**PUBLIC TRANSPORTATION OPTINIZATION**

**Phase 1**

**Abstract— Internet of Things (IoT) is a platform that the device used to be smart,**

**everydayis processed to be smarter, and every day communication becomes more**

**informative. IoT is still growing and continues to be researched by some researchers.**

**Various models, platforms and applications are proposed and designed in such a way as**

**to benefit society. This paper was developed using the systematic literature review (SLR)**

**method by conducting surveys on issues oriented towards the utilization of IoT related to**

**the development of intelligent public transport. The architecture presented proposes**

**solving real-life problems by building and disseminating powerful ideas. The purpose of**

**this study is to explore opportunities and challenges for the application of IoT on public**

**transport. The results of this study show that IoT utilization till now tends to give priority**

**to safety in avoiding road accidents but has not yet discussed how intelligent**

**transportation system can be developed by integrating bus scheduling, bus presence**

**detection, and payment efficiency by passengers by booking seat system so that minimize**

**congestion and reduce wasted time passengers. This research proposes breakthroughs**

**incorporating the concept of the Internet with the integration of platforms of industrial**

**actors involved in order to harness the power of IoT for various conveniences especially**

**in the field of public transport and produce intelligence transportation system which is**

**one of the smart city concept indicators.**

**Keywords: Internet of Thing, intelligence transportation system, smart transportation,**

**public transportation, smart city, integration of Platform.**

**1. Introduction**

**The progress of information technology in IoT development is very influential on the various**

**aspects of human activities. The paradigm of the IoT provides a reference to connect all physical**

**objects in the global Internet base as well as the existing infrastructure for information and**

**communication exchange. IoT aims to support rapid and precise identification such as location**

**tracking, monitoring and management. Therefore, IoT is based on multiple integration of**

**communications solutions, technology identification and tracking, sensor networks and actuators, and**

**sharing of other information distribution [1].**

**According to Chen [2], IoT Architecture network consists of several layers such as layers of**

**sensing, access layer, network layer, middleware layer and application layer. The application layer**

**integrates the functions of the lower system, and builds practical applications from various industries,**

**such as smart grid, smart logistics, intelligent transportation, precision farming, disaster monitoringand remote medical care.**

