

**Proceedings of
International Conference
on Innovations in Info-business and
Technology 2017**

**Business innovation through
Big Data analytics**

ICIIT 2017

30th November 2017

OZO, Colombo

Sri Lanka.

Organizing Committee of the ICIIT-2017

Informatics Institute of Technology

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INTERNATIONAL CONFERENCE ON INNOVATIONS IN INFO-BUSINESS AND TECHNOLOGY 2017 ICIIT 2017

The International Conference on Innovations in Info-business and Technology-2017 (ICIIT-2017), organized by the IEEE Student Branch of Informatics Institute of Technology (IIT) will be held on 30th November 2017 at OZO Colombo from 8.00am to 5.00pm.

The conference is technically sponsored by the E-learning and Technical Communication ACM Professional Chapter-Japanese Section. The theme for the conference is ‘Business innovation through Big Data analytics’.

The event will feature Professor Ian Witten from the University of Waikato, New Zealand, as the keynote speaker. Professor Ian is a Professor of Computer Science and will share his experience and knowledge on Data mining, Machine Learning and the Weka tool

As part of the conference, a panel discussion will be held on “Business innovation through Big Data analytics”.

There will also be over 25 presenters from local and international universities, who will share their views and experiences, during the conference.

This will be an invaluable opportunity for researchers, academics, professionals and interested parties, to gain an insight into emerging trends in the fields of IT and business, network with colleagues, communicate with industry leaders, stimulate their innovative selves and expand their vision while having a relaxing and memorable time.

MESSAGE FROM THE FOUNDER AND CHAIRMAN: INFORMATICS GROUP OF COMPANIES, SRI LANKA



The Informatics Group which is a pioneer in the ICT sector consists of Hardware and System Integration, Software, Education and Agriculture arms. The Informatics Institute of Technology (IIT), which is the education arm of the Group, has been credited to be Sri Lanka's first private higher education institute, which awards world renowned British degrees in the field of ICT and Business.

Today, Information Communication Technology has evolved rapidly with new technological innovations being introduced every day. I am proud to say that we have kept up with the new trends in technology and as a country, we have made great progress in the ICT sector. We started Informatics 31 years ago with the vision to empower the ICT sector. Back then people in Sri Lanka were cynical of ICT. However, they soon realized the value of ICT. In order to strengthen the workforce in the ICT sector in Sri Lanka, we need an ICT literate workforce and we strived to achieve that objective. With this in mind, we established IIT in 1990. As of now, IIT has produced over 3000 graduates and has awarded nearly 600 scholarships.

We have been able to shape and empower the progress of many industries in Sri Lanka through technology. The next goal for Sri Lanka's ICT industry is to become an international hub and all companies working in the ICT industry should work towards achieving that goal.

We are once again hosting the International Conference on Innovations in Infobusiness and Technology (ICIIT-2017) for the 2nd consecutive year to promote research and knowledge sharing to facilitate the ICT industry with current trends in data analytics. We are showcasing 26 research papers today. Congratulations to all the authors who will be presenting their work. We also warmly welcome Professor Ian Witten, who accepted our invitation as key note speaker. I wish the conference organizers' and participants a fruitful session.

Dr. Gamini Wickramasinghe

Founder and Chairman Informatics Group

MESSAGE FROM THE DEAN: INFORMATICS INSTITUTE OF TECHNOLOGY, SRI LANKA

Welcome to the 2nd International Conference on Innovations in Infobusiness and Technology (ICIIT-2017) organized by Informatics Institute of Technology (IIT). IIT has produced several high caliber IT and Business graduates who are playing a pivotal role in empowering many industries and organizations across the globe.

ICIIT 2017 has proved its maturity with over 25 academic presentations from local and international universities in the fields of Computer Science and Business Management. It brings to the forefront the work carried out by researchers worldwide to present their findings and ongoing work to academia and industry. In pursuit of innovation and enhancement, it enables researchers around the world to showcase their novel perspectives on diverse issues related to big data analytics.

We are extremely thankful to our technical co-sponsor the E-learning and Technical Communication ACM Professional Chapter of the Japanese Section. We also acknowledge the support of our Sri Lankan industry sponsors in making this a reality.

This year's theme "Business Innovation through Big Data Analytics" paves the way for researchers to review the new trends in Big Data Analytics. The revolution of Big Data Analytics lies in improved statistical and computational methods. The increasing demand and its capabilities are spurring advances in new ways of linking datasets to generate new insights and creative approaches to visualizing data for creating knowledge.

Professor Ian Witten from University of Waikato, New Zealand who is a well-known researcher in Data mining, Machine Learning and the Weka tool is most fitting to be the key note speaker. We warmly welcome him. We also thank our panel members for their contribution to today's session as their experience and knowledge adds immense value to our conference. We are indeed grateful to the 50 local and international reviewers and the conference organizing committee, who tirelessly worked towards the success of the conference.

Wishing you all a very fruitful and rewarding conference.

Ms Naomi Krishnarajah

Dean Informatics Institute of Technology

MESSAGE FROM THE CHAIR: ACM CHAPTER ON E-LEARNING AND TECHNICAL COMMUNICATION, JAPAN



On behalf of the ICIT2017 organizing committee, I am honored and delighted to welcome you to the International Conference on Innovations in InfoBusiness and Technology at the Informatics Institute of Technology, Colombo, Sri Lanka. I believe we have chosen a venue that guarantees a successful technical conference nestled in the culture and scenery of incredible Sri Lanka.

The IEEE student branch of IIT is organizing this conference with technical sponsorship from the ACM chapter on e-learning and Technical Communication, Japan. This is a unique conference in a developing economy context that is broadly focused on both pure technological innovations and the business of technology. Much of the research discussions and presentations related to this conference are related to the use, design and testing of software and other interfaces for info-business applications.

The last decade has seen the industry evolving significantly with new challenges requiring new approaches in applying technology to achieve cost and operational efficiencies, sustainability and stakeholder expectations. This new trend calls for innovation and new initiatives across every aspect of how the industry engages locally and functions globally. Given the changes and commercial realities, a customized set of tools and technology, systems, models and capabilities can further ensure cost efficiencies. This conference will address the approaches, challenges, successes and the future direction for new growth opportunities in this dynamic environment.

The ICIT 2017 conference theme is Business Innovation through Big Data Analytics. 2016 was a landmark year for big data with more organizations storing, processing, and extracting value from data of all forms and sizes. In 2017, systems that support large volumes of both structured and unstructured data will continue to rise. The market will demand platforms that are expected to help data custodians govern and secure big data while empowering end users to analyze that data. These systems will mature to operate well inside of enterprise IT systems and standards.

ICIT2017 is an opportunity to explore and discuss business technology in a way that can help small businesses look bigger than they are and keep them ahead in a competitive marketplace.

Our technical program for ICIT2017 is rich and varied with keynote speeches and multiple live presentations on software and hardware technology, business technology and practices in a developing economy. We also expect to provide an intellectually diverse and open exchange of ideas and numerous opportunities for informal networking.

The local organizing committee members have worked endlessly with dedication and commitment in planning and organizing both the technical program and supporting social arrangements. In particular, we thank the program chairs for their wise advice and brilliant suggestions on organizing the technical program; the program committee for their thorough and timely reviewing of the papers, and our sponsors who have helped us to maintain reasonable costs of attending and hosting ICIT2017 for all participants.

All in all, this effort is a brilliant achievement for this leading technological university in Sri Lanka. This initiative by IIT will go a long way in establishing a magnificent trend that would widen the

spectrum of info-business research in Sri Lanka and further open up networking opportunities with Japanese Universities and research laboratories. Finally, this conference has laid the groundwork for more faculty-to-faculty cooperation and student exchange between The University of Aizu, Japan and IIT.

I would like to thank everyone attending this conference. Have a great time.

Prof. Debopriyo Roy

Chair - ACM Chapter on E-learning and Technical Communication, Japan

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KEYNOTE SPEAKER



Emeritus Professor Ian Witten
(University of Waikato – New Zealand)

Ian H. Witten is a computer scientist at the University of Waikato, New Zealand. He is a Chartered Engineer with the Institute of Electrical Engineers in London who graduated from the University of Cambridge with a BA and MA (First Class Honours) in mathematics in 1969 and a M.Sc. in mathematics and computer science from the University of Calgary, where he was a Commonwealth Scholar, in 1970. He received his Ph.D., Learning to Control in 1976 from the University of Essex, England (Electrical Engineering Science). Witten is a co-creator of the Sequitur algorithm and original creator of the WEKA software package for data mining.

Witten is a Fellow of the Royal Society of New Zealand and a recipient of the Hector Memorial Medal which was awarded to him in 2005.

KEYNOTE SPEECH: BIG DATA, DEEP LEARNING, AND WEKA

Ian Witten

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ABSTRACT

When is data “big”? We examine this question with reference to the popular Weka interactive data mining system. The widely used Explorer interface is limited by the fact that datasets must fit into main memory. However, Weka also has facilities that transcend this limitation and can learn from effectively unlimited datasets – which requires machine learning methods that operate incrementally, in one pass through the data. Weka includes incremental implementations of standard classifiers. Its Knowledge Flow and command line interfaces can be used on datasets of any size. Moa, Weka’s big sister, is expressly designed to work on unlimited data streams, and includes suitable data generators and evaluation methods. Distributed Weka allows Weka to operate on multiprocessor clusters based on either the Hadoop or Spark architectures. We also survey what has been called the “deep learning renaissance”: the application of high capacity networks to overwhelmingly large quantities of data, particularly in areas of image recognition, face recognition, and language processing. High-speed GPU implementations are critical to the success of these techniques. Weka supports deep learning with a classifier that applies Deeplearning4j, an open source program library that includes distributed parallel versions – and the ability to operate on a GPU. This Weka facility is unique in that you can train a deep learning network without writing code. The aim is to defy the Oxford English Dictionary’s definition of big data as “data of a very large size, typically to the extent that its manipulation and management present significant logistical challenges.”

PANEL DISCUSSION: “BUSINESS INNOVATION THROUGH BIG DATA ANALYTICS”

The panel discussion will revolve around how 4 key technocrats are creating new industries at the global level in areas ranging from data science, business intelligence, big data analysis, data mining, and give you the opportunity to find out directly from them how you could best set about following their lead. Panelists include:

Panelists	
<p>Dr. Ranjiva Munasinghe Head of Delivery for Gestetner KPO and CEO of Argyle X</p>	<p>Ranjiva is the Head of Delivery for Gestetner KPO and CEO of Argyle X. He oversees business operations & delivery for the two companies. Both companies are in the Data Science space, with Argyle X focusing on Business Intelligence & Finance, and Gestetner KPO specializing in Biostatistics. Previously Ranjiva was Vice President at Copal Amba (now Moody’s Analytics Knowledge Services) in the Quantitative Services division.</p> <p>His areas of expertise are Data Science and Quantitative Finance, covering a wide range of projects in areas such as portfolio optimization, interest rate modelling, cost-benefit analysis, Monte Carlo simulations, derivative pricing, data mining, credit scoring, segmentation and survival analysis.</p> <p>Ranjiva has lectured at the University of Warwick, UK; University of Colombo and Informatics Institute of Technology, Sri Lanka. He also has extensive experience in training teams throughout his career at Copal Amba, Argyle X and Gestetner KPO.</p> <p>Ranjiva obtained a PhD. in Mathematics and a BSc. in Maths & Physics from the University of Warwick, and a Masters in Mathematics from the University of Cambridge. In addition, he holds a Certificate in Quantitative Finance (CQF) professional qualification in Financial Engineering.</p>
<p>Mr. Sankha Muthu Poruthotage Co-Founder - Linear-Squared</p>	<p>Sankha, is the co-founder of Linear-Squared providing sophisticated analytics solutions in a cost-effective manner across multiple industries such as Telecommunication, Apparel, Finance and Insurance, IT and FMCG. He is also involved in developing unique, customized and innovative solutions in predictive modeling, forecasting, segmentation / clustering, and optimization and an expertise in applying a wide array of modeling and analytics techniques drawn from statistical, mathematical, machine learning paradigms. He has also worked in the capacity of a researcher- Predictive Modelling and advanced Analytics at the Plymouth Rock Assurance in Boston.</p>

	<p>Sankha, holds a Bachelors degree in Statistics from the University of Colombo and has followed his Masters in Actuarial Science. He has obtained his PhD in statistics from the University of Connecticut. His research interests are towards the areas of Sequential sampling techniques, Probabilistic convergences, Multivariate analysis, Data mining, Predictive models, Decision theory and Bayesian inference</p>
<p>Mr. Sriganesh Lokanathan Team Leader Big Data Research – LIRNEasia</p>	<p>Sriganesh Lokanathan is Team Leader – Big Data Research at LIRNEasia, a pro-poor, pro-market think tank based in Sri Lanka, but active across emerging Asia-Pacific. At LIRNEasia, Sriganesh co- established and leads a multi-disciplinary research practice on big data for development in Sri Lanka and Bangladesh. His works involve the conceptualization and implementation of big data analyses to support global development, understanding its implications on society, and mainstreaming its use for social good. The research involves combining big data (mobile network big data, electricity consumption data, satellite imagery, CCTV footage) with traditional statistics and data to develop insights for informing various developmental policy domains (official statistics, urban and transportation planning, health, etc.).</p> <p>At the invitation of the Government of Sri Lanka, he recently contributed to the Western Region Megapolis Plan, providing data driven insights in the planning process. He has published widely and is often invited to speak on the topic in international forums. He holds a Bachelor’s degree in Computer Science, from the Massachusetts Institute of Technology, and a Master’s degree in Public Policy from the Lee Kuan Yew School of Public Policy of the National University of Singapore.</p>
<p>Jiffry Zulfer Founder-CEO of PickMe</p>	<p>An entrepreneur counting 17 years of founding and successfully running several technology-based ventures, Jiffry Zulfer is currently Founder-CEO of PickMe, a ground breaking technological innovation that addresses an everyday problem i.e. taxi hailing. Zulfer has not only driven the substantial growth of the 2 year old start-up, but has also inspired many others to take up the challenging route of ‘technopreneurship’ in the local ICT space.</p> <p>Zulfer started off with a server solutions business, when he was just a 17-year old school boy. He then went on to develop a peer-to-peer trading platform, followed by a fully-fledged Internet Agency.</p> <p>Zulfer’s efforts in technopreneurship won him the FCCISL Young Entrepreneur of the Year Award in2004) and the ICTA Young IT Professional Award in 2006.</p>

	<p>He was CTO and part of the founding management of anything.lk (re-branded as wow.lk, following its acquisition by Dialog). Anything.lk was the first of its kind in the e-commerce space in Sri Lanka and is still the market leader of the daily deals business. Zulfer exited wow.lk in 2014, to give life to his new brainchild, PickMe.</p> <p>Following the global trends towards smart investment and shared economy and with his experience with PickMe, Zulfer believes car ownership will soon become a thing of the past. He says ride sharing is the smart alternative to car ownership, which also benefits both the overall economy as well as the environment. He believes Sri Lanka has come a long way and is ready to embrace the next wave of growth.</p>
Convener	
<p>Dr. Ruvan Weerasinghe Former director of the University of Colombo School of Computing</p>	<p>A former Director of the University of Colombo School of Computing. He also served as a Visiting Professor at the Management & Science University of Malaysia (MSU) in 2010-2011, visiting Faculty at the Umea University of Sweden in the Fall of 2013 and Dean of the Informatics Institute of Technology, Sri Lanka in 2015/2016. In 2001 he was an ERCIM Fellow at France’s INRIA Labs and in 2002, a Fulbright Senior Visiting Scholar at Carnegie--Mellon University’s Language Technology Institute in Pittsburgh, USA.</p> <p>More recently, he serves on national committees for upscaling the talent pool in data science through the National Human Resource Development Council (NHRDC), for setting up of a Biotechnology park through the Ministry of Science Technology and Research (MoSTR), for designing a National Export Strategy in Sri Lanka through the Export Development Board (EDB) and for developing a policy for promoting Knowledge Services through the National Science and Technology Commission (NASTEC).</p> <p>His research interests are in Computational Linguistics including Machine Translation, and particularly in techniques employing statistical methods and machine learning using large data sets. He leads a group of 6--8 researchers involved in Language Technology at the UCSC’s Language Technology Research Lab (LTRL) since 2004. His research interests expand naturally to Artificial Intelligence and more recently Bioinformatics.</p>

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INFORMATION TECHNOLOGY AND MANAGEMENT

Realizing the True Benefits of Public Complaint Management Via an IT-Enabled Conceptual Framework

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ABSTRACT 1-1

Adoption of open government initiatives and enhancement of citizen engagement is on the rise across the world. Public complaint management solutions are a key part of such initiatives. However, in Sri Lanka, there is general dissatisfaction amongst citizens due to issues in the current public complaint management process. Having identified these issues, this research details the approach for creating an effective IT solution which is backed by a comprehensive conceptual framework. In order to ensure greater citizen participation in public complaint management, the framework highlights attitudinal, social, technological, and knowledge and communication factors which must be taken into account. These factors were analyzed based on existing literature and validated via interviews with government officials and questionnaire distribution amongst citizens. As a result, this research provides the blueprint for both an IT solution and a conceptual framework which government institutions can utilize to successfully improve their public complaint management process.

