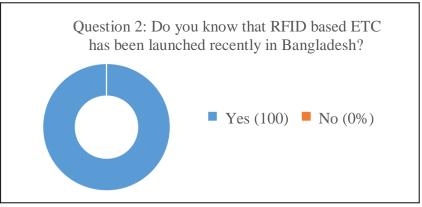

Figure 1: Survey Results of Question No. 1
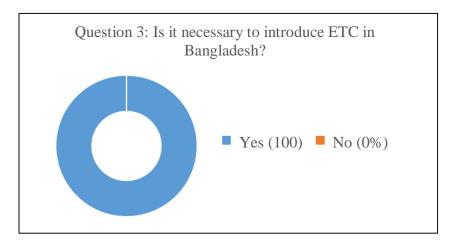

Figure 2: Survey Results of Question No. 2

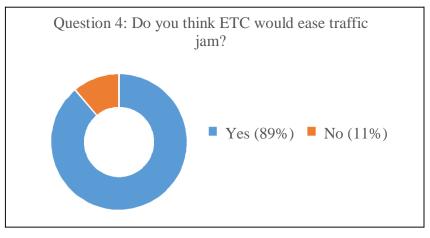**Figure 3:** Survey Results of Question No.3

Figure 4: Survey Results of Question No. 4

Major Challenges of Introducing ETC in Bangladesh

As the electronic toll collection is a new technology for Bangladesh, it needs an integrated system of communication, monitoring, and modern high-end technology to support the regular operation of the system. And this calls for a concerted effort from all stakeholders to make the system effective and sustainable in the long run. Other than this broad spectrum of challenges, some other problems have emerged through the key informant interviews. As some of the vehicle owners are not aware of the ETC, they are yet to apply for registration to be able to use the ETC lane for automatic toll payment. Some of the drivers even cross the ETC lane without knowing about it. Also, some vehicles who possess ETC registration don't use ETC lane due to a lack of understanding. Some of the vehicles enter the ETC lane do not have sufficient money in their account for automatic payment. In this case, they have to go back and use the manual toll gate. Naturally, this creates traffic congestion in the toll plaza. Even some of the vehicles registered for ETC did not activate the RFID tag and cannot use the ETC lane. Some of the interviewees think that registering for ETC would incur a considerable cost, and this is why they

keep themselves away from ETC. Indeed, this is due to a lack of awareness and misunderstanding about the value of ETC registration. Some of the interviewees attributed the inadequate use of ETC lane to the unwillingness of the toll operator and non-cooperation from the BRTA officials. It is natural that at the initial stage, some of the problems could happen as some of the drivers and the vehicle owners are not aware of the benefits of the ETC. A driver of a private vehicle owner opines that "I am a driver of a private vehicle. When I would ask my boss to install it, he may deny to do it."

Major Prospects of ETC in the Context of Bangladesh

There are huge benefits of introducing ETC in Bangladesh. The key informant interview has identified a host of benefits of ETC. They think that ETC would ease the traffic flow under the backdrop of the opening of the second Meghna-Gumti bridge. Traffic jams would be reduced to a great extent as there would be no need for manual cash transactions in paying the toll. Some of the interviewees think that the introduction of ETC would save a lot of time as well as human resources as fewer people would be required in the toll booth. They agree that the ETC is a hassle-free toll collection system as they can cross the toll gate without any stops. As the toll settlement rate is tremendously improved due to the automatic toll collection system, the drivers do not need to stop their vehicles at the toll gate resulting in the reduced jams of the vehicles in the toll booths to a great extent. This automation also reduces the average pausing time of the vehicles in the queue. They would like to see that the transparency and accountability of the toll operators are ensured as it is an automated system. Most of the people highlighted the time saving as the significant benefits of ETC, followed by the reduced traffic jam. The data suggest that about 70% are bus/truck drivers they would accept if they are given the opportunity as they can comprehend the benefits of using ETC.