**IoT's main function is to collect data to be measured by a sensor where it is integrated into a short-**

**range wireless network such as Bluetooth, ZigBee or Wi-Fi, and then transmit data to a larger network**

**such as an internet network gateway [3]. IOT sensors use low cost, highly scalable, efficient, low-**

**power, and integrated data across all sub-networks. The more sensors combined and with the increase**

**of data collection time, the data will become larger and known as the "Big Data". Big Data was**

**introduced by Gartner Report in 2001 [4] and has three dimensions covering 3Vs: Volume, Velocity,**

**and Variety. This definition has been rewritten and reasserted by others to include the fourth V:**

**Veracity [5]. In short, IoT provides a means of data collection, detection and monitoring of an event,**

**an algorithm for acting on an activity, storage of data and a considerable analysis.**

**From several papers, the authors observed and found that most researchers tend to use and utilize**

**IoT on passenger safety, so they focus more on features that help control drivers in driving the bus,**

**monitoring bus lines and utilizing radio signals and LAN networks and other applications to**

**maximizing IoT functionality on transport. The goal is to minimize the occurrence of accidents. But**

**what about passenger comfort in choosing public transportation? Inspired from the public transport**

**navigation system [6][7][8], The purpose of this research is to know the opportunities that can be used**

**to maximize IoT function on public transportation. if previous researchers have made a monitoring**

**system for bus travel, bus scheduling as well as early detector of the accident then this research tries to**

**explore opportunities that can be obtained and used to produce a better public transportation system.**

**Based on this, the research question is what the IoT function can be usedfor smart public**

**transportation?**

**2. Related Work**

**According to the autoidlab quoted from Xian, Internet RFID (Radio Frequency Identification) to**

**achieve intelligent recognition and network management. it was first proposed by the Auto-ID lab at**

**MIT (Massachusetts Institute of Technology) in 1999. Their ultimate support technology is wireless**

**sensor networks using radio frequency identification technology [2]. According to Mazhar, intelligent**

**transportation is one component that is an important part of a smart city. other opinions say, good**

**vehicle traffic information is one of the most important sources for smart cities [9].**

**According to Panchal [10] designing a wireless network using IEEE ZigBee technology more**

**responds to emergencies and informs the right individuals in a timely and cost-effective manner.**

**Greater transport efficiency and most importantly increased safety in driving [11]. According to**

**Tibor [12] that successfully simulate the research, the results of his study is to reduce congestion**

**and generate a rapid response to the information of an accident that occurred. The beaconing**

**frequency of a 1 Hz roadside unit was enough because the infrastructure managed to inform all**

**information related to the vehicle that had an accident on entering the intersection [12]. Krishna**

**using the Accelerometer as a car alarm application so that it can detect drivers who drive badly and**

**harm. As well as a vehicle rollover detector [7].**

**According to Brian [13] The public transport system plays an important role in dealing with**

**traffic congestion, reducing carbon emissions, and also helps promote a compact and sustainable**

**urban community. The rapid growth of technology and infrastructure today has made our lives**

**easier [8]. According to Stefan [6] Public bus services are widely used in cities around the world**

**because of their economical and economical prices, affordable to all levels of society, especially the**

**middle to lower class. However, from the point of view of city bus passengers, such systems can be**

**complicated and difficult to navigate. one of the studies produced the Urban Bus Navigator (UBN),**

**a navigation system for bus passengers with the ability to recognize and track physical transport**

**infrastructure such as buses. One of the key technologies of IoT is RFID (Radio Frequency**

**Identification) technology that started in the early 40s, widely used in fighter and other aircraft.**

**After several decades, RFID can be used for production management, safety, transportation,**

**logistics management, and other fields [14]. RFID on transport is used as one of the passenger**

**detection devices in the bus. IoT can connect with billions of smart devices with embedded systems.**

**As a result, the IOC will greatly increase its size and scope, providing new ways of opportunity, as**

**well as challenges. [15].**

**Based on some literature this research find idea to integrate some application in one platform. Incorporating several technologies that support the use of IoT already used in the modern public**

**transport concept.**

**3. Proposed Work**

**This paper uses the methodology systematic literature review [16] to review existing literature**

**related to IoT for public transportation, security in public transportation, and time efficiency. This**

**study conducts a thorough literature review of studies on IOT utilization on public transport. This is**

**the process of determining the source of the research used, which determines the keyword pattern**

**for the paper search process, initiates inclusion and exclusion criteria, data mining, and analysis of**

**findings for answer research questions.**

**A. Search Process**

**The first process is to determine the literature source to find the appropriate articles / journals.**

**Sources selected for systematic literature review are as follows:**

**1. IEEEXplore Digital Library (http: /ieeexplore.ieee.org)**

**2. Direct Science (www.sciencedirect.com)**

**3. Springer Link (link.springer.com)**

**4. Emerald Insight (www.emeraldinsight.com)**

**5. Google Scholars (https://scholar.google.co.id)**

**6. Wiley Online Library (onlinelibrary.wiley.com)**

**7. ACM Digital Library (dl.acm.org)**

**8. Elsevier (https://www.elsevier.com/)**

**The search mechanism inclusion criteria consists of three filter processes. The first is the search**

**process. All documents we find from source publications related to the specified keywords will be**

**saved as Founded Studies. After that, the next step we filter the paper according to title and abstract. If**

**the title and abstract are free and suitable for determining research questions, then this paper will be**

**stored as a ―Candidate Study‖. Then the final section to filter these writings is that all candidate**

**documents will be read thoroughly to answer research questions. If the letters are appropriate to**

**answer the research question, the paper will be defined as ―Selected Studies‖.**

**The applied keyword pattern for finding research papers relating to this research was made using**

**the Boolean operator to filter the data, so it can be specified priority to search data based on the**

**symbol used. Boolean symbols and operators used in this paper, such as OR, AND. Combination of**

**keywords are as follows:**

** (Internet of thing OR IoT) AND (public Transportation OR intelligence transportation system)**

**AND (smart transportation OR public transportation)**

** (internet of thing OR (IoT) OR (public AND transportation) OR (smart AND transport)) AND**

**(IoT OR RFID)**

** (public AND transport) OR (RFID AND key IoT)) AND (intelligent OR transportation)**

** (internet of thing OR smart transportation) AND (smart cities OR transportation)**

** (IoT AND transportation) OR (smart transportation OR Sensor RFID)**

**The inclusion criteria of the search mechanism in this study consisted of three filter processes.**

**The first is the process of "Founded Studies". All papers that we find from the publication sources**

**related to the specified keywords will be stored in Founded Studies. The next step we filter the paper**

**according to title and abstract. If the title and abstract have a correlation and are suitable for**

**determining research questions, then this paper will be stored as a "Candidate Study". Then the last**

**part is filtering out these writings and will be read thoroughly to answer research questions. If the**

**paper tends to be defined as "Selected Studies".**

**While to clarify the validity of the literature, the search exclusion criteria are defined in several**

**procedures, namely:**

**a. This paper is based on the date of their publication between 2010-2018**

**b. The complete paper structure, which means all identities (journal / conference, author's**

**identity, etc.) are mentioned on paper.**

**c. Duplicate paper from the same study will not be included and removed from the**

**SLRData Extractions**

**The research literature uses 105 papers from all sources and criteria. Of the 105 papersexamined, there are 53 papers that study candidates based on titles and abstracts related to**