Categories and Subject Descriptors

Applied computing ~ E-government

Keywords

Citizen engagement, Complaint management, e-Government, Conceptual framework

1. INTRODUCTION

In many countries, citizens are able to directly interact with government institutions, in line with open government initiatives. These initiatives are titled 'citizen engagement'. According to Open Government Guide, citizen engagement is crucial if open government initiatives are to be successful. Citizen engagement is important for governments as it ensures citizens enjoy their basic human rights via the creation of a just and fair society [1]. The ability for citizens to participate in government activities is also in line with the Universal Declaration of Human Rights. As a key component of engaging with citizens, many of these countries have implemented complaint management solutions which enable citizens to submit complaints

via hotlines, websites and mobile apps, on issues such as potholes, broken sidewalks, flooding, garbage dumps, illegal graffiti, faulty street lights, overgrown trees, etc.; with photo and video evidence and accurate GPS locations. After capturing the complaints in a centralized system, government officials are able to analyze these complaints and forward them to the relevant departments, while monitoring the complaint status in real-time.

Citizens are also provided access to this system, whereby they too can monitor complaints via a website/mobile app. In addition to monitoring complaints, citizens can also submit votes and comments for each complaint. Therefore, both government institutions and citizens work together in resolving complaints in a transparent manner. As a result of this transparency, the perceptions of trust and accountability of these institutions is high amongst citizens [2]. In addition, due to the ability to have issues resolved faster, and the subsequent creation of a better image of the government, the occurrence of conflicts with the institutions is also reduced [3].

2. RESEARCH PROBLEM

This research centers on the question of whether citizens have an effective public complaint management solution for submitting complaints to government institutions and monitoring these complaints; in a manner which suits their requirements. As such, the objectives of the research are - understanding the influence of citizen engagement concepts on public complaint management, identifying the factors affecting citizen participation in public complaint management, and to provide recommendations based on the findings.

In Sri Lanka, only a limited number of issues submitted via existing methods were resolved successfully [4]. In addition, the problems highlighted below have led to citizens being dissatisfied with the government's responsiveness to resolving their issues, while there is also a 'disconnect' between the government and citizens due to low levels of transparency and accountability [5]. Thus it is practical for a country like Sri Lanka to implement a comprehensive public complaint management solution, considering it is also a participant in the Open Government Partnership [6].

2.1 Hassle in reporting

It is evident that the current methods of submitting complaints have several issues including unnecessary wastage of time - making a call to government officials is time consuming and costly for citizens while public meetings are also time-consuming. Citizens are also inconvenienced as calls are unanswered and letters are misplaced by officials.

2.2 One-directional reporting

This results in citizens experiencing issues such as difficulty in tracking the status of a complaint in real time. Thus citizens are unclear if the issue has been attended to or not, unless they contact government institutions. This lack of feedback has caused low levels of transparency on government operations [7]. There is also inability to easily provide feedback on the solution provided for the complaint as the only 'feedback' is to submit a new complaint for the same issue.

2.3 Lack of an organized complaint management process

Government institutions face issues such as inability to readily track history of issues in different geographical locations due to the lack of centralized record storage. Duplication of work is also an issue as many citizens could submit a complaint on the same issue however these would be treated separately by different officials due to manual filing systems [8]. Inability to easily track status is also an issue for government institutions. It would take at least a few hours for the relevant reports to be prepared in order to identify the status of complaints [9].

2.4 Lack of evidence for government institutions

Government institutions face issues such as insufficient/poor grade evidence (photos, videos, etc.) to support a complaint at the time of submission and this impacts the validity of these complaints [7]. Delays also occur as officials would first need to visit the location in which the issue was reported and observe the situation, before attempting to provide a solution. This is mainly caused due to the unavailability of accurate locations - ideally GPS locations are needed [10]. Another headache for the government is that time and effort is wasted as some reports are fake - the government institution is unable to judge the validity of a complaint at the time of receiving it [7].

3. LITERATURE REVIEW

Citizen engagement is known as the "ways in which citizens participate in the life of a community in order to improve conditions for others or to help shape the community's future" [11]. As such the definition of public complaint management would be the 'ways in which citizens/communities can report issues to government institutions and the manner in which

government institutions resolve these issues in order to improve the future of citizens/communities'.

Being a democratic nation, Sri Lanka has indeed provided opportunities for its citizens to be involved with their government. Some of the examples of complaint management in Sri Lanka include such programs as Jana Saviya, Gramodaya Mandala, Gemidiriyaya, Jana Sabha and Gama Neguma [12]. In most of these initiatives, citizens are able to discuss their concerns and voice their opinion with government institutions. Many private media institutions and NGOs have also organized similar programs, making use of technologies such as teleconferencing to enable citizens to directly discuss issues with top government officials. Sri Lanka also has a dedicated hotline, operated by the Government Information Centre (GIC), which allows citizens to submit their complaints. Many government websites also allow visitors to submit their complaints/grievances via online forms. In addition, various government institutions have dedicated hotlines for citizens to complain about breakdowns, hazards and other related issues. Further, municipal councils have public complaint offices and 'public' days - weekly meetings where citizens can meet government officials [8]. The current (generalized) complaint management process in institutions is shown below (see Figure 1).

However, there are several issues. One of the more obvious is the focus on the use of letters [7], [8], [9]. This would certainly slow down the process. In addition, there is no method for citizens to provide feedback on the solution provided - they simply have to accept the complaint as 'closed'. Further, while some government departments such as the Colombo Municipal Council (CMC) and Central Environmental Authority (CEA) have implemented IT systems for government officials to manage complaints, citizens do not have access to these.

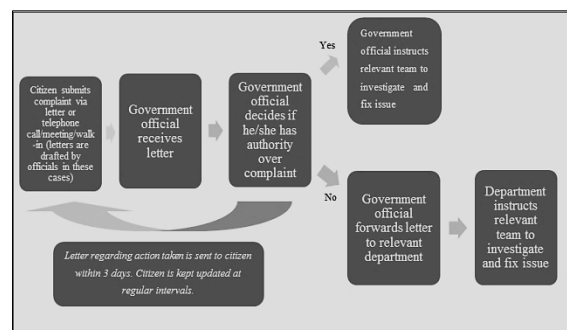


Figure 1. Current public complaint management

Thus Sri Lanka's complaint management methods have remained largely traditional with limited use of modern technology and primarily requiring citizens to approach governments to submit complaints. However, governments should "now go to where the conversations are by engaging citizens more proactively and demonstrating that citizens' engagement is valued" [13].

3.1 Shortcomings in existing complaint management initiatives

As highlighted previously, many countries have successfully implemented complaint management and other related citizen engagement initiatives. One primary example is 311 systems. Many cities in the United States have 311 hotline systems for submission of non-emergency complaints. Such cities include Boston, San Francisco and Washington DC, which also have websites and mobile apps [10]. 311 systems have also been implemented in several European nations including the UK and Germany.

While complaint management initiatives have several benefits as highlighted in the first part of this paper, many authors highlight a few inherent issues which should be considered when implementing a complaint management solution. One of the main issues is that there could be an overabundance of data and complaints in government departments. According to Offenhuber [14], this could lead to slow complaint handling, which will lead to citizens feeling frustrated. Thus government officials should be sufficiently trained so they possess the skills and resources to respond to complaints quickly [2]. Governments can also receive misleading and unhelpful complaints due to reporting of issues not covered by the system, vengeful submissions, over-use of the system, etc. [10]. Clark and Logan [10] further highlight the issue of biases in complaint submission. They conclude that the issue is unavoidable due to human nature. However, evaluation of existing solutions indicates that a system of reputation or loyalty points for citizens will enable governments to discern ‘trustworthy’ submissions from others. Therefore, IT-based complaint management solutions need to be planned carefully to ensure the benefits outweigh the costs. Governments would otherwise feel that they may have been ‘better off’ with their existing initiatives and methods. The government institutions too need to be aware of these inherent issues, so they could have the suitable mitigants in place.

3.2 Impact of technology on complaint management initiatives

Governments throughout the world have been incorporating Web 2.0 technology into their initiatives for at least a decade. A majority of these initiatives facilitate the submission of complaints to specific government departments via websites. These platforms have now evolved into mobile applications, driven by the rapid growth of mobile phone technology and use of mobile phones [15]. The implementation of these systems has also been made simpler due to easily accessible geographical information systems like Google Maps. Therefore, it is certainly prudent to utilize the latest technological trends in citizen engagement.

3.3 Comparison of existing IT solutions for complaint management

Having analyzed the existing solutions (see Table 1), a noticeable limitation is that none of the solutions allow citizens to provide feedback on the solution - complaints are simply closed by governments; and citizens have to assume that the government has actually resolved the issue. Further, citizens have no idea of how long they need to wait for a reply after submitting a complaint. In addition, a majority of the solutions do not allow other users to up vote/down vote complaints, so there would be insufficient pressure on the government. All solutions also give citizens the impression that governments have sufficient resources to solve all submitted complaints. It is also evident that there can be an overabundance of data as even complaints which lack proper evidence (photos/videos) are immediately directed to the system. Any new solution must take note of these and mitigate them.

3.4 Complaint management models/theories

The framework created by the Ombudsman of New South Wales (Australia) was chosen for identifying improvements to the current process, due to several factors. Firstly, the framework (see Figure 2) was created in order to implement AS/NZS 10002:2014: Guidelines for complaint management in organisations, which is itself based on ISO 10002:2014: Quality management - Customer satisfaction - Guidelines for complaints handling in organisations. Thus the framework provides guidance on the internationally recognized principles and concepts of an effective and efficient complaint management system [16]. Several public complaint management systems have also been implemented successfully in Australia and New Zealand based on this framework, and this further indicates its relevance.

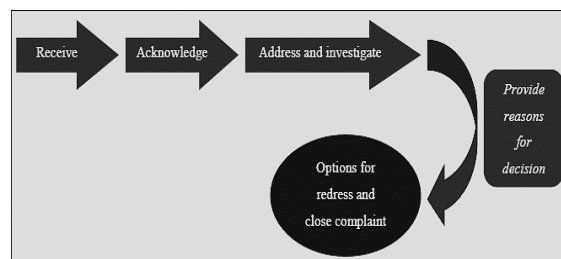


Figure 2. NSW Ombudsman complaint handling procedure [16]

This framework was compared with the current process in Sri Lanka and several notable differences were identified,

- Receive - At the reception stage, all complaint details, even for complaints which can be resolved fairly quickly (e.g. word-of-mouth); must be recorded and assigned a unique identifier. These guidelines are currently not fully adhered in Sri Lanka since even though letters are indexed, there

is no method to easily track them except in those institutions which use IT systems.

- Acknowledge - The government institution must provide acknowledgement of having received the complaint and the action taken, within a reasonable number of working days. This does happen in Sri Lanka, where the rule in departments is that a letter must be dispatched within three working days [7], [8].
- Address and investigate - The government institution which receives the complaint must decide if the issue raised is within its control and must also consider the outcome sought by the citizen/s. Following this, information must be gathered on the issue and it must be investigated thoroughly.
- Provide reasons for decision - The citizen must receive information on the outcome of the complaint action taken, justification for the decision, the solution put in place and options to review the decision. Though this does happen in Sri Lanka, the information is sometimes only received after a significant period of time; and citizens cannot easily review the government's decisions.
- Options for redress and close complaint - This is the end point of the process, where there is much room for improvement in Sri Lanka. According to the NSW Ombudsman, governments must store records on how the complaint was managed, the outcome/s of the complaint and any outstanding actions that need to be followed up. This allows analysis of the complaint at a later date and also ensures a history on the issue.

3.5 Factors affecting citizen participation in complaint management initiatives

Rather than simply identifying the existing issues and attempting to provide a solution, this research also considers what would drive citizens to use such a solution. Thus this section examines factors which would ensure citizens will use the complaint management solution since failure to have adequate citizen participation would only contribute to its failure.

3.5.1 Attitudinal factors

Attitudinal factors are related to the feelings of individual citizens regarding complaint management. One of the main factors would be social responsibility which drives such citizens to take action against wrongdoings in their community, help their local government in solving issues, etc.; so that society could be benefitted. Contradictory to the above, there are also citizens driven by self-interest and who only become involved with initiatives directly affecting their personal interest or the interest of the community in which they reside [17], [18]. Trust in government is also key since if citizens do not see the government

taking action based on their input within a reasonable time period, there is a tendency for them to feel their opinions were unvalued [13]. This would reduce participation levels. In addition to this, perception of government institutions plays a major part in willingness to participate [19]. Most citizens tend to have a negative view of their local government and believe the government would disregard their opinions and views, citing such reasons as poor provision of services, uncooperative government officials and false promises of politicians.

3.5.2 Social factors

Social factors are those factors related to complaint management which are shared by large groups of citizens. Some groups of citizens are of the mind-set that participation only suits certain types of people and that they themselves do not belong in this group. This perception is especially true amongst youth, according to Lowndes, Pratchett and Stoker [19]; who feel that governments are not interested in 'what they think'. In addition, according to Udagama [20], especially in countries such as Sri Lanka, there is also a "fear psychosis" where citizens have apprehension over submitting complaints due to the belief that this would put them out of favor with other citizens and the government. According to Brennan and Douglas [18], confidential complaint submission channels (which citizens trust) must be available. Lack of any form of direct reward - tangible or intangible, would also lead to reduced motivation. In IT-based initiatives, such motivation could be provided more easily as citizens could be recognized through gamification techniques such as a 'points system' based on criteria such as accuracy of submissions, validity, etc. [21]. Further, if governments recognize citizens through channels like newspapers, there would be an even greater sense of achievement.

3.5.3 Technological factors

These factors relate to the use of ICT in complaint management solutions. Mergel, Schweik and Fountain [15] highlight that there is a high tendency for citizens to use communication methods where less effort is required (such as IT solutions) to submit complaints. According to Mergel [5], citizens favor using dedicated telephone hotlines, websites and apps due to this convenience. Ease of use of the IT solution is key [21]. IT-based complaint management solutions which require less user effort and are faster and simpler to use; are more likely to succeed over solutions which demand more time and effort. Therefore, the IT solution itself must be simple, user friendly and easily accessible. Further, emphasis should not be placed on feature richness but instead on the "provision of a fast, specific service that satisfies a clear user goal" [21]. However, with the use of IT, there are instances where different classes of society are not provided with opportunities to voice their views. This 'digital exclusion' is especially true for IT-based complaint management initiatives where different income levels,

broadband access, device power and capability, etc.; can lead to a divide being formed where only wealthier citizens are able to engage with their governments using modern methods. According to Brabham [22], this would undermine the purpose of citizen engagement. Therefore, it is important for government institutions to not only focus on IT-based complaint management methods, but to also focus on enhancing existing non-IT-based methods.

3.5.4 Knowledge and communication factors

Knowledge and communication factors are those which are related to the transmission of information regarding complaint management. Traditional complaint management methods involve public days/meetings. Miah, Gammack and Greenfield [23] point out that most citizens are unaware of such meetings and the fact that they have the opportunity to participate. This is mainly because of a lack of direct communication regarding such initiatives [18], [19]. Traditional complaint submission methods such as public days also require citizens to be in attendance. However, time to attend such meetings is a scarcity in this day and age, especially for employed citizens. Busy and thoughtful individuals who perceive the meetings as a waste of time could also be discouraged from attending. Lowndes, Pratchett and Stoker [19] indicate that citizens favor a complaint management service available at any time of the day. Further, Brabham [22] points out that one of the main reasons for the popularity of IT-based complaint management solutions is the possibility of anonymous use. Such an opportunity for anonymity would not be possible in traditional methods such as meetings.

4. METHODOLOGY

A mixed methodology consisting of both qualitative and quantitative data gathering was used for understanding how citizens participate in public complaint management and to validate the above factors. The population for this research includes all citizens who live in/work in/regularly travel around Sri Lanka's key cities. From this, a sample of 300 millennials who live in/work in/regularly travel around Sri Lanka's capital were randomly chosen and a structured questionnaire was piloted via an online questionnaire tool. For gathering qualitative data, interviews were held with the following government institutions - Colombo Municipal Council (CMC), Central Environmental Authority (CEA), Road Development Authority (RDA), Urban Development Authority (UDA) and Ministry of Health (MOH). The gathered data, mappings and results of the findings

have been used to create the conceptual framework and IT solution.

5. KEY FINDINGS

The key findings are highlighted below (see Figure 3). These were identified based on the literature review and primary research.

- Citizens must be able to provide photos, video and GPS location for each complaint as lack of evidence is a major issue currently.
- Citizens must be able to vote and comment, with over 70% of respondents noting this enables institutions to judge which issues need to be resolved first.
- Anonymous complaint submission options are needed and the ability to use the entire system anonymously would be an added advantage.
- Citizens must be able to escalate complaints for which suitable solutions were not provided, directly to selected government officials.
- Citizens will need regular and timely status updates from government institutions as 82% of respondents agreed that feedback was not presently provided quick enough or not in an appropriate manner. Further, 76% of survey respondents indicated they would feel their complaint is not valued sufficiently if action was not taken within a reasonable time, thus directly leading to loss of trust in the government institutions.
- While recognizing citizens who use the new system, government institutions must continue to develop their existing non-IT-based complaint submission methods so as to avoid digital exclusion.