The advantages and benefits of the Electronic Collection system, as identified through the questionnaire survey, are as follows: The system saves a lot of travel time as the electronic toll users do not need to pause their vehicles for giving toll charges in the toll booth. The system reduces the harmful carbon emission to a great extent due to the removal of the acceleration and idling. Hence the electronic toll system dramatically helps in air pollution reduction, especially at the toll plaza area. The ETC-enabled toll plaza is capable of containing the increasing number of traffic without additional toll lanes. It is found that the ETC has reduced the number of accidents caused near the toll premises due to a significant decline in jamming of vehicles near the toll booths. The customers do not have to think about looking for cash for the toll in the electronic toll collection set up. As the users open an account with the ETC server, it provides them the freedom of disbursing their toll fee with cash deposited in their accounts. Braking, speeding up, and stopping is eradicated in the electronic toll collection system. This aids in saving fuel, and thus ETC plays a crucial role in lowering the operating cost of the vehicles to a large extent. There is no direct cash transaction involved in the electronic toll collection system. As no money transaction takes place in the electronic toll collection system, the intricacies with cash carrying are removed, which helps in improved audit control by consolidating the consumer accounts. The ETC enabled system makes an enhanced data collection. The different data, such as vehicle types and count, time, date, etc. can be stored and analyzed for better traffic management because of the implementation of this electronic toll collection system.

Major Problems Encountered in Paying Toll with the Existing System

There are many problems associated with the manual toll collection system. The interviewee informant interviews have identified some of the problems they face while paying the toll. The majority of the key informant uttered that significant time is required for cash change in the manual toll collection system. Sometimes there is no cash change available, and this creates an unwanted brawling situation between the toll collector and the driver. Some of the influential people want to avoid the toll. Some of the vehicles owned by some specific government departments are exempted from paying the toll. However, some of the vehicles owned by other government departments also take advantage of toll exemption. Sometimes the cash register does not work correctly, which hampers toll collection. This trouble causes a delay in receiving the payment. This is one of the primary reasons for the severe traffic jam in the toll booth. A long queue of vehicles consumes a considerable time in the toll plaza.

Appropriate Measures for Making ETC Effective

One of the questions to the key informants was to express their views about the appropriate measures that can be taken to make ETC effective. They think that massive publicity is required to enhance the awareness of the benefits of ETC. They also believe that there is a need to inspire the vehicle owners to use this high-end technology for automated toll payment. This would require the vehicle to apply for registration and collect RFID tag so that they can use the ETC lane. The Ministry of Road Transport and Bridges has a pivotal role to play in this regard. The ministry is trying its best to publicize the ETC technology in the mainstream media to augment the awareness building. Some people say that they knew about the ETC through media reports. The passengers opined that they no longer need to wait at the toll plaza due to the introduction of ETC, as reported in online newspaper bdnews24.com, dated May 31, 2019. This indicates the role of media in awareness building about the ETC technology. Unless the ministry keeps on publicizing the ETC, it can lose the momentum already gained about the benefits of ETC. Some of the models of advertising may be through the distribution of leaflets among the relevant stakeholders of the transportation sectors about ETC. The major stakeholders in the transportation sector are bus transport companies, vehicle owners, drivers, bus transport owner's association, transport sectors labor organization, vehicle owners, etc. It is also needed to periodically inspect the effectiveness of the RFID tag. This can be informed to the drivers and owners by sending a short text message in their cell phone, mentioning the date and place getting an updated RFID tag. They also opined that ETC should be launched in all the toll bridges and roads. Once completed, it will increase the number of ETC registration. Indeed, efforts from all corners can move the ETC forward and make the modern and digital technology in the payment of toll in line with the viewpoint of Digital Bangladesh.

CONCLUSIONS

Electronic Toll Collection (ETC) system is a digital technology that allows vehicles to pass through the toll plaza without stopping for toll payment. One of the most remarkable benefits of this technology is that it reduces traffic jams at and around the toll plazas. Toll operators would

also be benefitted from the operation of ETC. In this study, problems and prospects of introducing ETC in Bangladesh have been assessed with the help of the Questionnaire Survey and Key Informant Interview. A total of nine samples were surveyed. It was revealed from the study that there are both problems and prospects of introducing ETC in Bangladesh. The respondents strongly feel that it is utterly essential to introduce ETC in Bangladesh. They stalwartly perceive that ETC would help ease traffic jams created by long queue in the manual payment of toll.

ACKNOWLEDGMENT

REFERENCES

Andurkar, GK & Ramteke, VR 2015, 'Smart highway Electronic Toll Collection system', *International Journal of Innovative Research in Computer and Communication Engineering*, Vol. 3, no. 5.