**research questions. After further study, there are only 32 papers that can be used because it has a**

**very strong correlation with this research.**

**Table 1.**

**Number papers in selected sources**

**Source Founded Studies Candidates Studies Selected Studies**

**IEEE**

**Science Direct**

**Springer**

**Emerald**

**Google Schoolar**

**ACM**

**Wiley**

**Elsevier**

**Total**

**d. Result and Discussion**

**This study aims to investigate the extent of IoT utilization on public transport and what kind of**

**model is appropriate for countries with relatively high levels of congestion such as in Jakarta. The**

**tendency towards high congestion that was also identified to have impacted the accident-induced**

**mortality rate resulted in some findings of the model differences on the use of IoT public transport.**

**Based on this, this research will be identified as a new model on IoT transport by adding new**

**features. C.1 Demographic and trend characteristics**

**C.1.1 Publishing outlets**

**As shown in Table 2, this shows the title, type, and sorting in the year of publication.**

**Table 2.**

**Source of Publication**

**Title Tahun Type**

**OneBusAway…[13] 2010 J**

**Micro-Navigation …[6] 2014 C**

**An IoT Based …[7] 2015 C**

**IOT based Smart …[17] 2016 C**

**IoT Based Vehicle …[8] 2017 J**

**Research on …[14] 2012 J**

**An Internet-of-Things (IoT) …[3] 2016 J**

**Experiences Creating a …[18] 2016 C**

**A Proactive Complex …[19] 2013 J**

**An IoT enabled …[20] 2013 J**

**Efficient Graph …[9] 2015 J**

**Internet Of Things …[21] 2015 J**

**Intelligent Transportation …[22] 2015 J**

**Developing a Nova …[23] 2014 J**

**Internet Of Things …[24] 2013 J**

**Collaborative real-time …[25] 2010 J**

**Implementing the …[26] 2014 C**

**Application of Internet …[27] 2017 J**

**Internet of Things Based …[28] 2018 J**

**A DNS Architecture …[29] 2013 J**

**Reducing driver‘s …[30] 2016 J**

**A survey on Internet …[31] 2016 J**

**Use of IoT Technology …[32] 2016 J**

**A prototype IOT …[33] 2017 J**

**Computer Modelling …[12] 2017 J**

**A Survey On Iot …[31] 2015 J**

**Phase 2**

**Title Tahun Type**

**Demand for Agent-Based …[34] 2016 J**

**Management …[35] 2016 J**

**Transportation Model …[36] 2013 J**

**Energy Efficient …[10] 2017 J**

**The Internet of Things …[37] 2010 J**

**Ravel: Programming IoT …[38] 2015 J**

**Total: 32 papers**

**C.1.2. Most prolific authors**

**As seen from the writer‘s analysis perspective, there are 94 authors who have written 32**

**papers in total. There is no consistent author in writing about the use of IoT on public transport.**

**All theseauthors wrote 1 paper each, as shown in Table 3. The data in table 3 provides**

**information that there are still many opportunities that can be used to maximize the IoT function**

**of public transport.**

**Table 3.**

**Most prolific authors**

**Authors # % Authors # %**

**Anand Paul 1 0,01 Dhananjay Singh 1 0,01**

**A. Anusiya 1 0,01 DijanaCapeskaBogatinoska 1 0,01**

**A. Rakotonirainy 1 0,01 DimosthenisKyriazis 1 0,01**

**AbderraffiaaKoukam 1 0,01 Dr.Thyagaraju G S 1 0,01**

**Aishwarya S.R 1 0,01 Dr.J.R.Panchal 1 0,01**

**Alan Borning 1 0,01 Dr.K.Venugopal Rao 1 0,01**

**AlekseiSebastiani 1 0,01 Dr.R.N.Panchal 1 0,01**

**AnantDattatrayawasare 1 0,01 E Krishna Priya 1 0,01**

**Andreas Menychtas 1 0,01 E. Hajrizi 1 0,01**

**AnithaChepuru 1 0,01 Felix Wortmann 1 0,01**

**Ansar-Ul-HaqueYasar 1 0,01 E Krishna Priya 1 0,01**

**Antonio Iera 1 0,01 E. Hajrizi 1 0,01**

**Antonio Marcos Alberti 1 0,01 Felix Wortmann 1 0,01**

**Arnav Thakur 1 0,01 George Kousiouris 1 0,01**

**Ashish Rai 1 0,01 GerdKortuem 1 0,01**

**Awais Ahmad 1 0,01 Giacomo Morabito 1 0,01**

**Bill Karakostas 1 0,01 Gwanggil Jeon 1 0,01**

**Brian Ferris 1 0,01 HMT Gadiyar 1 0,01**

**Charitha 1 0,01 J.Sherly 1 0,01**

**Cheng-Ming Chang 1 0,01 James Hong 1 0,01**

**D. Gruyer 1 0,01 John J. Lee 1 0,01**

**D.Somasundareswari 1 0,01 Jonghoon Kim 1 0,01**

**Dan D. Koo 1 0,01 K. Banupriya 1 0,01**

**Kari Watkins 1 0,01 S Umamaheswari 1 0,01**

**Karl Ernst Ambrosch 1 0,01 Samar El-Amine 1 0,01**

**Kristina Flüchter 1 0,01 Savitha S.C 1 0,01**

**LaurynasRiliskis 1 0,01 Sheng-Wen Hong 1 0,01**

**Li Kexin 1 0,01 Shian-Shyong Tseng 1 0,01**

**Linbing Wang 1 0,01 Stefan Foell 1 0,01**

**Luigi Atzori 1 0,01 StéphaneGalland 1 0,01**

**M. Deebika 1 0,01 T. M. Anand 1 0,01**

**M. Mazhar Rathore 1 0,01 Theodora Varvarigou 1 0,01**

**Marcus Handte 1 0,01 Tibor Petrova 1 0,01**

**Marty Humphrey 1 0,01 U B Sujit 1 0,01**

**Mayra Samaniego 1 0,01 Umer Iqbal 1 0,01**

**Milan Dadoa 1 0,01 V Mythra 1 0,01**

**Mingquan Wang 1 0,01 Vishal Chandrasekaran 1 0,01**

**MuriloFrônioBassora 1 0,01 Wei Zhang 1 0,01**

**NiederauerMastelari 1 0,01 Wei-Hsun Lee 1 0,01**

**O. Orfila 1 0,01 Wern-Yarng Shieh 1 0,01**

**P Manju 1 0,01 William Tärneberg 1 0,01**

**P.P. Ray 1 0,01 X. Krasniqi 1 0,01**

**Pedro Marrón 1 0,01 Xian-Yi Chen 1 0,01**

**Philip Levis 1 0,01 Yinning Zhang 1 0,01**

**Prasanth M.A 1 0,01 Yongheng Wang 1 0,01**

**RalphDeters 1 0,01 Yucheng Huang 1 0,01**

**Raul Mariano Cardoso 1 0,01 Yue Hou 1 0,01**

**Reza Malekian 1 0,01 Zhi-Gang Jin 1 0,01Table 4 informs the University of the authors. Table 5 informs the year of paper**