Figure 3. Key findings of the research

6. CONCEPTUAL FRAMEWORK

The conceptual framework (see Figure 4) is constructed using a bottom-up approach and provides direction to the findings from the background research, literature review, interviews and questionnaire, in terms of increasing the efficiency and effectiveness of complaint management.

6.1 Dissatisfaction regarding the process of submitting complaints & the solutions provided for issues

As identified previously, many countries have successfully implemented complaint management solutions. This fact, along with the current problems in submitting complaints has led to a gap which needs to be addressed, in countries such as Sri Lanka.

6.2 Factors affecting citizen participation in complaint management initiatives

The factors identified above are incorporated into the conceptual framework as the second element. These factors ensure citizens will use the complaint management solution effectively.

6.3 Process improvements to the complaint management process

The third element is process improvements. The speed of resolving issues and frequency of status updates on a complaint are key areas for improvement - government institutions must ensure that status updates are provided regularly in order to avoid citizens losing trust in the initiatives. For this purpose, the government may need to consider allocating dedicated staff. Another area for concern according to McNutt [13] and Mergel, Schweik and Fountain [15], is that many officials fear a loss of control in terms of the content exchanged with citizens. In addition, there can be disturbances to the perception of power balance as some officials feel the government's mandate and sovereignty are compromised [15]. Therefore, careful attitudinal shifts are certainly required.

6.4 IT solution for public complaint management

The IT solution (named Spotlight) increases the effectiveness and efficiency of the overall complaint management process and allows citizens to easily participate. Thus the IT solution 'bridges the gap' between the current and expected standards of the complaint management process. As a result of detailed evaluation of existing IT solutions and innovation on part of the project team, the implemented IT solution is one of a kind as it includes all features of existing solutions in one interface, while also providing many novel features (see Table 1). The front-ends are a mobile app and web app which allow citizens to submit complaints with photos, video and GPS location and then monitor the

complaints. Visibility of complaints is global, with complaints sorted by issue type, location, submission date, etc. Once the government acknowledges a complaint as closed, citizens are able to validate this closure with photo, video evidence and a rating, while they could also re-submit/escalate the complaint to a particular government official if they are unhappy with the solution. Citizens are rewarded via a points/badges scheme.

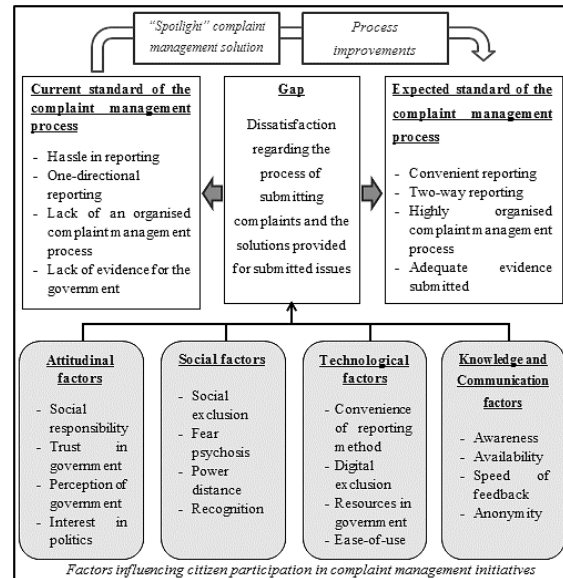


Figure 4. Spotlight conceptual framework

7. RECOMMENDATIONS

While the framework and IT solution proposed here are based on comprehensive primary and secondary research, the following recommendations could be noted. Firstly, the process by which complaints are directed to government departments based on their issue type could be explored in more detail and an effective logic introduced, which considers location when allocating issues to institutions. Further, more research could be conducted on reducing the impact of misuse which can cause an overabundance of priority complaints for government institutions. An SMS/USSD based solution for basic complaint submission could also be considered in order to reduce digital exclusion. With regards to the conceptual framework, specific research for each government institution would need to be undertaken prior to implementation of the framework since each institution would have unique complaint management procedures and processes; and attitudinal shifts required for successful implementation.

Table 1. Comparison of existing solutions

Features	Existing IT solutions					Solution
	<i>SeeClickFix</i>	<i>BOS:311</i>	<i>FixMyStreet</i>	<i>Commonwealth Connect</i>	<i>CitySourced</i>	<i>Spotlight</i>
Ability to upload multiple photos	Yes	No	Yes	Yes	Yes	Yes
Ability to upload video	No	No	No	No	Yes	Yes
Anonymous complaint submission	Yes	Yes	Yes	Yes	No	Yes
Ability to vote and comment on complaints	Yes	No	No	Yes	Yes	Yes
Ability to actively track/monitor complaints	Yes	Yes	Yes	Yes	Yes	Yes
Complaint merging	No	No	No	No	No	Yes
Complaint closure with verification (photos, videos, rating)	No	No	No	No	No	Yes
Complaint can be escalated/re-submitted	No	No	No	No	No	Yes
Gamification/reward system	Yes	No	No	Yes	No	Yes

8. CONCLUSION

This research has seen the development of an effective complaint management solution for use by government institutions - the IT solution provides a strategic overview of how citizen engagement can be strengthened via the use of IT and any government institution could use the conceptual framework detailed above as a blueprint. These could be utilized to ensure citizens are provided with an effective public complaint management process in which they would be key players.

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Application to Reduce the Road Offence by Improving the Productivity of Colombo Traffic Police Operations

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ABSTRACT 1-2

Traffic police sector is one of the important sectors that directly influence the citizen's living standards and the economy of the country. Due to unproductive operations by traffic police divisions many nations face high number of road offences. In order to reduce this drawback some developed and developing countries have successfully implemented road offence management solutions for diverse offence type. In Sri Lanka there are many obstacles that hinders the productive work carried out by Colombo Traffic Police Division (TPD). Some of these barriers are communication gap among enforcement divisions and with external entities, lack of road offence and defect data, lack of human resources and poor organized road offence and defect reporting; which have led to increase number road offences and inconvenience process faced by traffic police divisions and the motorists. Based on this background, the research aims to analyze and investigate the difficulties in delivering productive work by the Colombo TPD; and to design, develop and evaluate an IS solution and business framework, which facilities traffic police to increase the productivity of operations, in order to reduce the number of road offence in Colombo district. The project is focused on increasing the efficiency of the process that are currently being used by the traffic police officers.

Keywords

Road offence, road defect, government, traffic police, violator, post office

1. INTRODUCTION

In early 1920s, Sri Lanka Traffic Police Division (SLTPD) had been started, in order to control vehicle congestion [18]. Consequent to increasing fleet numbers and road offences, the government established the TPD as one of the major departments of the police sector. With the intention of improving quality services, the TPD was divided into four divisions, which are Education, Enforcement, Environment and Engineering (E&E) and Statistics units [18]. In order to improve the road safety, many

countries have implemented mobile and web based solutions to enable the traffic police division to get as much as data, such as exact location of an offence, date and time of offence, violator details, violator's health issues, root cause of the offence, vehicle details, CCTV camera and etc.

Using such data improves the level of convenience for the authorities to find out what their focus should be in order to eliminate traffic offences. However, in Sri Lanka this technology advancement is not available owing to the use of traditional reporting. In 2015, 2801 people were killed and 9.3 billion rupees was wasted due to road offences [2]. In addition, violator's inconvenience level is high in Sri Lanka, compared to other developed and developing countries [15]. The above two findings clearly show that the productive level of traffic police operations is very low in Sri Lanka. Therefore, an effective traffic police solution is essential for SLTPD, which allow officers to feed offences, road defects and analyze the collected data, in order to make healthy decisions in policy improvement and reduce the inconvenience level in current process.

It is found that, in Sri Lanka there no many researches done in improving the performance of SLTPD and reducing the inconveniences level of violators. Therefore, researching on the root causes for inefficient and ineffectiveness of the operations under TPD is essential.

2. PROBLEM DOMAIN

There are plenty of reasons for the increase in road offences, such as road problem, lack of driving skill, carelessness, weather changes, etc. [18]. The fact the one of the major reasons for the road violations is inadequate information to make decisions on the particular problem, such as black sport locations where road offences often happen, violation creator's information, accurate date and time of offences [8].

Use of traditional reporting method always lead to lack of transparency and accountability between TPD and road offence [8]. However, all the above mentioned root causes of road offences cannot be eliminated by using an Information System (IS) solution. In fact,

there are some root causes of offences, which could be minimized by the TPD; if there is a proper IS solution to track and monitor system, which does not require the help of third parties [12]. Therefore, the author came up with the following problems that need to be eliminated from the TPD, in order to develop quality work that would reduce the number of offences

2.1 Lack of road offence and defect data

Good decision-making is dependent on the availability of data, accuracy of data and sufficient amount of data. However, in SLTPD, this data is unavailable due to traditional reporting. Therefore, a situation is created, where TPD does not have any proper, clear path to implement road offence preventive actions/policies on particular problem. For an example, the unavailability of violator's details leads to stopping in the Driver Improvement Points System (DIPS) policy, which was to be implemented in Sri Lanka in 2012 [15].

On the other hand, TPD is not aware of the time when more offenses happen and the locations where more frequently offense happen [8]. This drawback leads to improper offense management those location and time. Meantime, statistics state that, the underreporting of traffic offence is 60% to 70% range due to underreporting and lack of research among the SLTPD [6]. Therefore, collecting sufficient road offence and defect data is essential to make healthy decision on offence preventing policy.

2.2 Communication gap among enforcement divisions and with external entity

This is a common issue for all organizations, which is especially true is high at government organizations [3]. The main factor that influences this drawback is traditional reporting culture. Owing to this culture, there is no proper communication within enforcement division's officers regarding the road offence and with the Registrar of Motor Vehicles Department (RMV), the post [8]. Due to this drawback the enforcement division unable to access sufficient information about road offences in order to implement road prevention action.

On the other hand, due to the communication gap with the Post Office Department (POD) creates absence of validation of violators who had paid the road fine and not. Due to this obstacle, many road violators often escape from punishment. In fact, the research of experts [4] found, that the most of the violators who violate the road rules and law are escaping from violation due to high inconvenience process face to get their driving license back if it had confiscated.

Relatively 10% of drivers meeting with accidents are reported to be without valid driving license. This percentage is increased to nearly 25% in the case of serious accidents [1]. The above statements clearly show that violators do escape from offences and cover up by creating fake driving licenses. Therefore,

bridging the communication gap between TPD and POD will have high chances to track violators who did not pay offence fine and thereby, reduce the loop holes to escape from offence. Furthermore, the process between TPD and post office also creates high inconvenience for violator's in terms of getting their license back.

2.3 Poor road offence and defect reporting

Government does not handle large volume of offences data in organized way. Due to this, it is impossible to track repeat violators details, waste large human hours to analyses the offence data and lack of realistic offence data ...etc. In order make decision on road offence, accurate and sufficient data is highly important. Due to traditional process, the island wide and city wide data does not come on time to the statistic division in order to analyze on offence and make appropriate decision [20]. Therefore, TPD's offence prevention actions are always delayed.

2.4 Lack of human resource

The traffic police officers do not have a specific role to perform [12]. Frequently, they change their role according to necessity. In fact, "police who belong to other divisions are also assigned to traffic management work" [4]. Therefore, the specialized work culture is missing in Sri Lanka police division. In order to analyze and investigate on road offence, the professionalism and experience are essential. Nevertheless, [13] research state that, multitasking increase the productivity of work and job satisfaction.

Research highlight that, lack of resources is one of the drawback in TPD [7]. In fact, "Lack of specialized work cultures" also influenced by unavailability of resources to manage the traffic work. Moreover, insufficient resource would produce a problem where, the traffic police could not able to cover the place where offences often happen.

3. LITERATURE SURVEY

3.1 Road safety in Sri Lanka

The major responsibility of the TPD is, to keep the road's safety level high for all type of road users [6]. As per the author, a TPD's performance can be evaluated by the country's road safety level. Therefore, the author researched Sri Lanka road safety in order to evaluate the SLTPD's performance.

In 2015, Sri Lanka has hit 2794 death rate due to road accidents and this has increased to 3003 in 2016 [2]. The statistic division of SLTP reveals that every three and a half hours a Sri Lankan is killed in road accident and two victims will be critically injured [7]. On average 7 to 8, people are being killed due to road accidents each day. The fig 2.1 (below) shows the graphical view of different road users killed in 2015.

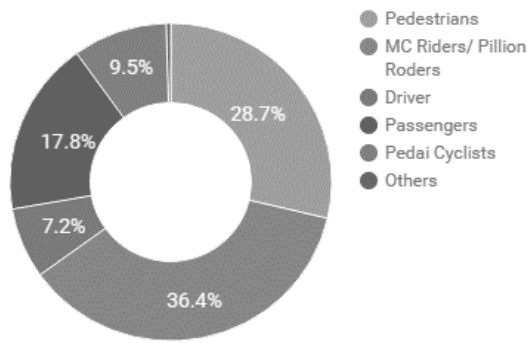


Figure 2.1. Road user killed 2015 [Source: [7]]

In Sri Lanka, Colombo city is more urban when compared to other parts of the country and it contains all necessities and luxuries. Therefore, the occurrence of traffic congestion is very high. On average 250,000 vehicles enter Colombo daily [6]. This causes high traffic congestion and there are not enough alternatives road facilities to manage the traffic congestions. As a result, the Colombo city got the highest number of road fatality in 2015.

On the other hand, poor road safety and traffic management would be cost to the government and the individuals. As per [9] statistics, Sri Lanka loses 9.34 billion rupees each year due to road accidents damages recovery and in the last decade 100 Billion rupees worth of damages caused by road accidents were recorded [19]. Furthermore, 1.5 % of the Gross Domestic Product (GDP) is lost each year due to traffic accidents. Therefore, losing 1.5% GDP every year will highly affect the nation and citizens negatively in middle-income countries.

In a nutshell, the above statements and findings are clearly show that Sri Lankan traffic police division is not productive enough to control and manage the road offence. To adopt a good road prevention strategy plan, it is essential to consider the other countries who had a high number of road offence and the strategy they have implemented to overcome this problem.

3.2 How other countries control road offence

Dubai has faced complication in appropriate decision making for the prevention of road violation due to underreporting. Therefore, they have initialized a system call Transportation Information and Management System (TIMS) to feed accidents data, which includes injured and non-injured accidents along with other sub features, such as continuous traffic counting, operational analysis, highway asset management and travelers guidance and information systems, amongst others. This system has helped the Dubai traffic police to improve the programmed decision-making in offence prevention actions. As a result, the Dubai has become less accident rated country in the world [11].

Netherland road safety policy has remained unchanged since 1986, once the policy has changed the 50% reduction in causalities and a 40% reduction in hospitalized injury victims by 2010. The policy changes were four line of actions, such as comprise infrastructure, road user behavior, vehicles and Intelligent Transport Systems (ITS). Their policy contains improve the road infrastructure for each category of vehicle type, separation of opposite traffic flows, improve the road design to increase the visibility of vehicles, revoked novice licenses who has committed serious road violations and introduced new technologies to manage vehicle flow and track violations [17].

Singapore had to face number of road offence due to significant increase in population and vehicle usage. To eliminate the high number of road offence in the city, the government had introduced Driver Improvement Points System (DIPS). Through this system the whoever commit the offence and who has increase the minimum point for their driving profile, those driver's license will be cancelled for certain period. Thus, eliminating the frequent offence makers from road would significantly reduce road offence in Singapore [14]

In a nutshell, based on those three country the lesson learned is Information System and collection of road offence data are very important in order to reduce the road offence.

3.3 Road offence entering process by SLTPD

According to the industry interviews, the following process has been identified. Every individual traffic police officer has traffic offence-reporting book to enter road offence details. At the end of the year, all 480 TPD have to create an excel sheet of encountered road offence details and send it to the Colombo statistic division through mail. Once the statistic division receives island wide offence details, the processing and analyzing work commences. The non-fatal accident details are being processed manually and documented in Microsoft Excel sheet. The fatal accidents details are processed with the help of the Micro Accident Analysis Package (MAAP) system.

Sri Lanka purchased a system called MAAP, to record and investigate road fatal accidents. The MAAP is a desktop-based application, which process and analyze the data of accidents and provided reports and statistics information such as, property loss, loss of life, and recovery cost of government and insurance cost of each accident [18]. In Sri Lanka, road accident information is being entered into manual B-Form and later the details are transferred into MS-Assess file and finally with the help of MAAP system, road accidents are analyzed and presented as statistics and in report form [10]. The following limitations have been identified, while analyzing the MAAP solutions,

- MAAP use MS Access database, which is not powerful enough to retrieve or feed data effectively to prepare statistics of accidents [4].
- MAPP represent the accidents information through GIS view only [10].
- Therefore, the realistic information is missing in MAAP system, because the system is handled by non-Traffic Police, where they judge accident spot by themselves and enter it into MAAP system [4].