Balmer, U 2006, *Kilometer Fee for Heavy Goods Vehicles The Swiss Experience Driver for Introduction: Transit Traffic*, Budapest, Hungary.

Creswell, JW 1998, *Qualitative Inquiry and Research Design*, New Delhi, India.

Dhurat, G, Magal, P, Chheda, M & Ingle, D 2014, 'Gateless Electronic Toll Collection using RFID', *IOSR Journal of Computer Engineering,* vol. 16, no. 2, pp. 73-80.

Deek, HMA, Mohamed, AA & Radwan, AE 1997, *Operational Benefits of Electronic Toll Collection*, vol. 123, no. 6, Available at: https://doi.org/10.1061/(ASCE)0733-947X(1997)123:6(467).

Engdahl, J 2013, *Implementation of the EETS in Switzerland*, Basel, Switzerland.

Felix, A & Neuenschwander, R, 2002, *WP 3: Case Studies Task 3.2: Case Study Switzerland*, Basel, Switzerland.

Feng, Z, Zhu, Y, Xue, P & Li, M 2010, 'Design and realization of expressway vehicle path recognition and ETC system based on RFID', *3rd International Conference on Computer Science and Information Technology*, Chengdu, pp. 86-90, doi: 10.1109/ICCSIT.2010.5563803.

Hewitt, RJ & Encinas-Escribano, MA 2017, 'Developments in Environmental Modelling', in: Participatory Modelling for Resilient Futures. Elsevier, pp. ii. Available at: https://doi.org/10.1016/B978-0-444-63982-0.21002-1.

Kamarulazizi, K & Ismail, W 2010, 'Electronic Toll Collection System Using Passive RFID Technology', *Journal of Theoretical and Applied Information Technology*, JATIT & LLS,

vol. 22, no. 2. Available at: http://www.jatit.org/volumes/research-papers/Vol22No2/1Vol22No2.pdf

Lauren, S & Mariko, B 2007, *ElectronicToll Collection*. Available at: http://www.atm.com.

Levinson, D & Chang, E 2003, *A Model for Optimizing Electronic Toll Collection Systems*, Department of Civil Engineering, University of Minnesota, Transportation Research Part A 37, 293-314.

Lee, WH, Tseng, SS & Wang, CH 2008, 'Design and implementation of electronic toll collection system based on vehicle positioning system techniques' *Computer Communications*, Elsevier BV, Vol. 31 No. 12, pp. 2925–2933, doi:10.1016/j.comcom.2008.05.014.

Nowacki, G, Mitraszewska, I & Kami, T 2011, 'The National Automatic Toll Collection System for The Republic of Poland', *Transport and Telecomunicaction* vol. 9, no. 2, pp. 24–38.

Planning Commission 2018, *Bangladesh Delta Plan 2100*, Planning Commission, Ministry of Planning, Government of the People's Republic of Bangladesh.

Predko, M 1999, *Programming and Customizing the 8051 Microcontroller*, Tata McGraw-Hill, pp: 157-167.

Prud'homme, R, Bocarejo, JP 2005, 'The London congestion charge: a tentative economic appraisal', *Transport Policy*, Elsevier BV, Vol. 12 No. 3, pp. 279–287, doi:10.1016/j.tranpol.2005.03.001.

Rahman, KJ, Hasan, MM, Ahmed, M & Zaman, R 2016, 'Electronic Toll Collection System Using RFID Technology', BSc theses, BRAC University, Dhaka. Available at: http://hdl.handle.net/10361/7730

Satyasrikanth, P, Penna, M & Bolla, DR 2016 'Automatic Toll Collection System Using RFID', *International Journal of Computer Science and Mobile Computing*, Vol. 5, no. 8, pp. 247 – 253.

Sharma, P & Sharma, V 2014 'Electronic toll collection technologies: A state of art review', *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. 4, no. 7, pp. 621-625.

Singh, VP, Vijaya, PA & Ravikumar 2019 *International Journal of Engineering and Advanced Technology (IJEAT)*, vol. 8, no. 5S3.

USAID Center for Development Information and Evaluation 1996, *Conducting Key Informant Interviews Performance Monitoring and Evaluation Tips*, Washington DC, USAID.

Yan, X, Wu, C & Yang, Z 2006 *Intelligent transportation systems - principle, method and application*, Wuhan University of technology press, 2006:3-4.