**publishing. Based on the data it is known that in the year 2016 is the year where the researchers**

**are focusing on IOT transportation. Although such a decline in interest in the next year but this is**

**likely due to the occurrence of different interests. Where in 2017 their focus is to use IOT for**

**other fields one of them is the health field.**

**C.1.4. Publication trends**

**Although not too significant but based on table 5 it is known that the interest of**

**researchers to increasingly cultivate IOT especially for transportation is increasing. We can**

**conclude that the convenience and safety in using transportation is of more concern than the**

**researchers in addition to the safety of passengers and drivers. Frequency of papers published**

**between 2010-2018 can be seen in Table 5. At most years the earnings are 2015 (six papers) and**

**2016 (eight papers). In 2017 IoT utilization is more to the Vehicle Tracking and Accident**

**Detection System [17], Seating Status Monitor System[27], traffic information monitoring [39],**

**intelligence transportation system[12], shifting in 2018, where IoT began to be utilized as Internet**

**Based Solution for Road Safety and Traffic Management in Intelligent Transportation Systems**

**The main purpose of this paper is to maximize IoT functionality with an integrated platform. We**

**have applied the SLR methodology to identify the IoT functionality that has been used on public**

**transport in 32 selected papers from 105 papers found. The focus of research and analysis lies in**

**the issue of technology used. five important components of technology in IoT utilization have**

**been tried and will be further developed by integrating on a platform using smartphone**

**applications.**

**Table 9.IoT function can be used in smart public transportation**

**component technology on the IOT**

**smartphone application[40]**

**RFID[41][17][14][42]**

**GPS[14]**

**Bus Navigation[6]**

**Wireless Sensor[39]**

**With IoT functionality that can be used in intelligent public transportation as shown in table 9,**

**better public transport systems such as passenger information systems are waiting at the bus stop**

**and on the bus (passenger count system) with a usable payment method with several bank**

**options. According to findings on publicity trends, this research can also be developed into an**

**intelligent public information system of information. Smartphone apps can be used. RFID can be**

**used to scan passenger id codes when boarding a bus. GPS and wireless sensors can be used as**

**Bus Navigation.**

**4. Conclusion**

**Based on the analysis of some literatures used, the authors know that most of the researchers**

**focus more on IoT utilization as a medium in monitoring the moving objects. Especially for**

**transportation, IoT utilization using wifi or sensors that will monitor and provide a signal as useful**

**information as a precaution before the occurrence of a condition that will result in an accident.**

**While some authors also explain that IoT can be used. This is more functional for drivers and road**

**managers for both personal and public transport drivers. Need other features that can be used by**

**passengers and drivers to monitor each other conditions during the trip. Such as scheduling process**

**of arrival, departure, availability of bench, and prediction of traffic jam in the streets. Based on this,**

**this study recognizes that there are still many opportunities for developing smart and smart**

**transportation systems to maximize IoT functionality by integrating existing platforms.**

**According to the SLR Program here, there are some functions of IOT that can be used on smart**

**public transport. Based on 32 papers, the SLR found that there is still an unused IOT function that is**

**online payment function. Public transportation has become a necessity of society so it is expected**

**better improvement. increased knowledge in the field of IoT is also the reason why this research**

**should continue to be developed further. This study aims not only to assist academics and**

**researchers in the study of IOTs on public transport but also to assist government and industry.**

**Increased knowledge in the field of IoT is also the reason why this research continues to be**

**developed further. In the modern era, a large number of heterogeneous objects has been connected**

**to the internet, referred to as Internet of things (IoT). In 2008, the CISCO report showed that the**

**number of devices connected to the internet is more than the number of people living on earth.**

**While in 2020, it will touch the 50 billion limit, which resulted in a remarkable increase in the**

**digital world [CISCO, ―The Internet of Things, Infographic‖, May 24, 2015].IOT on public**

**transport but also to assist government and industry. This is because intelligent and intelligent**

**public transport procurement requires the cooperation and comprehensive support of all sections,**

**governments, industries and communities involved. In another aspect, IoT pays an important role**

**and improves the quality of human life in health care, automation, and transportation, emergency**

**response to man-made, and natural disasters where it is difficult for humans to make decisions.