The system that is currently being used by statistic division has many limitations in order to make road prevention action. These fundamental factors are evaluated here, and proved by industry survey.

3.4 Existing solutions and their limitations

MAPP is a system that is available in Sri Lanka to support the traffic police operation. MAAP use MS Access database, which is not powerful enough to retrieve or feed data effectively to prepare statistics of accidents [4]. MAPP represent the accidents information through GIS view only. Therefore, the realistic information is missing in MAAP system, because the system is handled by non-Traffic Police, where they judge accident spot by themselves and enter it into MAAP system. Majority of solution do not have feature to add violator's health issue and root cause of offence details. Majority of system does not have mobile application to handle the offence situation very effectively. None of the solutions enter road defect details to analysis the offence rate with the particular location.

4. DEVELOPMENT APPROACH AND METHODOLOGY

The Object Oriented (OO) approach is an incremental and iterative software development approach, which has a wealth of documentation and Unified Modelling Language (UML) of design techniques to improve communication between customer and software developer. The OO approach contains many methodologies itself. Each methodology is generated with uniquely features to overcome the drawback in other methodologies. In-depth comparison was carried out with each OO methodology and finally the author has selected Rational Unified Process (RUP) as the most appropriate methodology, which meets all criteria for the development of the IS solution.

In a nutshell, the available approaches, methodologies, tools and techniques was identified and justified the reason for chosen particular one for IS project to ensure the successful completion of the project and to achieve its aims and objectives.

5. RESEARCH FINDINGS

The finalized questionnaires were distributed among Colombo region traffic police and to citizens who fit in the project scope. Each questions were created

based on the indicators identified in the literature review. Most of the questionnaire were distributed through Online and online difficulties and availability problems, some questionnaires were conducted face to face. Over all hundred and fifty response came from, Sri Lanka road users and thirty-two responses from Colombo TPD.

TPD's questionnaire aftermath, 89.5% of industry survey was conducted with well experienced traffic officers, who are having more than 5 years of experienced in TPD. Moreover, the entire industry survey was conducted with the Colombo TPD only. General public questionnaire aftermath, 80.7% of survey response are came from vehicle users and 19.3% of survey results were gathered from non-vehicle users (Other road users). Out of 150, 60% of responses came from Colombo resident's people, and remaining came from out of Colombo.

The industry survey questions are validated with literature review findings, which indicate the project problem domain. On the other hand, the survey has help the author to find new requirements and finalize the existing requirements through the feedback got from traffic police and general public. In addition, Colombo TPD needs a good efficiency and effectiveness IS solution and which is going to be presented IS mobile and web app. Mobile solution is for field workers (E&E and Enforcement division), who always on the road to perform their routine work, and website application is for office workers (Statistic and Post office division).

6. SOLUTION

The solution is going to be a mobile and web based application. Mobile application is for Enforcement, Environment, and Engineering (E&E) division of traffic police and web application is for statistic (traffic police division) and post office.

Enforcement user's features are, to update all kind of offence details along with offender's details (personal and health details), vehicle details (validating through from Registry of Motor Vehicles (RMV) database), GPS location of offence, root cause of offence, pictures and video of vehicle damage and other common information. This will provide the opportunity to track repeat offender details. This can be enhanced to implement points system for drivers.

E&E user's features are, to update road infrastructures defect details along with GPS location of the defect, video and pictures of defect and prioritize the important of the defect.

Statistic user's application is known as big data analytic tools, which represent the gathered data, logically associate with each of them, and present through geographical and map view. This will help to give information about the places where the traffic offense happens most, main cause of most offences, current traffic police officer's location, link between traffic offence and road defect etc.

Post office user's application will provide an interface the post office officials to look at the list of offenders and make the payment process more efficient.

In nutshell, this project fills out the significant gaps in traffic police department and will help to improve the traffic police operation to next level. As a result, provides healthy opportunity to make implement right action on right time by Sri Lanka traffic police division.

7. DEVELOPMENT PHASE

The TrafiCop development has taken place after the requirements are finalized and prioritized. Visual studio 2015 and Microsoft SQL server 2014 tools have chosen to develop the website application. The languages, which were used to develop the prototype is C#, HTML, CSS, JavaScript and MS SQL that used as database tool. The Android Studio had been selected to implement TrafiCop mobile application, since in Sri Lanka the number of Android user's level is relatively higher than other mobile operating system users.

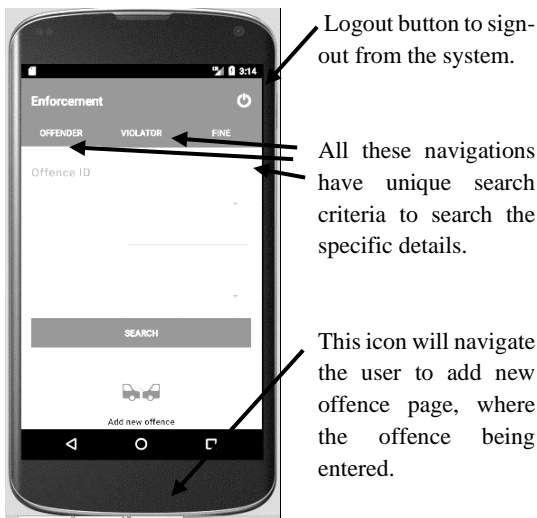


Figure 7.1. Enforcement user's home page

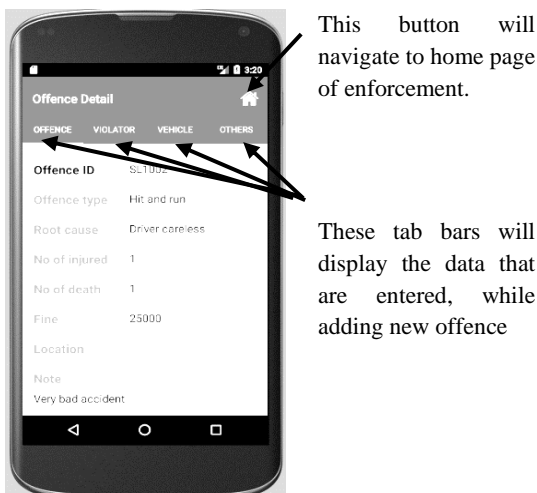


Figure 7.2. Add images and video page

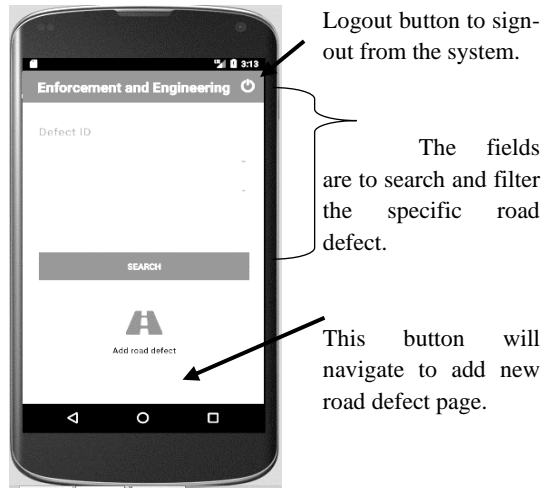


Figure 7.3. E&E user's home page

This page represents the entire road offence and defect through chart and geographical view. The first three tables are representing the quick summary of current status of road offence, fine payment details, injury and death range. Other charts are representing the offence, violator and vehicle details and last two map display the view of current traffic police officer's location and offence often committed place. With the help of this page, the TPD could able to produce new prevention police plan and improve effectiveness of allocation of human resource on black spot places.

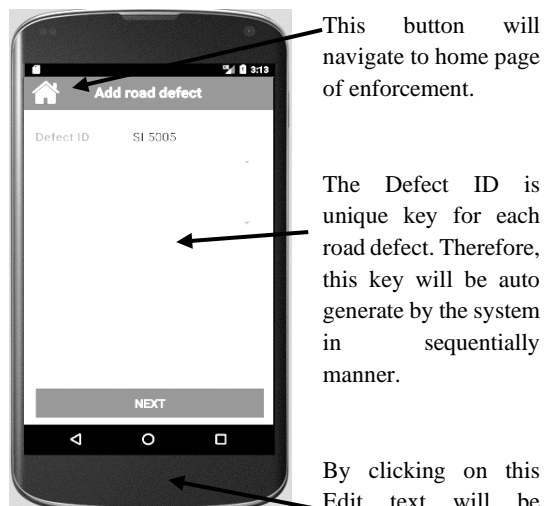


Figure 7.4. Add new road defect page



Figure 7.5 – Statistic user's home page

8. EVALUATION METHODOLOGY

Evaluation methodology conduct to assess the strength and weakness of the solution from expertise feedback. Several technologies are used to evaluate the project, which are questionnaire, hand on experience and demonstration. This will allow the author to gain a good understanding of the project. The TraficCop system will be used by the Colombo TPD's enforcement, E&E and Statistic division's officers and the post office users in their routine work. The solution was demonstrated with the use of hand on experience and through visual presentation with end users and expertise and the evaluators were asked to fill out the evaluation questionnaire to evaluate the outlook of the TraficCop solution's functional and non-functional requirements.

99% of people evaluators highly welcomed by the government and the general public who faced inconvenience in current offence handling process. However, all most every evaluator is highlighted that the prototype is not 100% working and some requirements are not developed. Therefore, before launching the product the bug fixes, developing remaining requirements and optimizations are need to be done.

9. FUTUER WORK AND RECOMMENDATIONS

9.1 Recommendations

- Creates connect between TraficCop and RMV database through API would improve the efficiency of process and bridge the communication gap between RMV and TPD.
- Indicate the location where high traffic congestion, road blocks or other inconveniences to drivers develop, and provide alternative paths.
- Connect with island wide hospital to auto generate the violator's health issue details while entering the offence

- Multi language facility to change the language based on their convenience.

9.2 Future work

- Connect with CCTV camera to get as much realistic data of each individual's behavior, especially those of divers. Find out who drives fast during certain time periods and notify him/her of this.
- Collect more data about road defect by provide feature to enter road infrastructure defect for public.

10. CONCLUSION

Sri Lanka faces a major problem due to increase in the number of road offences. These offences mainly occur due to poor operations among Colombo traffic police divisions. However, the TraficCop solution has addressed few high priority problems that are faced by TPD that hinders the efficiency of their performance.

As indicated earlier, not much research has been carried out in Sri Lanka traffic police industry. Therefore, this project and solution will be good initiate for Sri Lanka. This solution can also be customized and used by any country, especially South Asia Counties who are having similar laws, regulation, policies and culture as in Sri Lanka.

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A Participatory Approach in Reducing Bus Bunching and its consequences in Private Bus Industry Sri Lanka

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ABSTRACT 1-3

In Sri Lanka, there are so many inefficiencies existing in the Private Bus Industry such as communication gap between the key participants, lack of data to analyse the current position of the industry and the productivity, hassle in complaint process and many more which will have an impact on the continuous decrease of passenger demand. The main root cause for all these concerns has been identified as the “Bus Bunching Phenomenon”. Bus bunching is where two or more buses along the same bus route arrive together at the same time. Hence the project aims to identify the factors influencing the bus bunching in relation to public transport in Sri Lanka, in order to design, develop and evaluate an IT solution which will assist in reducing bus bunching as well as other inefficiencies faced by the connected beneficiaries of Public transport. The project is mainly focused on meeting the requirements of the National Transport Commission, Private Bus Owners, Bus Drivers and Passengers. The framework incorporates a mobile solution for bus owners, drivers and passengers which is named as “BunchBus” and the National Transport Commission receives an internal website to monitor and analyze the data received from the mobile application.

Categories and Subject Descriptors

Information systems---Data management systems---
Database design and models---Graph-based database
models; 500.

Keywords

Bus Bunching, Private Bus Industry

1. INTRODUCTION

Travelling in developing countries of the world is an insurmountable challenge due to the fact that, regardless of health, education and housing, travelling tends to get worse when the society becomes richer (Peñalosa, 2013). Irrespective of a country being developed or developing, they tend to face inefficiencies in the public bus transport industry. Critical inefficiencies can be seen in countries like South Asian, BRIC, Colombia and many more. When considering the bus transport in many countries, it can

be concluded that the majority of the countries are following the hybrid approach which is the combination of public as well as private sector to provide bus transport facility to the people. However due to the conflicting interests of the private and public sectors, the passengers as well as industry itself faces many challenges. (Rengarasu, Chanaka and Gallage, n.d.). It is also identified that the service quality of the bus transport is rarely measured and the passenger views are not been considered to overcome the prevailing inefficiencies in the industry (Rohani, Wijeyesekera and Karim, 2013).

2. PROBLEM DOMAIN

In an ideal scenario, the buses will travel to each bus stop with a pre-determined time interval where the crowd of the bus stop will be less. Furthermore, one bus will arrive at the bus stop at a particular time. However, Bus bunching is a phenomenon where two or more buses along the same bus route arrive together (or a short distance from each other) at the same time, rather than being evenly dispersed. In such an occurrence, at least one of the buses has diverged off their planned timetable by a huge margin. Thus bunching takes place when one or more buses are unable to maintain their scheduled time interval, and as a result, passengers along the route experience longer waiting times in the bus stops. Often, bunching results in a congested front bus followed by a rear bus with significantly lower passenger staking (Matias et al., 2016).

2.1 Changing of Bus schedules

Due to bus bunching each bus will consume extra time to complete predefined time schedule. This is due to the fact that in order to cater higher number of passengers, buses spend more time at the bus stops to mitigate the revenue reduction occurred as a result of bus bunching. Ultimately delayed completion of time slot by one bus will affect to the entire bus journey schedule of the industry (MORI, 2004).

2.2 Difficulty in accessing the industry performances

Currently, the NTC does not main a standardized process or mechanism to streamline and reduce the

consequences of bus bunching. Manual processes and initiatives have been taken only to address the passenger dissatisfactions and no measures or a benchmark been used to assess the productivity, efficiency and effectiveness of the private bus transport industry. Furthermore, the bus owners do not know whether the buses they have put to the industry been effectively operated or not. They will only receive the rent at the end of the day and do not have a proper measure to evaluate the productivity of each bus (MORI, 2004).

2.3 Drop in Driver Productivity

Due to bus bunching, the required revenue and passenger amounts will not be able to cater which affects the successful completion of shifts by meeting the requirements. This will lead to unnecessary speeding up to catch the passengers in the next stop or finish the shift on time will result in unforeseen accidents. Furthermore, the rare bus will not be able to collect the required amount of passenger levels to meet his targets. This will lead to the reduction of the revenue of the rear buse and reduce the productivity of both drivers. Moreover, driving with the motive of meeting the revenue and passenger demands will lead to violation of road rules and ethics due to rushing (MORI, 2004).

2.4 Decrease of passenger demand for the buses

Due to growing passenger dissatisfaction, in long run there will be drop out of passengers which will cause revenue reduction to the industry. Public will move to the usage of private vehicles than the bus transport. Due to excessive increase of private vehicles, it will increase the nation fuel demand, environmental pollution and traffic congestions (CARRASCO, 2014).

2.5 Continuous development of dissatisfaction of key stakeholders

It is identified that the key players such as the National Transport Commission (NTC), Bus owners, Bus drivers and Passengers are highly dissatisfied due to bus bunching. Due to lack of information about bus schedules, ETA for next bus and many more, the general public does not have much information to plan their journey which will cause higher passenger dissatisfaction levels due to waiting time. Also low passenger involvement for assessing the service quality measures can be seen in the industry, where passenger concerns and grievances have not been considered to define the transport service quality and minimise bus bunching. They were also not been provided with an effective mechanism to provide the feedback (Rohani, Wijeyesekera and Karim, 2013). Most of the time NIC, bus owners and passengers are unaware of sudden breakdowns and accidents. This can be a contributing factor for the creation of vicious cycle for bus bunching and passenger dissatisfaction. Also bus owner is unaware about the status of his bus

until the bus driver finish all the shifts and handover the bus to the owner in night.

3. LITERATURE REVIEW

A simplified model of bus bunching has been initially recognized and projected to the world by Newell and Potts in 1964 (Ruff, 2011). They were the first to introduce the effect of bus bunching on a single line. However, this model was considered as unrealistic as they have neglected critical aspects such as transport anomalies connected to holding and overtaking, en-route service perturbations and complex transport network features such as presence of “Common-lines”. They assumed that the passenger loading is constant and identical travel times among bus stops which showed that at a stop if the passenger arrival rate is greater than half of the passenger loading rate for the bus, the occurrences of bus bunching is small and manageable. Moreover, it is been identified that bus bunching phenomenon is very prominent when there are more buses and the output will be amplified further in the latter part of the route. Hence based on that Schmöcker et. al extended the bus bunching research to a route where high frequency of buses is observed which is served by two lines (Ruff, 2011).