**

**Moreover, most countries have implemented national strategies for the use of IoT at the service**

**level. For example, Japanese broadband provides facilities accessing communication between**

**people, people and objects, objects and objects [Srivastava, Lara.―Japan‘s ubiquitous mobile**

**information society‖. info, vol. 6, no. 4, pp. 234-251, 2004.]. Similarly, South Korean smart homes**

**allow their citizens to access long-distance goods [Giroux, Sylvain, and Hélène Pigot. From Smart**

**Homes to Smart Care: ICOST 2005, 3rd International Conference on Smart Homes and Health**

**Telematics. Vol. 15. IOS Press, 2005].This is because the procurement of smart and intelligent**

**public transportation requires the cooperation and comprehensive support of all involved sections,**

**government, industry and society.**

**5. Limitation and Future Research**

**The limitation of this research is the absence of an integrated system in the platform. All**

**researchers designed and recommended public transportation monitoring and monitoring systems.**

**The priorities and focus of their research are limited to the security of public transport use. What**

**about passenger needs? The future of this research will be developed by adding other features, such**

**as bench locking system by first registering or paying online so that while on the bus, passengers**

**need to scan the received code when making payment using RFID technology. The model to be**

**developed is platform integration by utilizing IoT technology that can be used by passengers to**

**search for public transportation schedule, choose the route to be used, choose bus and choose bench**

**or place that is still available until payment process before boarding. bus. Passengers will be**

**comfortable and save waiting time. By using the prediction feature of bus arrival then passengers**

**can also wait according to bus arrival time. Efficient and very effective. Next research will be**

**combining IoT technology, RFID, bus presence detection, bus scheduling monitoring and booking**

**seat with online payment. The model will be developed will combine the interests of industry in the**

**government environment such as cooperation with all banks recognized by the government and the**

**ministry of transportation and smart city managers.**

**International Journal of Pure and Applied Mathematics Special Issue.**

**Phase 3**

**Abstract— With the ever growing global population,**

**crowding in public transport is becoming an increasing**

**menace. Public transport systems around the world have**

**remained largely the same over the past several decades**

**although the population they serve has burgeoned. This pa-**

**per aims to demonstrate a low cost IoT based solution to the**

**crowding problem by using smart seats that can detect and**

**display the seat occupancy status in real time over an inter-**

**net or mobile application. The feasibility of the project was**

**assessed and simulated using the NETSIM simulation soft-**

**ware. The results of the software simulation showed promise**

**and hence a hardware prototype was built using the IEEE**

**802.15.4 standard on the Arduino - Raspberry Pi – nRF plat-**

**form. The prototype results are positive and show a fully**

**functional IoT system that can be implemented in buses and**

**trains.**

**Keywords— IoT; Crowd management; Raspberry Pi;**

**IEEE 802.15.4; Public Transport.**

**I. INTRODUCTION**

**The population explosion around the world over the**

**past century has seen a tremendous increase in the de-**

**mand for public transport services. This demand is rarely**

**adequately met since the public transport services in coun-**

**tries like India and China have failed to catch up to the**

**growing rates in population. In addition to this, newer**

**technologies have scarcely been implemented to manage**

**crowds in public transport. Beijing and Singapore have**

**seen cases where individuals are crushed to death due to**

**overcrowding in the subway systems. This begs the need**

**to implement technological solutions to ease the problem**

**and perhaps save lives. The concept of IoT first emerged**

**when Kevin Ashton originally used the term IoT in 1999**

**under the context of supply chain management and it later**

**evolved to include applications like healthcare, utilities,**

**and bio-sensing [1]. Today with the development of**

**RFID, IPv6 and cloud computing, IoT is becoming ubiq-**

**uitous [2]. The various application scenarios include smart**

**cities, environments, security, retail, logistics, agriculture**

**and homes [3,4]. Urban IoT applications for smarter and**

**more efficient cities focus on smart homes, public**

**transport, street lighting systems and energy systems [5-**

**8]. In the domain of public transportation, IoT has been**

**explored only to cover the following aspects:**

**1. Navigation and Route Planning**

**2. Real-time Tracking**

**3. Accident Prevention and Safety**

**4. Information Alerts**

**Keeping in mind the increase in crowding seen in pub-**

**lic transport and the lack of IoT based solutions for this**

**problem, this paper presents an IoT crowd management**

**system. It uses an individual sensor per seat to display the**

**seat occupancy over a mobile application. The seat occu-**

**pancy status being displayed in real time would allow**

**passengers to know before hand the crowding situation in**

**an arriving bus/train. This would inform them to look for**

**an alternate route or mode of transport in advance to reach**

**their destination on time. The accuracy of the system also**

**allows for passengers to form evenly distributed queues toto implement technological solutions to ease the problem**

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**pancy status being displayed in real time would allow**