The operational strategies also have been practiced by many authors to address this problem. Strategies such as to maintain the minimum distance between the buses and holding strategies for early buses have been practiced. Authors such as Osuna and Newell in 1972, Newell in 1974, Hickman in 2001, in Xuan et al. in 2011 and Cats et al. in 2011 have investigated to implement the holding strategies by building slack times in the estimated schedule at key timing points. Then the buses will be held in these points to streamline the schedule (Ruff, 2011).

Most of the analytical studies show that the research is carried out by assuming or considering one controlled timing point due to the complexity and dynamism of the project. In 2001, Hickman suggested and developed a simulation approach to solve this problem by using the optimal holding point's concepts. However due to the static nature of the holding points, this approach has been unable to cater the dynamism in actual performances of the buses. Using this constraint as a benchmark, in 2001, Eberlein came up with a model which capture and hold the buses dynamically by considering the real time data and information of the bus headways which aimed to reduce the passenger waiting times at the bus stops. This model only assumes the bus travel times between the bus stops and deterministic passenger demand. Daganzo in 2009 came up with a systematic approach to address this problem by considering the real-time information of bus performances (Fonzone, Schmöcker and Liu, 2015). The model emphasis on the holding at several timing points which allows the bus to return to the schedule while driving in a longer bus route. Furthermore, this model addresses the random anomalies relevant to the bus travel time and dwell

time and passenger demand. In 2011, Daganzo and Pilachowski pioneered an adaptive bus control mechanism which is based on two-way bus to bus corporation, where the standalone bus adjusts its speed to match with both front and rear buses. Proceeding from this model, Bartholdi and Eisenstein in 2012 were able to come up with a self-coordinating mechanism to regularize the bus headway. This theory was used as benchmark for Pilachowski's research in 2009 and he proposed a model where GPS data being directly used to counteract the amplified effects of bus bunching by allowing the buses to cooperate and communicate with each bus and determine their respective speed limits based on the respective positions.

By using the proposed dynamic simulation approaches to model and address the stochastic nature of the bus transport network, Hadas and Ceder in 2010 initiated the examination of the effect of operational tactics to improve the reliability of the bus reliability. Muñoz in 2013 investigated on how the capacity of bus, frequency of buses and passenger loading trends effect on the dynamic bus control strategies. In 2011, Nagatani was able to show a solid relationship between delay of the bus and the number of passengers on board and have suggested a solution to skip a particular bus halt in order to adhere to the schedule (Fonzzone, Schmöcker and Liu, 2015).

Generally, bus bunching occurs in the congested city areas. Several factors subsequently affect for the rise and growth of the bus bunching phenomenon in Sri Lanka as well as globally. They are (Source: Ma, Ferreira and Mesbah, 2013);

3.1 High passenger turnouts in the bus stops

Due to two or more buses travel together, there will not be a following bus to cater the passengers which cause high passenger turnouts to the stops and increase their waiting time (Liang et al., 2016). Empirical studies of Ben-Akiva and Lerman in 1985 have shown that the time spent at the bus stop waiting for buses is more troublesome than the time they spend inside the bus while reaching the destination. The particular reason is the higher levels of foreseen uncertainty linked with the waited transit vehicle. This was further analysed by Duffy in 2002 where he said, "People don't mind waiting for a bus if they know how long it's going to be. Even if they have to waste the time, at least they know it's going to be 15 minutes. Otherwise they're sitting there thinking the bus will be along in about two minutes, and when it doesn't show, then they start getting frustrated" (Mishalani, McCord and Wirtz, 2006).

3.2 Dwell Time

This is the total time spent by a bus at a bus stop in order to cater the passenger demands by allowing the passenger alighting and boarding, including the time spent open and close the bus doors (Meng and Qu,

n.d.). However, when applying the factor dwell time to Sri Lankan context we will have to exclude the concern regarding the closing and opening of the bus doors since the buses in Sri Lanka tend to keep the doors open except in the Highway and Intercity Buses.

Hence dwell time has a direct connection to the individual travel time of the bus and the total buses required to provide the scheduled transport service. (Kittelson & Associates, Inc. et al., 2003).

3.3 Traffic Congestions/lights

The interruptions caused by traffic as well as traffic lights can create a snowball effect on buses getting bunched in the process of reaching the destination or the specific bus stop. That is for the reason that sometimes one bus will meet with the traffic lights while the other moves on (Kabak, 2016). This is due to direct relationship with the delay in time and passenger arrival in the next bus stop. (Ma, Ferreira and Mesbah, 2013).

3.4 Competition among bus drivers for passengers

It is a common phenomenon seen on the road where the buses race, in order to reach the bus stops first and capture the available passengers. This will also have a cascading effect on the whole concept of bus bunching. (Urban Bus toolkit, 2006).

3.5 Driving patterns of the bus drivers

If the driver is inexperienced and unaware of the driving techniques, he will spend more time to reach a bus stop or the destination than an experienced driver. Thus, results in a bunching situation with the following bus. (Pilot Study, 2016).

3.6 Improper schedule design

Sometimes the schedule plan allocated for a bus would be very rigid or decided without considering the impact from the external factors such as traffic congestions, bus driver experience, road conditions and passenger turnout in the bus stops. Hence it will take longer time to complete one shift which will mess up the entire bus schedule for the day and it will affect to the schedules of the rest of the buses too. (MacKechine, 2016).

4. SURVEY FINDINGS

Research question acts as the foundation for this private bus transport management project. The question that has been identified is as follows;

"Whether bus bunching phenomenon and its consequences are threat to the Sri Lankan private bus industry's efficiency, productivity and sustainability in short run as well as in long run?"

Structured interviews have been carried out with the following persons when it comes to bus owners, bus drivers and NTC officials. Based on the results

gathered from the interviews, the scope, problem domain and the literature review findings have been further defined and validated. Furthermore, the requirements for the project have been identified. Semi – structured interviews have been conducted with the bus drivers due to the time limitation and nature of their job role.

In order to extract the requirements for the passenger concerns, a Google form has been created and circulated among the passengers. The questionnaire has been created by mapping the theories identified in the literature review. The sample contains the 68% male responses and 32% female responses.

4.1 Usage of Public Transport and Private Buses.

Identifying the modal class of public transport and the usage of private buses is mandatory for this project. Based on that, the general public was questioned on the frequently used transportation mode and how likely they use the Bus as the mode of transportation. 68.3% of the responses are revolving on the usage of bus transport as their main mode of transportation and rest of the 31.7% scattered among the rest of the transport modes. Furthermore, regarding how likely the public tend to use the bus transportation, it is evident that 65.5% of the selected sample uses the bus very often and 26.6% have responded as “often” which is the majority to reach the intended destination while the rest of the sample of 7.8% has responded as rarely and very rarely.

4.2 Inefficiencies persisting in the bus industry

From the selected sample of 259 passengers, 177 responses have been received regarding the inefficiencies existing in the bus industry. “Longer time taken to reach the destination” has been identified as the biggest inefficiency with a response rate of 89.80% and the “Conductors being offensive” can be considered as the inefficiency with lowest responses (except Other) with a response rate of 61%. Some have responded for “Other” as lack of crowd management in the evening, lack of comforts in the bus and many more which have a lower impact. An interview with Mr. T. H. J. D Perera (Bus owner, 23rd Oct 2016) opinion was that the root cause for all these inefficiencies is the Bus bunching phenomenon.

According to the responses received by the bus drivers regarding the problems they face, it can be analyzed and shown that these problems have a direct impact on the inefficiencies identified by the passengers. Owing to “inability to cater the needed passenger amounts” and “Inability to meet the daily revenue target” will cause the “Longer waiting times” and “Longer time take to reach the destination”.

Regarding the current passenger satisfaction, 177 passengers have responded and majority with a 54.2% insisting on the dissatisfaction levels while a very

smaller portion from the sample insisting on the satisfied levels with a 5.1%. 40.70% of the passengers have mentioned as neutral considering all the factors since every day is not a bad day.

However, the satisfaction levels help to predict and prove the current demand for private buses. Both passengers and drivers have mentioned that there is a continuous decrease of demand by 55.70% and 93.80% respectively. 44.30% of passengers and 6.30% of drivers have mentioned that there could be an increase of passenger demand which is insignificant.

4.3 Bus bunching

The literature has been already validated the existence of the bus bunching phenomenon. However, in order to validate the problem in Sri Lankan context, the passengers in the Colombo city limits were questioned. 68.90% of the participants are aware of the bus bunching phenomenon.

4.4 Factors affecting Bus Bunching

As mentioned in Literature review, six factors contribute to the rise of bus bunching. Opinion on how these factors contribute were questioned from the passengers and majority has responded for the “Competition among bus drivers for passengers” with a percentage of 93.80%. During the interviews with bus drivers, this factor was validated furthermore and they added that this is due to the strict daily revenue targets and increase in operational costs. Furthermore, they added that only four factors contribute more for the bus bunching in Sri Lanka. The interview with bus drivers have responded as “Strongly agree” for the Dwell time and Traffic Congestions factors. Yet due to the complexity and nature of the factor traffic congestions, it needs to be addressed through a separate solution.

4.5 Effect on the Private Bus Industry, Country and Participants

At the moment the industry is facing numerous losses and that has an indirect impact on the country’s GDP and NDP. In the interview with Mr. T.H.J.D Perera (Bus owner), he stated that, “The private buses face many losses daily which will have a direct impact on the industry’s overall performance and country’s GDP will decrease eventually”. Using the passenger questionnaire this point has been further validated. Approximately 58.20% of passengers has given a positive response justifying that the bus bunching has a severe impact on the industry as well as on country as shown in the chart 5.10. Majority of the responses of 47.45% and 40.68% signifies a decrease in revenue to each bus and passenger turnout to each bus. However, several researchers have found that there is a significant loss for the passenger turnout and revenue to the industry. Yet, the selected sample has responded as no change to each element.

4.6 Problems faced due to bus bunching

Due to bus bunching effect, the passengers tend to face many problems. The bus passenger survey conducted across Scotland in 2005 justifies that the main problem persisting is the reliability of the service (Rohani, Wijeyesekera and Karim, 2013). Even in Sri Lanka, the current survey received highest responses for the concerns on reliability. 66.7% and 69.50% responses have been received for the reliability concerns. However, 80% responses have been received for the buses getting overcrowded which is also a major concern affects to the passenger satisfaction levels.

Moreover, the bus drivers face main two problems such as the reduction of the revenue and the reduction of passenger levels which they have been strongly agreeing.

Thus, the research findings and conclusions are revolving around the fact that bus bunching phenomenon is the bottleneck existing in the private bus industry which hinders the performances and effectiveness of the operations. Moreover, the factors contributing to this concern have been identified with the existing processes. Furthermore, how technology could solve this problem is been also analyzed and researched and certain requirements are been validated within the research which will showcased in Section 5.

5. SOLUTION

Since Sri Lanka is a developing country with lesser capital investments for the transport industry, the only way to solve with limited resources is with the use of Technology. Thus, the solution comprises of a;

- Mobile solution for Passengers
- Mobile solution for Bus owners
- Mobile solution for Bus drivers
- Web solution for National Transport Commission by incorporating the research results.

In the mobile solution given for the bus driver will provide the view of the bus moving on the road with the rest of the buses. Meanwhile when there is a chance of bus bunching happening the driver will receive the warning alert. Then when there is a bus bunching phenomenon the bus driver should be provided with the journey plan by considering the factors of start and end times of the shift, number of bus halts remaining, expected passenger turnout at each stop and time that needs to be spent at each stop as shown below.



Figure 1. Display of Buses on a map

Figure 2. Bunching alert

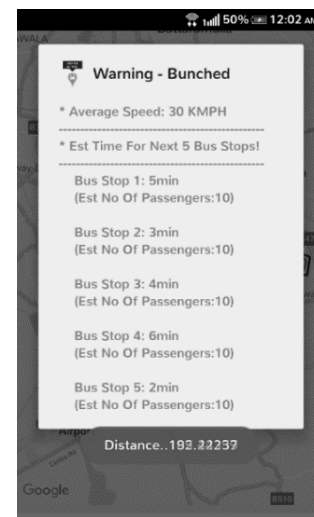


Figure 3. Forecasted Driver Plan

In the mobile solution received for the passengers the features seeing the moving buses on the map in real time, search buses, bookmark buses, ETA for the bookmarked buses, complaint and rate the buses are facilitated as shown below;

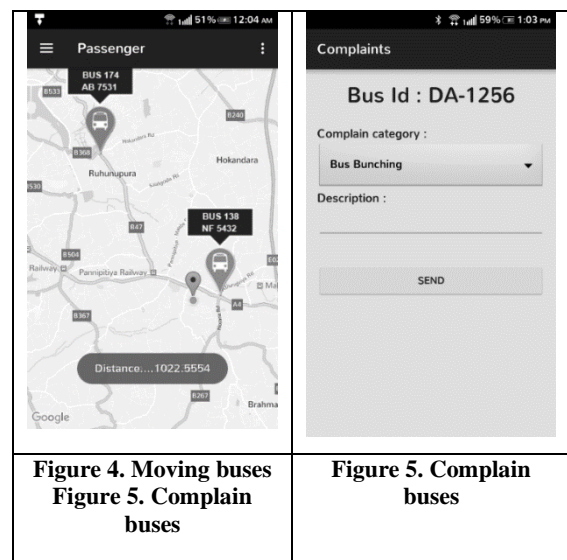


Figure 4. Moving buses
Figure 5. Complain buses

Figure 5. Complain buses

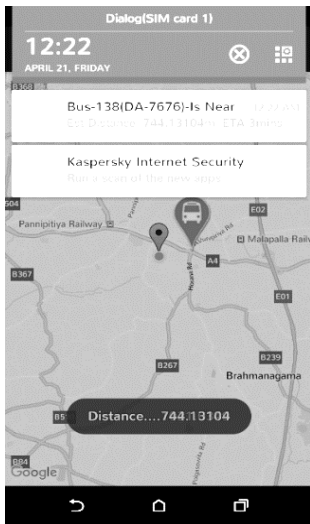


Figure.8 Notification for the bookmarked buses

Also in the bus owner’s mobile solution he will get to see his registered buses moving in real time on a map, the bus portfolio with the respective bus profile displaying the necessary information, summary of the daily passenger’s complaints and ratings, notification when a bus meet with bus bunching with the respective locations of the bus tops as follows;

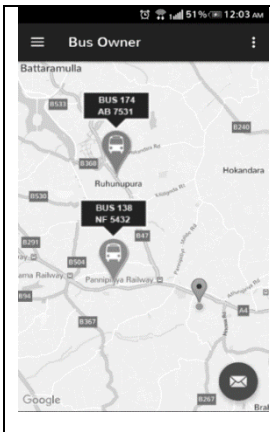


Figure 9. Display of real time buses on a Map.

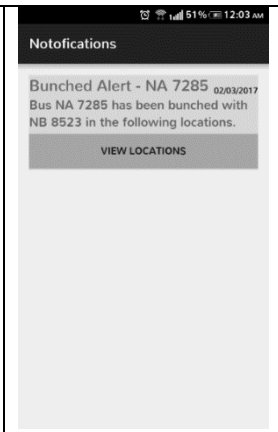


Figure 10. Bunching notification

Moreover, in the web solution given to the National Transport Commission, who will be the owner of this project will be able to view the data that has been collected from all the mobiles applications in a well analyzed and illustrative dashboard as follows. The web solution will assist the authority in future decision making to provide a satisfactory public transport service to the community. The data is been analyzed in the means of individual bus, contribution by bus owner, productivity of bus fleet and many more. They also can get an idea of bus bunching and see in real time how the implemented solution is helping to eradicate the problem.

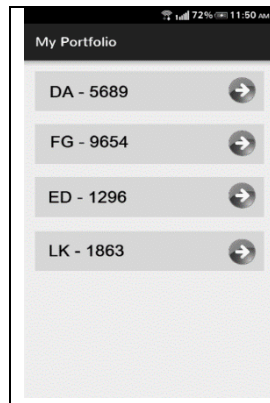


Figure 11. Owner’s bus portfolio

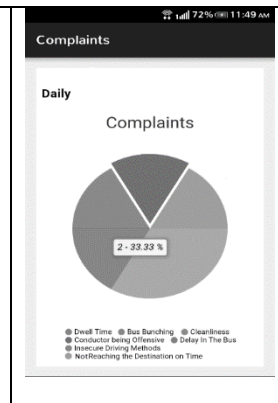


Figure 12. Complaint Summary

6. CONCLUSIONS

After researching about the topic bus bunching and the concerns raised due to prevalence of the problem through different means such as literature review, interviews, questionnaires, the answers have been finalized for the identified research question. Thus a most comprehensive solution has been designed to overcome the main as well as sub problems which have been identified. Hence the project intended to develop an effective solution to mitigate and evacuate bus bunching and its consequences. The solution comprises of an IT solution accompanied by a business solution facilitating NTC to implement the solution in a standardized manner. The front-end solution of BunchBus which is the mobile application designed and developed for bus driver, bus owner and passenger whereas back-end application which is the web portal is given to the NTC users. All the stakeholders have shown interest on the solution. Since BunchBus project solution incorporates new and all the requirements, it has competitive advantage over most of the applications in the industry. Owing to that the solution can be expanded to other industries with fewer customizations as shown below;

- Cab service industry
- Hospital industry
- Emergency services industry
- Train industry

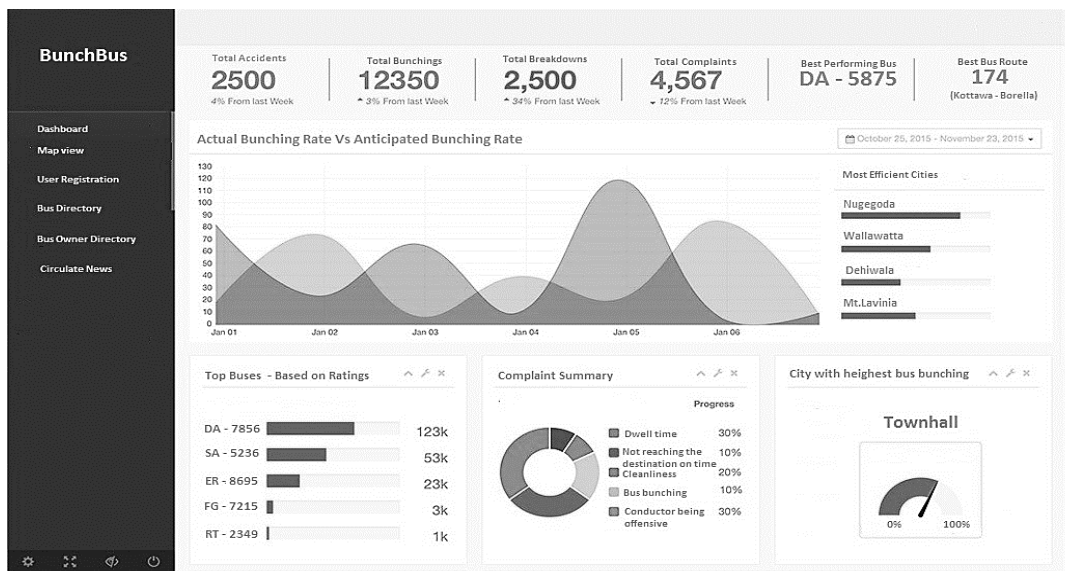


Figure 12. NTC Web Dashboard

7. ACKNOWLEDGEMENT

I would like to thank all who supported me to make this project success specially my project supervisor, family and friends.

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DCM – A solution to bridge the communication gap between Fast moving consumer goods (FMCG) companies and their distributors in complaint management

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ABSTRACT 1-4

Key problem communication gap was identified in complaint management process between fast moving consumer goods (FMCG) companies and their distributors by means of conducted primary research. Thus, the research is set to identify the barriers of the communication gap and to eradicate the consequences of the due course in complaint management by bridging the communication gap that requires significant attention in Sri Lanka. Extensive literature review and research findings revealed that the key four contributing factors such as lack of transparency, delay in attempting complaints, knowledge gap and poor record management causes the communication gap. Framework “Distributor complaint management (DCM)” which is comprised of both IT and business solution was designed to rectify the identified causes and thereby to minimize the consequences. The FMCG companies are provided with a front-end desktop application for optimized complaint handling whereas the distributors are provided with a self-service technology (SST) aligned mobile solution for improved reporting capability. Further, the concept will impose a standardized discipline across the distribution channel which in turn will create a WIN-WIN business situation. This paper concludes with recommendations and future work for DCM project.

Keywords

FMCG, complaint management, communication gap, distributors

1. INTRODUCTION

FMCG is an industry where fast moving day-to-day consumer products are manufactured and delivered to the end consumers through distributors. According to Simms & Trott (2010), it is considered as a highly competitive arena which is ruled by numerous multinational companies such as Unilever, Nestle, Coca-Cola etc. Studying the industry globally, the everlasting industry is responsible of consumer spending worth of £125 billion and contributes over 8% to Gross domestic product (GDP) according to Weightman and Bourlakis (2004) cited in Simms &

Trott (2010). Every day, FMCG products are used by 3.6 billion individuals around the globe.

There are multiple business partners and processes involved right from the conceptualization of the idea to the end consumer product delivery, in FMCG. The distributor is the main entity whose function is to make end products available to customers. (Ali and Dubey, 2013). The distributor who bridges the gap for business to business (B-to-B) retailing of the FMCG end products are a very essential entity in the context of an organization. Thus, we can argue that the role of distributor has reformed to be an important entity from mere supplier of goods. In addition, the entity holds a responsibility to build a substantial feedback loop between businesses. Further it has been validated that the manufacturers should also realize the significance of B-B satisfaction for their growth whereas they are more concerned on business to consumer (B-to-C) satisfaction. (Ali and Dubey, 2013). In favor to the above argument, Barin-Olariu (2009) has also validated that the durable long-term profitability of FMCG companies can be accomplished through mutual benefit and positive relationships with distribution channels. Positive relationships can be achieved by effective communication.

2. PROBLEM DOMAIN

FMCG companies receive a complaint from a distributor at one point or another. Handling a distributor properly is crucial to the success of a company. (Barin-Olariu, 2009). As per the primary research, all the FMCG companies validate that it is very critical to maintain a healthy distributor relationship. An organization that handles distributors with their complaints in the right and efficient way can lead the company to bloom in all areas. Failing to do so, may harm the reputation of their business and as a result it will lead the company towards a decline. Distributors can be classified as General Trade, Modern Trade and New Channels /Independent super market. According to the primary research, majority of the complaints are received from the General trade distributors. Hence the study will be focused on the complaints received from general trade customers.

Mainly a communication gap is observed between the FMCG customer services (CS) and their distributors for general trade as per the findings of primary research conducted by the author.

2.1 Knowledge Gap in Complaint Receiving End.

When receiving a complaint from the distributors, the CS teams are unable to drill down the complaint. This is crucial to find the root cause of the reported query to take a corrective action. Besides, misunderstanding the received complaint also takes place. This is mainly due to the knowledge gap in the receiving end of CS team. As a result, similar complaints are reported frequently. Finding the root cause of the problem and taking a corrective action in the first instance of the reported query can minimize the repetition of similar queries being reported. By means of conducted primary research, this problem is subjected to 34% of the companies only whereas rest argues that they don't face such concerns.

2.2 Knowledge Gap in Complaint Reporting End.

Each complaint should be reported to the respective departments or teams of CS teams to take corrective action efficiently. Distributors have an ambiguous understanding of the departments that they need to address their complaints. However, distributors report to the irrelevant department and wait for the result due to unclear understanding. Thereby, it is essential for a distributor to report a complaint to the relevant department. Failing to do so, the probability of the complaint being ignored is high and delay in feedbacks can be subjected. By means of conducted primary research, this is subjected to 66% of the companies while rest states that they don't face such concerns. Thus, knowledge gap in complaint handling by both the ends lays a foundation for communication gap.

2.3 Poor Record Maintenance

Initial source of documented information or history of complaints are used to make decisions to analyze the complaints sequence. Poor track of data is an unreliable source. The repercussions of such behaviors can result in incompetence decision making. In a nut shell, poor track of complaints leads to communication gap. Documenting complaints manually leaves space for improper record management. The required fields of complaint master data are not captured and documented in a right manner which leads for poor track of complaints. This is due to, missing few complaints while documenting and inexperience or negligence of data entry operator. Business relies upon important facts; incorrect interpretations of data can lead the business to make erroneous decisions, waste of quality time and cost. Poor record maintenance will lead to resolver being unable to track real time complaint status or history easily, increase threat for data losses and data inconsistency. The primary

research illustrates that the 66% of the teams are finding it hard to keep a track of complaints due to manual process.

2.4 Delay in Attending to the Issues and Providing Feedback

The CS team face delay in attending to issues and providing feedback. Critical complaints such as product damages, pack shortage etc. should be given more importance whereas non-critical complaints such as promotional product running out of stock etc. can be given less importance comparatively. But, resolvers take more than the expected service level agreement days (SLA days) to solve a complaint or provide a feedback. This is mainly due to inexperience, not prioritizing the complaints based upon its criticality, language barrier, personal problems reflected in work, too many complaints per day can lower the individual's level of commitment, apathetic from hearing the same problem frequently, lack of empowerment and inconsistency in data entry when complaint is received. Thus, required information and distributor communication will take place several times. Thereby, causes a delay in providing feedback or solving a complaint. Besides procrastinating the complaints will lead to complaint overload. Delays in distributor feedback and engagement are one of the biggest causes of ineffectiveness, inefficiencies, and poor performances which lay a foundation for distributor dissatisfaction and communication cap. The primary research specifies that 33% of the FMCG companies frequently face delay in attempting issues and providing feedback. Further 33% of the companies' state that they moderately face delay in attempting issues and providing feedbacks even though, 33% of the companies' states that they don't face such concerns.

2.5 Lack of Transparency

Lack of transparency is a concern faced by distributors which should be focused. Distributors are unable to receive complaint status in real time due to lack of transparency in the process between distributors and resolvers. Distributors are unclear on certain subject matters. For instance, responsible resolver of the complaint, status of the complaint and contact details of the resolver to directly contact for further inquiries. This situation has caused disappointment among the distributors. The primary research reveals that lack of transparency is evident with 66% of the distributors.

The research is set to identify and analyze the consequences and root causes of communication gap faced between CS teams and distributors of FMCG in Sri Lanka that requires significant attention. Ignoring the priorities of a distributor complaint may lead to distributor losing the trust with the company. This may reduce distributor loyalty and the company's reputation among its distributors. Not settling distributor complains can also affect a company's process towards improvement. Understanding the

benefits and objectives of settling distributor complaints will help a company understand the importance of developing and implementing a proper system to handle complaints.

3. LITERATURE REVIEW

3.1 Importance of Distributor Management for FMCG Companies “WIN-WIN-WIN Distribution”

Distributing goods to retail locations economically and faster than competitors is a key factor that contributes towards competitive advantage and top-line growth. (Mukherjee, et al., 2013). A healthy distribution will benefit the companies in cost reduction, from bad investment in excess stock of goods, profit growth and enhances communication for all the players in distribution line. (Barin-Olariu, 2009). Meanwhile, the influence of distributors in marketing channel is growing stronger which gives numerous benefits in negotiation with dealers and customers and makes it more essential. In terms of distribution, FMCG have three main objectives such as. (Barin-Olariu, 2009).

- **Brand availability** – The products of the right brand should be available in the right location at the right time.
- **Product quality** - Companies should ensure that the consumer goods are supplied in a good condition in terms of packaging, quality, freshness and appearance.
- **Effective distribution in terms of price** - Most effectively making the quality products available will lay a foundation for efficient distribution.

Right from the product manufacturer to distributor to the retailer, every key partner allied in the distribution channel has expectations in return on investment (ROI). Hence FMCG companies should maintain a WIN-WIN distribution relationship. (Mukherjee, et al., 2013). In summary, it is understood that, successful FMCG companies achieve long term profitability by maintaining a positive, healthy relationship and mutual benefit between distribution channels. (Barin-Olariu, 2009). Despite, an unhealthy relationship will lead to negative word of mouth and in worst case high distributor turnover can be witnessed in the business.

3.2 Barriers to Effective Communication

Communication gap arises when the intended meaning by the sender is not received by the recipient. Instead, an inaccurate message is received. In worst case, distributors are not willing to send message due to the prior bad experience. There are innate communication barriers that needs to be recognized to establish a well-organized management. Steers in 1991 defined five barriers for effective communication as follows. (Sands, 2014).

- **Distortion**- This takes place when the receiver receives an altered message in the communication flow. This will lead to data inconsistency which will lead to poor decision making. Language barrier or human error can be the cause for such act. On the other hand, Harris and Hartman in 1992 emphasize that misleading circumstances is the root cause for distortion, which is cited in Sands, 2014.
- **Omission**- This takes place when the complete intended message is not received by the receiver. Intentional filtering or human error can be the possible cause for this act. Besides, Huczynski and Buchanan in 2001 claimed that language barrier is a key potential cause for omission which is cited in Sands, 2014.
- **Overload**- This takes place when the complaint receiver is packed with complaints where the individual is unable to make a rational, coherent and logical approach for decision making. Organization structure not supporting individual teams handling the distribution of tasks could be a potential reason.
- **Timeliness**- Delay in message transition will lead to distribution process failure. Thereby delay in feedback by the CS team will lead the distributor to face financial losses, slow distribution process and loss of customer share.
- **Acceptance**- This takes place when the complaint receiver declines to take over the complaint. This can be due to, distributors reporting complaint to incorrect department or receiver’s state of mind which is a prevailing factor for communication.

Moreover, the cost of communication gap in complaint management is identified as follows. **Financial losses** due to product return or storage cost for non-moving product. **Slow distribution process** due to complaints not being resolved within SLA days. **Loss of customer share** due to un-satisfaction.

3.3 Distributor’s Attitude Towards Complaining

Distributor’s attitude towards complaining should be given attention to provide an effective solution. Thus, two theories have been chosen to evaluate the attitude. Complaint management is a practical mechanism where customers can realize and evaluate the effort that companies put to fulfill their needs. Complaint management lay a foundation for a quality relationship. (Waarden and Sabadie, 2012). Distributor’s attitude can be evaluated with two parameters such as *role of relationship quality* and *perceived justice*. The following sections will provide an idea to the reader on the two parameters.

3.3.1 The Role of the Relationship Quality

Crosby, Evans and Cowles in 1990 stated that there is a psychological connection between the customer and companies which is indicated by the relationship quality. Meanwhile, it was stated that relationship quality influences the necessity of trust, customer satisfaction and commitment. (Sirdeshmukh, Singh and Sabol, 2002). Conversely, it also leads to judgments and actions that are comparatively negative for the company. (Aaker, Fournier and Brasel, 2004). Indeed, a solid relationship quality will have a protective effect and higher expectations in terms of complaint management. (Ahluwalia, 2012). Further, trust and commitment of customers can be negatively influenced by a bad complaint management (Tax, Brown and Chandrasekaran, 1998) and they tend to get demotivated since the company has disappointed by an incident which broke the trust they had in the company. (Robinson, 1996).

Having said that, distributor will have lower expectations on the service quality if the bond between them and FMCG is healthy and strong. In this case, complainant satisfaction is determined by the less profound judgment of the service. Hence, the probability of distributors provoking to competitor's offer is less. Meanwhile, a bad experience on complaint service will influence a complainant's trust and commitment which will lay a foundation for unhealthy business relationship. On the other hand, relationship quality will route to judgments where the distributor might be quite demanding with the FMCG company knowing that they are good customers.

3.3.2 The Role of the Perceived Justice

The justice theory describes on how personalities react to conflicts (Gilliland, 1993) and it has been anticipated as a theoretical framework for complaint management (McCull-Kennedy and Sparks, 2003 cited in Chalmers 2016).

The perception of justice is derived from a three-dimensional evaluation i.e. distributive, interactional and procedural justice. (Tax, Brown and Chandrashekar, 1998). On the other hand, Colquitt in 2001 brings forth the fourth dimension which is known as informational justice. However, all four dimensions are distinct to each other. The distributive justice is related with the perception of tangible results and the equity such as exchanges, refunds and discounts. The interactional justice is perceived upon the degree to which a complainant is satisfied about their personal treatment by complaint receivers. The procedural justice is concerned with the treatment received by the complainant by means of procedures such as policies and formal structures. The fourth dimension; informational is determined by the transparency, differentiation and the support. (Chalmers, 2016). Complainer satisfaction is highly influenced by the distributive and interactional justice whereas procedural justice has a very weak role. (Orsingher, Valentini and Angelis, 2010).

Consequences of the complaint handling satisfaction, with the application of perceived justice dimensions would be return intent, overall satisfaction and word-of-mouth. Further, *return intent* is an attitudinal loyalty which determines the likelihood of purchase repetition from the same dealer. *Overall satisfaction* which is a long term magnitude attributes to the degree which the complainant perceives the service provided. Moreover, *word of mouth* impacts the service providers since, either negative or positive feedback is spread among the key business partners. Hence, customers are dissatisfied with injustice and they expect to be treated with respect by the company.

3.4 How Will Technology Bridge the Communication Gap?

Despite, the existing privileges, organizations still struggle with data inconsistency, security threats, lack of transparency, information trapped in one station etc. Henceforth by providing an IT solution to bridge the gap the following benefits can be obtained.

There will be *connectivity* since all the required information is presented in the dashboard in an aerial view. *Centralization* can be achieved. Currently the complaint from distributors are collected in manifold formats such as mail, letter, phone calls and physical meet. (Thumma, N.A). It will be efficient to use the concept Enterprise content management (ECM) since all the critical information is housed under one roof where record maintenance will be enriched.

Hence desktop base ECM is most appropriate for storage centralization. ECM will facilitate *integration* between the captured data and content management where managerial decisions are made effectively. A better *Insight* will be facilitated since the system is designed in a manner where accurate information is extracted and pushed to the relevant party internally and externally at the due course. Technology and communication convergence has redefined the tactic to do business (Thumma, N.A).