**passengers to know before hand the crowding situation in**

**an arriving bus/train. This would inform them to look for**

**an alternate route or mode of transport in advance to reach**

**their destination on time. The accuracy of the system also**

**allows for passengers to form evenly distributed queues todistribute the crowd across multiple train coaches.**

**This system also offers the added benefit of data analytics.**

**Large amounts of data regarding seat occupancy can be**

**gathered by the transportation corporations to study and**

**analyze travel patterns to better organize, distribute and**

**plan public transport routes. This would avoid having**

**empty buses/trains during off peak hours and overcrowd-**

**ed buses/trains during peak hours. This system is only**

**applicable to transport systems where pre-booking of**

**seats is not done for example metro trains, local buses and**

**general compartments of non-local railway trains. Crowd-**

**ing is a nuisance in these systems and not in systems**

**where pro-booking of individual seats is done.**

**The validity of the system was assessed using the**

**NETSIM simulation software. Section 3 discusses the**

**throughput, delay and feasibility. Section 4 demonstrates**

**the prototype that was built and tested using the Raspber-**

**ryPi – Arduino – nRF platform..**

**II. LITERATURE SURVEY**

**The use of IoT for public transport has largely been**

**limited to routing, navigation, safety and tracking [9-11].**

**On the other hand, wireless sensor networks to determine**

**seat occupancy have been used in auditoriums, cinema**

**halls and concerts [12]. These systems use large multi-hop**

**networks with a hybrid topology to determine seat occu-**

**pancy for large systems. However, the use of such sys-**

**tems in public transport is nascent and not fully explored.**

**There have been different approaches to estimate crowd-**

**ing in public transport [13,14]. Primarily, these systems.**

**Phase 4**

**The Velostat’s resistance changes as pressure is applied when someone sits on the seat. This change in**

**resistance is converted to a voltage change using a voltage divider circuit. The voltage change is**

**measured and converted to a digital signal by the ADC on the Arduino Nano microcontroller. The Nano is**

**also used to threshold the pressure applied to differentiate between a person and a bag/suitcase. The**

**Nano then transmits the data at 2.4GHz over the nRF24l01 module. The library used is the RF24 library**

**that allocates addresses to a particular channel over which the transmission occurs.**

**The Raspberry Pi receives the incoming packets through the nRF24l01 module. All nRF interfaces are SPIs**

**(Serial Peripheral Interfaces). The RPi then calls the URL for the FreeBoard cloud services that hosts a**

**web link to display the received seat status. This status can be accessed over**

**The software simulation results were quite promising with an Average Throughput of 89 bps and an**

**Average Delay of 0.516 seconds. The hardware prototype also gave promising results with a final**

**resulting real time delay of 4.58 seconds with an internet connection speed of 1 Mbps. The delay was**

**between pressing the sensor and the occupancy changing on the website. This is well within expected**

**limits and can be improved by increasing internet connection or using better cloud systems that offer**

**paid services. The plots for two test cases of the piezo resistive sensor output is given in Fig. 5. The**

**webpage hosted can be seen in Fig. 4(b). This particular experimental setup is scalable to 42 sensors**

**since each Arduino Nano can support 7 sensors and the nRF24l01 can simultaneously transmit and**

**receive across 6 channels. To go further beyond in capacity, addressing schemes need to be introduced**

**for channel allocation.**

**Fig. 5(b) Small weight followed by a human**

**VI. CONCLUSION**

**Given the increasing need for crowd management systems in today’s public transport and the paucity of**

**IoT implementation in the same, this project has demonstrated a robust, cheap and scalable system to**

**mange crowds in public transport. The software simulation was carried out to check feasibility of such a**

**system to work in a real time environment. The project design was built and tested for various loads and**

**seating profiles to better estimate the threshold. The prototype was built and tested in real time seating**

**environments. The final results show promise for implementation in the real world. Further work can be**

**done to account for standing passengers, implementing addressing schemes to increase scalability and**

**introduce web development to improve the webpage interface. [1] R. Journal, “That ‘Internet of Things’ Thing – 2009-06-22 – Page 1 – RFID Journal”,**

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**Misic, V. B. Misic, and S. Shafi, “Performance of IEEE802.15.4 beacon enabled PAN with uplinkRESULTS AND DISCUSSION**

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**CONCLUSION**

**Given the increasing need for crowd management systems in today’s public transport and the paucity of**

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**and seating profiles to better estimate the threshold. The prototype was built and tested in real time**

**seating environments. The final results show promise for implementation in the real world. Furtherwork can be done to account for standing passengers, implementing addressing schemes to increase**

**scalability and introduce web development to improve the webpage interface.**

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**support in completing this paper.**

**Phase 5**

**Abstract—Internet of Things (IoT) is a platform that the**

**device used to be smart, every day is processed to be smarter,**

**and every day communication becomes more informative. IoT**

**is still growing and continues to be researched by some**

**researchers. Various models, platforms and applications are**

**proposed and designed in such a way as to benefit society. This**

**paper was developed by conducting surveys on issues oriented**

**towards the utilization of IoT related to the development of**

**intelligent public transport. The architecture presented proposes**

**solving real-life problems by building and disseminating**

**powerful ideas. The purpose of this study is to explore**

**opportunities and challenges for the application of IoT on**

**public transport. In this paper, we focus on to an IoT system that**

**is used to build intelligent transportation bus system (IBTS).**

**IoT based intelligent transportation systems are designed to**

**support the Smart City vision, which aims at employing the**

**advanced and powerful communication technologies for the**

**administration of the city and the citizens.**

**Keywords—Internet-of-Things (IOT), WSN, Transportation**

**system, Public transportation, Smart city, Intelligent Bus**

**Transportation System (IBTS).**

**I. INTRODUCTION**

**In the past two decades, the proliferation of modern**

**technology has made a huge impact in the lifestyle of the people.**

**Emerging technologies have developed features that are tightly**

**aligned with people’s interests like: being compact, easier to use,**

**feature-rich, connected to the internet, being fast and smart. The**

**availability of affordable sensors, together with the proliferation**

**of internet infrastructure enables an interesting technology**

**called the Internet of Things (IoT). IoT had resulted from context**

**aware computing [1], that aims to allow people and things to be**

**connected anytime, anywhere with anything/anyone. In other**

**words, devices and application have the ability to communicate**

**each other without/less human influence. There is also**

**significant interest and attention towards IoT from the industry**

**[14]. This interest has triggered the development of myriad of**

**sensors for different applications like location sensing, weather**

**forecasting, biomedical applications, and many more. Many**

**companies has come out with their custom board targeting IoT**

**applications [14], [11]. ITS is plays one of the major role in**

**contributing towards smart city development. In most**

**developing countries like India, public transportation system**

**(bus) are the main source of travel for many commuters living**

**in urban as well as rural. Our project theme is to develop a**

**prototype for ITS, which will be useful to track a vehicle through**

**GPS [18], payment of tickets, crowd analysis inside the bus**

**through NFC [19] and finally, the ambience inside the bus can**

**be measured with temperature and humidity sensor [13]. Within**

**our IoT infrastructure, the data collected from our sensors is sent**

**through the internet and processed by the monitoring system to**

**make useful decision and send it to the display system (as per**

**our application requirements). We have grouped the entire**

**architecture into has three systems namely; the sensor system,**

**monitoring system and the display system. The sensor system**

**utilizes GPS, NFC, temperature and humidity sensors, which are**

**always connected with the internet via a GSM network [17] to**

**track the location, commuter and ambience inside the bus. The**

**monitoring system is not only intended to extract the raw data**

**from the sensors database and convert it in to a meaningful**

**context but, it also used to trigger some events with in the bus as**

**well as provide information to the bus driver. The display system**

**is used to show the context data to all the commuters in the bus**

**stop regarding bus and travel information**

**II. LITERATURE SURVEY**

**Intelligent Public transport, especially the bus**

**transport system is one area which requires the smart sensing**

**and communication technology to enable commuters to enjoy**

**the benefits of hassle free transport. Though most of the bus**

**services provide a pre-planned time table for travelers, the**

**information is only limited. The information requires constant**

**updates based on the current traffic scenario. Also, accurate**

**arrival time and updated information on the crowd onboard will**

**be beneficial for travelers. In countries like India, where**

**majority of travelers depend on public transport for**

**communication, there is an urgent need to address the problem**

**of intelligent transport system. By combining information**

**technology, advanced communication techniques and smart**

**sensing system, it is possible to address the growing demand of**

**connectivity. IoT presents a unique framework to achieve the**

**required degree of connectivity.