4. APPROACHES AND METHODOLOGIES

Iterative and incremental model (IIM) was selected by author as the general approach for this study considering the changing nature of the project. Even though key requirements were fixed before implementation, the chances of system being modified after user evaluation was high. Thus, IIM was chosen. It was quite certain that Rational Unified Processing (RUP) was the most appropriate development methodology as it meets the project criteria and it is inclined with IIM. Projects IN Controlled Environments 2 (PRINCE 2) was selected as the most appropriate project management approach as it ensures the project completion within triple constraints such as time, cost and scope. Further, project management was structured with the use of techniques such as Work Breakdown Structure, Gantt charts, risk logs, initial project plan and revised project plan. The next section

will be focused on the conducted research findings to study the industry behavior against the literature findings.

5. RESEARCH FINDINGS

Questionnaires were circulated among the FMCG company CS team in the Colombo district and their respective distributors throughout the island. Keeping the time constraint and target population size in mind, the author decided to conduct qualitative fact-finding technique for the FMCG companies whereas quantitative for distributors, for industrial survey. A total of 70 questionnaires were circulated among the distributors and received 60 responses whereas 57 were only valid. Hence response rate is 81%. The response within the distributors comprises 38.6% of small scaled distributors, 36.8% of medium scaled distributors and 24.6 % of large scaled distributors. Besides, distributors sample contained 41.2% from Western, 14.7% from North-central, 23.5% from Eastern, 8.8% from North-western, 8.8% from Southern and 2.9% from Central provinces. Despite the quantitative analysis, the author conducted qualitative data gathering by means of semi structured interviews with FMCG companies.

The survey results depict that majority (24.6%) of the distributors embrace a mediocre relationship with their FMCG companies. Communication gap which is the reason behind the imbalance of WIN-WIN situation, is witnessed in all the FMCG companies and 95.7% of the distributors. Meantime, it is understood that the identified communication barriers; overload and timeliness is highly observed (75%) whereas distortion and acceptance is mediocre in the industry. Moreover, omission is not observable in the industry. This can be due to insufficient data gathering or participants not willing to reveal the real situation.

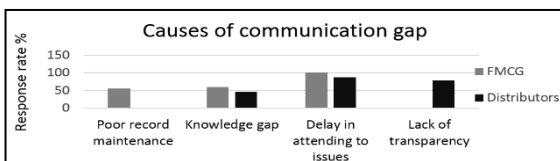


Figure 1. Communication gap causes (Source: Survey data)

With reference to Figure 1, it is revealed that all four key causes for communication gap which were identified in problem domain are proved valid in the industry.

When considering the sub elements of the causes, the study illustrates that 19.6% of the distributors find language barrier as an element for the communication gap. This is subjected to 75% of FMCG where it can be observed that minimum complaints are reported from Northern and Eastern province (majority Tamil speaking) distributors since the distributors believe that their complaints won't be taken into consideration. Despite, 25% validates that such practice cannot be observed in their background. Meanwhile, it can be

observed that 75% of the FMCG companies find inefficiency on prioritizing the complaints which is one of the root causes for complaints being ignored. Majority (40%) of the distributors have claimed that the contributing factors of communication gap will slow the distribution process. Similarly, 34% of the sample considers financial loss whereas 25% of the sample considers loss of customer share as consequences of communication gap. This subject in turn will make the unsatisfied distributor to discontinue reporting complaint which is subjected to 17.9 % of the sample.

With reference to the placed arguments, it can be clearly understood how distributors and FMCG companies are affected with the key problem and their perception on causes and effects. Moreover, it can be witnessed that majority of the encountered problems are faced by both the parties above average where significant attention is requisite. Further, the findings from the above-mentioned factors indicate that there is an opportunity for the author to empower DCM solution to change the negative perceptions of the distributors and to eradicate the identified concerns.

In average, a FMCG receives 6-10 complaints on a weekly basis where product related complaints are being reported the most. The number of incoming complaints is directly proportional to complexity. More the number of complaints, more the complexity it is. With reference to the above argument, it is evident that the complaint management process between the business stakeholders is an active business process where the opportunity for an IT solution is high to manage the complexity in efficient manner.

Further, considering the majority (72.3%) of the survey results, it is evident that the solution should be a responsive mobile application to meet the Android OS platform for distributors. On the other hand, it is depicted that all the FMCG companies are willing to adopt a desktop application over web application due to security reasons.

6. SOLUTION

This section brings forth the solution framework for the identified gaps. Functional and non-functional requirements were elicited and specifications were documented. Each functional requirement was prioritized with MoSCoW rule to identify the most crucial functionalities which was followed by system designing with the use of UML diagrams such as class diagram and use case diagram to understand the big picture in diagrammatic representation. Once the functionalities were confirmed, system mockups were sketched using balsamiq tool. Further the system was deployed and evaluated by users and industry experts to meet their expectations. Finally, the DCM system was ready for GO-LIVE with requested modifications.

6.1 System Architecture

Figure 2 represents the high-level architecture diagram of the solution.

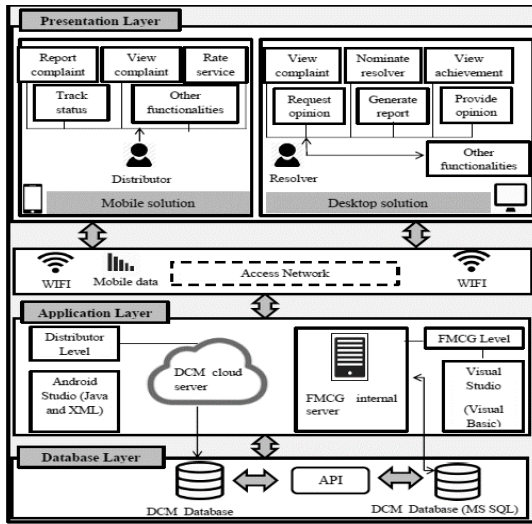


Figure 2. System high-lever architecture diagram
(Source: deived by author)

6.2 Change Management in Client Environment

The proposed solution has an impact on the management process of both FMCG companies and distributors. Thus, a requirement for change management arises. Many aspects of the organization such as structure, culture and current procedures need to be considered and customized in accordance to the company practices prior to implementation. Mainly, the existing applications within the organizations should be focused. The desktop application database should be integrated with the existing solution which is used for order processing. Besides, the database of the mobile application also needs to be integrated with order processing database to capture invoice numbers relevant to a distributor.

7. IMPLEMENTATION

The mobile solution for distributor to report complaint was developed through Proto.io whereas the desktop solution for FMCG companies was developed through Visual Studio. The database used was MS.SQL 2014.

7.1 Desktop Solution – FMCG CS Teams

7.1.1 View Tasks

The user will be able to view the new complaints assigned with the list of on-going complaints. Under *My Tasks*, panel all the received complaints will be auto prioritized based upon its criticality. This functionality was developed to eliminate the problem stated in section 2.4. The key word ‘Complaint Type’ is captured from the complaint to prioritize complaints. The following Table 1 shows the SLA days and prioritization based upon its criticality. It is to be noted

that the priority and SLA days may subject to differ by company.

Table 1. Priority by complaint type

Complaint Type	Criticality	SLA Days	Priority
Pack Shortage	High	1	2
Product damage	Very High	3	1
Transportation delay	Medium	2	3

Research findings reveal that the factor timeliness in complaint management plays a significant role. Feature “alert” was brought in forward to address the mentioned factor. This tracks the SLA days and send reminders accordingly to the resolver until the complaint status becomes complete. Also, when there are no commands passed by the respective resolver, it automatically escalates the complaint to higher personnel. Escalation is determined by a hierarchy which is fed into the system.

7.1.2 View Complaints

User can select a complaint from the list to view the complete details. (see Figure 3). Resolver can request the system to suggest similar complaints from the history dashboard to obtain an understanding on how similar complaints had been resolved in past. Besides, the user can edit complaint status, request opinion from peers in terms of doubts. According to research findings, complaint overload is subjected to 75% of the companies. To eliminate the problem, the user can nominate another resolver if the user is unable to attend the complaint. Besides, the user can view the feedback provided by the peer for requested opinion. Moving on, the resolver can view the interactions he/she had with the distributor and send appropriate feedback to increase transparency which was one of the main concerns observed in the research findings.

The user is provided with an option to generate auto solution for complaints. Consider the following scenarios to understand the work flow.

Scenario 1 - if the complaint is *pack shortage*, the system will calculate the required stock and match with the available stocks in the nearby warehouse and prompt the solution with SLA days and number of stocks to be delivered. If in case, the stocks are not available, it will send the command to order stocks from order management and will command the logistics to deliver. Above mentioned commands are automated which has user control. Figure 4 represents the user interface of automated solution for scenario 1.

Scenario 2 – if stocks are repeatedly reported as non-moving items in a location, it means either the stock is not well promoted or lack of use in that location. In this case, DCM will highlight the issue and advise the user to conduct an activation program. This notification will be activated after the 6th time of the reported complaint.

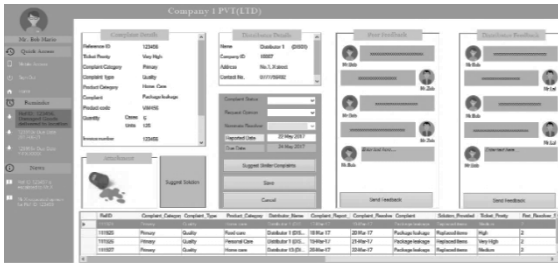


Figure 3. User interface of View complaints (Source: developed by author)

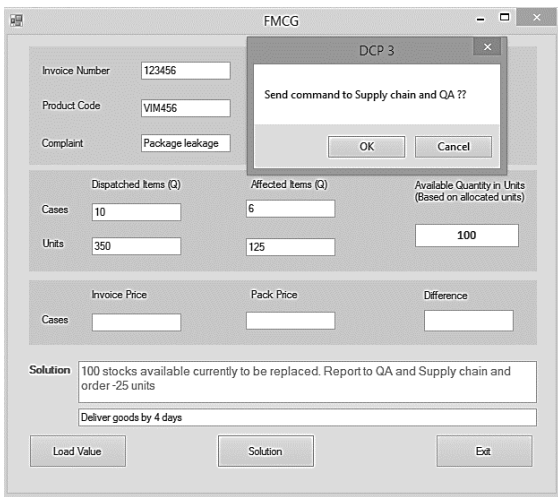


Figure 4. User interface of auto solution (Source: developed by author)

The above mentioned features were built in order to eliminate the problems explained in section 2.1 and 2.4.

7.1.3 Personal Profile

The user can view his/her personal and professional details, performance achievement and highest peer achievement in graphical and data view from this panel. This gamification concept will encourage the user to increase their productivity to maintain their profile which is monitored by CS department head. Moreover, personal score meter, complaint handling improvement are represented in graphical manner. Besides, user can view the comments received by the superiors (see Figure 5).

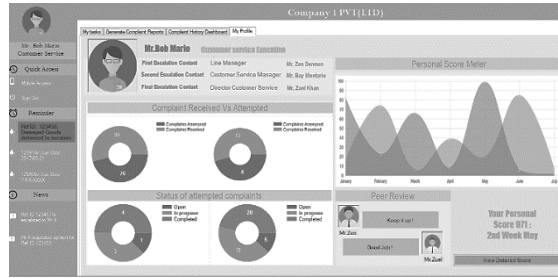


Figure 5. User interface of Personal Profile (Source: developed by author)

The achievement of the resolver depends on factors such as sum of customer rating and customer weightage, complaint attempted and complaints resolved. Based on the factors, Equation 1 was derived which was evaluated by field experts.

$$\text{Achievement} = \frac{\text{Complaints completed}}{\text{Complaints attempted}} + \text{Sum of service rating for completed} + \text{Sum of Complaint weightage} \quad (1)$$

Further, the user is entitled to view their score meter to check their progress by week, month and year. Refer Figure 6.

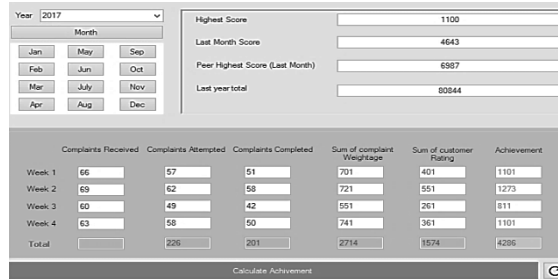


Figure 6. User interface of Score meter (Source: developed by author)

7.1.4 View Reports

Report generating feature was provided to address the problem stated in section 2.3. The user will be able to generate reports based on their preference which improves decision making. For example, the user will be able to view the highest complaint reported province, distribution point, product, complaint type, non-moving products etc.

7.2 Mobile Solution – Distributors

The distributor is entitled to report complaint, view real-time status, view dashboard of complaints and interact with FMCG companies. This set of features were built to eliminate problem stated in sections 2.2 and 2.5. It is to be noted that all the fields are pre-loaded and distributor have no necessity to type. This is mainly to avoid misunderstanding and typo errors. Besides, the application itself will direct the complaints to respective channels based on the “complaint type” to avoid the problem stated in section 2.2. The distributor will be provided with a toll free

and user-friendly complaint reporting platform. Refer Figure 7.



Figure 7. User interface of Mobile solution (Source: developed by author)

8. CONCLUDING REMARK

8.1 Business Solution

In brief, it can be indicated that the FMCG companies will have an enhanced complaint management process by bridging the communication gap. Elimination of the contributing factors of communication gap will increase the productivity and effectiveness of the process. Besides, the productivity of the resolvers will be enhanced due to the incorporated personal achievement concept. The business concept facilitates distributors for advanced reporting capabilities. The business solution imposes a standardized process across the distribution channel which will enable WIN-WIN situation for the business parties.

8.2 IT Solution

Project DCM provides an effective front-end solution for recording and managing distributor complaints with advanced set of functionalities to optimize the outcome for FMCG company resolvers. Functionalities such as alert facility and complaint prioritizing facility will increase process efficiency and reduce delay in attempting issues. Besides, proper record management will increase transparency in process where both the parties will have a visibility on the process. Suggesting similar complaints, auto solution, requesting feedback will minimize the knowledge gap. On the other hand, distributors are provided with self-service mobile application to report and track complaint status which will increase the likelihood of complaining and which in turn will minimize the communication gap.

9. RECOMMENDATIONS

- Business intelligence can be utilized to predict unknown correlations of big data and to optimize decisions further.
- The mobile solution can be enhanced further to be used for pre- purchase activities from distributor end and incorporated with company internal systems like SAP. Hence the distributors can have a single platform for all related activities.

- Mobile solution should be available in multiple languages such as Sinhala and Tamil to reduce the language barrier.
- The mobile application should track the time and reflect in desktop application to predict the most popular complaint reported time zone. This will help the resolvers to organize tasks accordingly.

10. DIRECTION FOR FUTURE WORK

The project is aimed at reducing the communication gap and enhancing the complaint management process. Instead, only general trade is focused where modern trade and new channels also need to be addressed. The identified barriers of communication gap and consequences might be constant but the variables might differ with market maturity. Thus, it is essential to continue the research domain to cope up with the change.

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Best of Breed ERP: A dashboard for strategic decision makers

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ABSTRACT 1-5

The success of an Enterprise Resource Planning (ERP) system is measured by the return on investment (ROI) it brings about to a business. Data is the core of an ERP system regardless of whether the ERP system is a full suite, or an incorporation of multiple best of breed vendors. Strategic decision makers usually make use of KPIs and other performance indicators which improve their insight into the operations of a business at a higher level. Best of Breed (BOB) solutions usually made up of custom tailor made modules, lack a central point for monitoring of data in an aggregated manner. This paper reviews and discusses how BOB solution users could gain a better ROI through a central point of data. A proposed design in the form of a centralized portal that would provide vital information in the form of a dashboard is discussed. The paper discusses the expectations of an ERP system vs. the reality of what is expected when BOB solutions are involved.

Categories and Subject Descriptors

Integration of business data to provide intelligence.

Keywords

ERP, CEO, ERP dashboards, dashboard, best of breed, CXO, ERP systems, CXO dashboards, KPI

1. INTRODUCTION

The success of an ERP system is measured by its ROI. ERP systems have reached many milestones since its first outbreak and have had significant impacts on businesses as defined by Gartner [1]. The definition of an ERP system is often referred to the synergy of multiple modules that solve a business process. As businesses implemented ERP systems problems arose in various forms. A major conflict that is noted, is the selection of an ERP system vendor with a full suite or using multiple vendors each branded as the best of their expertise (known as a BOB solution – best of breed).

According to the research conducted by Marwa et.al [2], there are several alternatives to shifting towards BOB solutions to obtain maximum return while large numbers were already headed towards full suite ERP systems. The clash between a full suite ERP system and BOB solutions is still a topic of debate because

variables such as structure and configuration of business operations will vary based on the implementations of these systems. The users' of ERP systems usually vary from the highest level of management to the least automation of a business process involved.