**

**Authors in [2] present a survey of over 100 papers**

**which highlight the application of IoT in various domains such**

**as health, sports, transportation and agriculture. Based on the**

**survey on the transportation domain, the authors have identified**

**usage of GPS and RFID tags as primary the mechanism of**

**location tracking. Also, GSM/ GPRS have been used for**

**communication of information to users in the form of SMS.**

**Cloud computing and IoT are the terminologies used**

**for intelligent systems. Authors in [3] have provided a clear**

**differentiation between Cloud and IoT based on parameters**

**such as reachability, computational capabilities, role of internet**

**etc. Also, the authors have presented the advantages of**

**integration of cloud computing and IoT, termed as Cloud-IoT. NMEA sentence, we can find few parameters like latitude,**

**longitude, speed, time stamp, etc.**

**The system utilizes GSM module from Arduino which has a**

**M10 by Quectel radio modem and uses AT commands to**

**communicate with another device. The GSM module can help**

**to make/receive voice calls, send/receive SMS messages and**

**175 allows to connect with the Internet through GPRS wireless**

**network. A SIM card is very essential for the GSM module to**

**operate.**

**Microcontrollers play a vital role in our application. We used**

**Arduino UNO and MEGA with Atmel’s microcontrollers**

**ATmega328 and Atmega2560 in it. A software program written**

**in C programming language is compiled, then stored in the flash**

**memory of the microcontrollers.**

**C. Commuter subsystem:**

**The commuter subsystem predominantly uses NFC**

**technology. The system consists of 3 modules such as NFC**

**reader and Mifare tag, GSM and Microcontroller. NFC is a set**

**of short-range (typically up to 10cm) wireless communication**

**technologies designed to offer light-weight and secure**

**communication between two devices.**

**Before starting a journey in the smart bus, the commuter**

**need to apply for his a Mifare card, which is a unique card for**

**each commuter. During the application process, all the personal**

**information (Name, address, Id proof, photo, email, phone etc.)**

**of the commuter are acquired and then a unique id is issued to**

**the commuter. Now, the commuter needs to credit his/her travel**

**card with some money. This can be done online through payment**

**gateways. At the start of the journey, the commuter taps the**

**Mifare card in the NFC reader and enters the details through the**

**serial console of Arduino. Once the details are furnished, it is**

**acquired by the NFC reader and sent to the database through the**

**GSM module. Then the details of the commuter along with the**

**sum of amount (credited or debited) is stored in the database.**

**The confirmation of NFC payment and tickets can be generated**

**through a thermal printer or through an SMS to the commuter’s**

**phone.**

**D. Ambient subsystem:**

**In our work we are also interested to analyze the ambience**

**inside the bus. This is because, in countries like India and China**

**which has large population with varying climatic conditions on**

**various parts of its geographical locations. So, when many**

**people get in a bus, the climatic temperature outside the bus and**

**inside the bus varies to a substantial extent. By placing**

**temperature and humidity sensors, after a certain threshold it can**

**automatically switch the air conditioner on through relay circuit**

**or it can indicate the driver to switch on A/C because of intense**

**temperature in the bus.**

**E. Alcohol detection subsystem:**

**Here, Alcohol sensor is used to detect the driver’s behavior**

**whether driver has consumed alcohol or not. If driver is drunk**

**and drives, then status report is given to depot manager and**

**manager can make alternate arrangement and can stop the bus at**

**next junction. This can be a good approach to avoid accidents**

**and can save more lives also.**

**Working:**

**Initially, a circuit is designed by integrating the sensors with**

**the microcontroller. After integration, a program is written and**

**burned in the flash of the microcontroller. Once we compile and**

**execute, we can get the raw value from sensors (location,**

**commuter, ambience) in the terminal. For example, we get**

**different data form GPS such as latitude, longitude, speed etc.,**

**from NFC, we get the source, destination, cost related values.**

**Furthermore, from temperature and humidity sensor we get**

**temperature and humidity. All this raw information shown in**

**Figure 2, are transferred to the server through the GSM. The**

**GSM modem begins with searching for 2G/3G network. Once**

**the GSM senses the network, it then connects to the GPRS.**

**Once the internet is connected, the data such as LP (Location**

**Parameters), CP (Commuter Parameters) and AP (Ambience**

**Parameters) are transferred to the database through http protocol.**

**The process of storing happens between, HTTP client and HTTP**

**server. Below is the HTTP client request, on which, it first**

**identifies the server with IP address or domain name through**

**DNS. Apart from the server, we need to mention the port number**

**by which it need to connect with the server.**

**As the server is connected, it looks for the file.php, were the**

**PHP file redirects to a database, where the sensor information is**

**stored. For example, if we want to store the GPS parameters like**

**latitude and longitude, the values are passed to the server and the**

**data are store in the Location DB. Similarly, all the sensor**

**information is respectively stored in the server databases.**