Businesses that use BOB solutions usually have the modules tailor made for the best management of their data and ensuring the real-time interoperation of each BOB vendor. Light et.al [3] have identified that while BOB solutions are carefully planned and well researched into, there are negative impacts on the requirements of IT skills from a business's perspective. A multitude of platforms and integrations come with a high cost of managing changes between modules. It's clear that a change on a single integration will indefinitely break the flow of an ERP system's real time data updating and retrieval.

A modern ERP system is now expected to provide intelligence to support in decision making and analysis of important data. ERP suites now come built with their own dashboards to aid in visualization of data that is of importance. It was identified by Wijaya [4] that there was a necessity and usefulness of a dashboard system to some extent for decision making. Key factors on the importance of data and scorecards were mentioned. Wijaya [4] also highlights on the fact that the main success factor used to measure an ERP system, is through the ROI which is gained through the assistance of higher levels of management who can make use of data that ERP systems provide.

Based on the information above, a gap is identified where BOB solutions seems to lack a central form of data visualization. A question arises: 'What is the intelligence a business/individual who uses BOB solutions can gain from the use of a central portal for ERP data?' In this paper we then go on to discuss how a central mapping of data, for BOB solutions, could provide a beneficial ROI. A proposed design infrastructure is discussed which involves the development of a centralized portal across BOB solutions. This centralized portal will serve as a single-sign-on (SSO) as well as a command and control dashboard of KPIs.

2. BEST OF BREED – USERS – OVERVIEW

The synergy of BOB solutions allows them to interoperate with flexibility with available resources and provide a seamless experience to users' due to its tailor-made nature. With the recent paradigm shift towards cloud, it has become effortless to run diverse solutions that will operate with another. Since the core of an ERP system is data, it is essential that it is used effectively as identified by Maas et.al [5] who have done a detailed study into the impact of how simply the 'usage' and 'control' defines success in terms of ERP. According to their study, they hypothesize that the 'greater the infusion' provided by the ERP system users', the more positive the overall outcome is going to be.

ERP system users' in general will vary from the least automated task across all modules to the higher levels of management. Each user is somehow going to be involved in at least one module or another. An overlap occurs as the management level increases. Maas et.al [5] also identified this in their research to show that a system is not successful unless it's being used to its fullest extent by the users. When it comes to BOB solutions, the advantage gained over a full ERP suite is that it's easier to gain access to specific data from a BOB vendor for those who are involved in only a single module or so.

BOB solutions have gained their name for being the most effective solution that is applied to solve a particular business process. Considering the comprehensive study conducted by Maas et.al [5], it is evident that there definitely is a variety of users' required to bring the best out of an ERP system. Adding on to that Govindaraju et.al [6], mention that there is a 'significant influence' by higher levels of management which makes the implementation of ERP systems seamless. In order to influence acceptance of ERP systems, it is understandable that higher levels of management are capable of comprehending the various modules and data provided by the systems.

3. PROBLEM REDEFINED

In this section we define the problem with the usage of BOB solutions that can cause it to lose its value and prove unfulfilling in environments that meet the following conditions.

- Data is the core of an ERP system. With BOB vendors comes multiple points of data, which will of course interoperate, but are each in their own 'shell' (module).
- Users – The number of users for an ERP system are significantly large. Users' may overlap in certain modules where the overlapping increases at higher levels of management, who are the ultimate decision makers.

It was noted by Simonsen and Nielsen [7], that knowledge sharing is expected from an ERP system once implemented, to enable strategic decision making and gain operational efficiency. BOB solutions, being decentralized in terms of vendors, lack the ability to provide an immediate big picture.

Transparency of data in a nutshell is something that BOB solutions cannot provide, compared to a full suite ERP. In the works of Wijaya [4], it was identified that a dashboard that could aid full suite ERP users to gain a much bigger picture from their central data point, and is beneficial to the ultimate decision makers.

BOB solutions are ultimately expected to bring about the same return or greater than what is to be gained from the usage of a full suite ERP.

Considering the technical knowledge and requirements noted by Wijaya [4], it is evident, that to higher levels of management, key metrics is what is they look at as an ERP system user. In terms of BOB solutions, the multiple points of data access and data representation makes things harder to gain key metrics and performance indicators, which were identified.

4. IDENTIFICATION OF PREVIOUS RELATED WORK

With the problem being clearly defined, pointing out the gap that exists, previous attempts at similar work are outlined.

- A dashboard to enhance performance of ERP systems was attempted along with the identification of 'Critical Success Factors' which could prove useful identified by Wijaya [4].
- The adoption and success factors of BOB solutions identified by the research conducted by Elghany et.al[2].
- Omar and Gomez [8] have conducted a research on the scalability of modules in the rapidly increasing usage of mobile ERPs'.

While there is definitely sufficient research on the debate of full suite ERP vs. BOB solutions and identification of metrics, critical success factors (CSF), there is definitely a gap in solving a fundamental yet simple problem that could benefit BOB solution users to benefit and gain an ROI on their BOB vendors.

5. PROPOSED INFRASTRUCTURE

As outlined in Section: 'Problem Redefined', we define the requirements that are required to be satisfied in order to provide a better ROI on users' of BOB solution ERPs'.

- A higher level of management is able to give maximum input so is therefore a more suitable user of a dashboard system where key metrics,

KPI will play a larger role, allowing stronger decision making and planning.

- There are multiple points of access to data, and data is accessible externally. This is to ensure that there is no difficulty or unnecessary steps taken to access data, and also to ensure that data is available for a tool to be designed.

For higher levels of management, ideally what is needed is the ability to view key metrics, instead of mining through data for what may be irrelevant. It was identified in [9], that one of the most expected outcomes from a completed ERP system is the visibility of information. As depicted in Figure 1, it is possible for businesses to employ the use of a central dashboard that will provide real time insight on data they prefer. A middleware tool can be designed with SSO to provide central access, then be integrated with the externally available data from each BOB vendor. Data integrations from BOB vendors will require a hierarchical data model to be well defined for data lineage. An extension in the form of a mobile component can be considered which the way forward is [8], [10]. It is then possible to look at the components that could be employed to meet the outlined architecture.

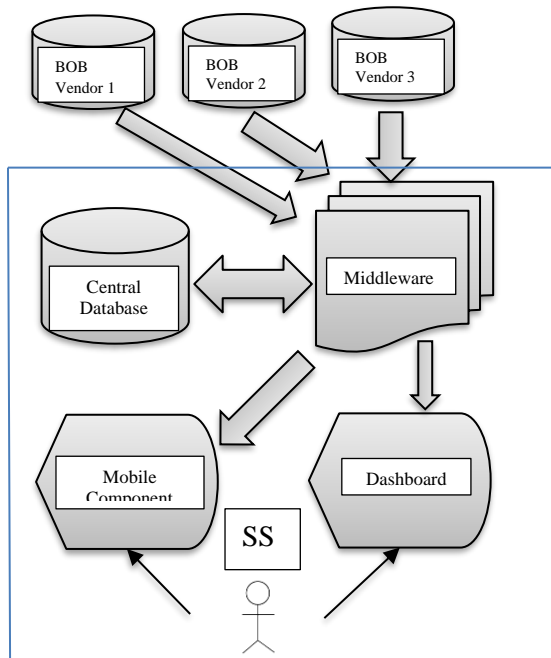


Figure 1. Proposed Design Infrastructure

5.1 Functional Requirements

5.1.1 Multiple points of entry to access data from each vendor

Since each BOB solution is going to specifically solve a functional module or more of the business, it will have its own login/sign on to access information. As outlined in Section: 'Problem Redefined', there is a high chance that ERP users' overlap, causing a multitude of user access levels and logins to these

BOB vendors. In contrast to the access to unnecessary excess data from each vendor, higher levels of management will not need to maintain multiple logins, but a single common account to access the specific, more valuable data they need.

5.1.2 Ability to pick data for key metrics

In this situation it is expected that the users of the tool should be able to customize only the metrics and indicators they need. Irrelevant data should not be forced allowing maximum customization.

5.1.3 Provide Intelligence

Various tools exist to provide business intelligence for ERP suites. Major examples include Microsoft Power BI [11], SAP Business Objects BI [12]. For BOB solutions there is gap in literature as to how businesses cope up with intelligence. The tool is going to use key metrics, KPI, to provide users with data from multiple BOB vendors.

5.1.4 Mobile Extension

Mobile is going to be another key extension point, considering the rapid advantages that could be gained. Omar and Gomez have gone through an extensive research on the usability of mobile apps in an ERP context [8]. Omar et.al have identified a 'heuristic checklist' [10] that is going to aid not only for the mobile but the dashboard tool itself.

5.2 Operability Requirements

5.2.1 Diverse number of integrations

Powell (et.al) [13] have shown how SSO can successfully be implemented to some extent across diverse cloud environments. Similar communications will play a part in the interoperability between BOB vendors and the tool. A hierarchical data model will need to be designed for each integration as metrics will need to be prioritized and categorized for data lineage.

5.2.2 Fault Tolerance

The tool will ensure that at any given time users are able to access the tool irrelevant of the status of BOB vendors. The technology and infrastructure used to design the tool must be stable enough to be capable of handling alternate flows, and BOB vendor faults. An event management system could be employed to assist in fault tolerance.

5.3 Ease of access & use

5.3.1 Easily accessible

The tool should be accessible to ensure that data is readily available, where the mobile component especially is to play a major role.

5.3.2 User Interface/experience

The tool is expected to be easy to understand and use, while maintaining performance to ensure higher levels of management are able to utilize it to its maximum.

6. BOB INTEGRATOR OVERVIEW

The BOB integrator requires two major components, the middle-tier component and the Web/Mobile component. The middle-tier is used in the mapping of the BOB vendors to a SSO, and the Web application is required to support infrastructure required to satisfy mentioned in Section: Possible Infrastructure Design (A: Functional). Individual breakdowns of the components are explained below.

6.1 Middle-Tier

Since there is going to be SSO involved, it has been decided that using an existing solution to integrate with WSO2 Identity Access server which enables the use multiple protocols including SAML [14], which is going to be used for the SSO. WSO2 is being considered since it is completely open source and is already enterprise integration ready. This removes the need for an SSO to be designed from scratch and solves the interoperability mapping of BOB licensing. A micro service architectural approach is going to be implemented on the connector level between the tool and BOB vendors. This approach is taken primarily to ensure fault tolerance and robustness is maintained on the tool [15].

6.2 Web Application

A web portal will be provided to access the tool which will comprise of a SSO login and then the dashboard. The dashboard is to be configurable with a UX such that higher levels of management are going to be capable of adding their BOB vendor data sources and then deciding what data they wish to visualize. Currently it is not decided what technology stack is going to be used to communicate with the middle-tier. An extension could be developed in the form of a mobile app following the rules discussed by Omar and Gomez, Omar et.al [8], [10], enabling optimal usage of the tool.

7. CONCLUSION

Through the course of this paper, from a broad level of the problem definition to a proposed design infrastructure, it is evident that there is an identified gap. The main arguments are based on the point that the main purpose of an ERP system is to bring about an ROI. To achieve this there needs to be transparency in data, access to this data and valid input from decision makers.

The proposed design infrastructure is of a very high level to simply map out the possibilities. There are further gaps that could be considered as future enhancements, such as knowledge sharing to be

implemented on the dashboard, increasing intelligence on the dashboard to mirror strategic decisions of a decision maker through training and learning.

8. ACKNOWLEDGMENTS

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SimplyFresh: Effective consumer participation in organic initiatives and creating awareness in Sri Lanka

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ABSTRACT 1-6

Organic food has gained popularity around the world due to its nutritional benefits and has now become a symbol of fashion and status. Many organizations are now coming up with different intermediaries and IT platforms to sell organic produce around the world.

The concept of organic food has now reached Sri Lanka and many organizations and government in Sri Lanka have created different channels to offer consumers organic produce. But it is quite evident that not all consumers get to indulge in chemical free fresh organic produce such as vegetables, fruits, herbs and green leaves which is unfair, as all consumers are entitled to access food that are nutritious and healthy and need to be given a choice. Hence it is quite obvious that there are many issues with the current organic initiative program in Sri Lanka, such as lack of awareness on conventional and organic produce, negative attitude and perception, limited accessibility to organic produce, price and certification which has led to consumers not engaging in current organic initiatives. Based on this background, the paper aims to analyze why consumers don't participate in organic initiative and design and develop an IT intelligent solution where all consumers can participate in this initiative or purchase organic produce. This research focuses on promoting organic food produce and making them available for the consumers to purchase at a reasonable.

The key factors: health, effort, quality, status, price, safety, trust, value and economy which influence consumer participation of the organic programs were identified and an effective conceptual framework was create. Mobile based IT solution was recommended to increase the consumer engagement to support organic initiative of the country and motivating to consume healthy home-grown food.

Categories and Subject Descriptors

D.3.3 [Software and its engineering]: Language Constructs and Features – *abstract data types, data structures and algorithms, polymorphism, control structures*. Software modelling, hybrid mobile computing.

Keywords

Organic produce, organic initiatives, conceptual framework, home gardener

1. INTRODUCTION

Sri Lanka is quite famous for their diverse cuisines which involve different traditional dishes and healthy beverages such as *kola kanda*, which is consumed for breakfast and ending the day with *mallung* and with assortments of vegetables. Living in an island that is rich in exotic fruits and vegetables, the food is expected to be immensely healthy and nutritionally wholesome and not just cater to taste. However, despite this, we see an alarming number of adults and children falling sick which is mainly due to the poisonous chemicals present in their food. Fig. 1 shows the increasing number of admission and fatalities due to pesticide poisoning [1].

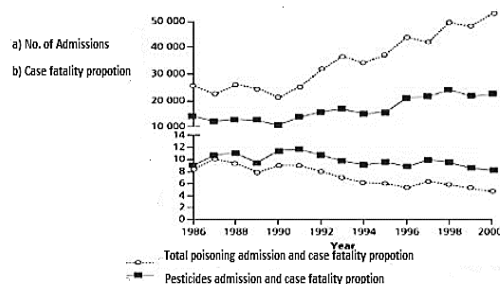


Figure 1. Number of admissions and fatality cases in Sri Lanka

According to Asian Tribune [2], Sri Lanka uses a large quantity of pesticides in order to mitigate increasing pest and weeds in crops. It is said that pesticides may alter psychological processes that influence the uptake and metabolism of food constituents needed for the optimal growth and development. Interference with such processes can result in disorders of overall growth or functional disorders of specific organ systems.

But gladly times are changing. With the emergence of social media, people are now aware of the harmful effects of pesticides. According to European Commission, 2012, Europe and America have the

biggest organic agriculture sales, then comes Asia and finally Africa. In order to encourage consumers to purchase organic produce, Europe and America have implemented different organic initiative programs incorporating IT where consumers could purchase organic produce through website and other systems where consumer could check for the closest organic store through mobile apps which makes it easier for the consumers to actively take part in these initiatives.

Small organizations, and organic markets are also popping up in Colombo and few supermarkets have also reserved a small section to sell organic produce. But these are mainly targeted at the elite crowd and don't reach all consumers. All people need to be given a choice by making healthy organic home grown produce available at their fingertips. Consumers have the right to know what's in their product, where they are made, how they are made and by whom. For this purpose, consumers should be given the right to pay a visit to the garden plot to see how their produce grows. Hand plucking produce during the harvesting period is considered an educational experience and also is an interesting hobby. But unfortunately not all Sri Lankans can experience it unlike other countries. All people deserve a firsthand experience of plucking their own produce and providing their family a healthy disease free meal. Thus it is clear that there is a clear issue in the current organic initiative programs in Sri Lanka and a need to implement a comprehensive solution which will enable all consumers to access and consume organic produce and to consume food that is safe and healthy.

1.1 Problem Domain

People are now more educated on harmful effect of consuming food consisting of chemical fertilizers and are more selective in what they are eating and are now more interested in growing produce in their home backyard and eating it fresh as organic home grown produce are much safer and healthier. There is a high and increase in demand for home grown organic food in Sri Lanka [3] [4]. This study focuses on following four key factors that influence the consumer engagement to the organic food initiative in Sri Lanka: Negative perception and attitude towards home cultivation, Lack of awareness and motivation for home-grown options, Limited accessibility to organic produce, Price of organic produce is very high.

2. METHODOLOGY

A combination of qualitative and quantitative research methods is used to meet different objectives of the research process. Qualitative research was used to identify the perceptions and attitudes of people. Face to face interviews were conducted with unhappy consumers who are victims of poisonous chemicals, Home- growers who want to earn an income and consumers who seek organic foods. Questionnaires

were given out to respondents for the statistical representation of the findings in the study.

Non-Probabilistic sampling technique was used due to the limited time period and its impracticality to cover all Sri Lankan consumers and Home-Farmers. Within non-probabilistic technique, purposive technique was used there is a higher chance of data being more accurate.

Five key administrative personnel in the country such as Duminda Disanayake (M.P.) - Minister of Agriculture, Achala Samaradivakara Maddumage – Director, Good Market, Dr. Hashir Ariff – Consultant Pediatrician, Dr. Ranil Jayawardena – Consultant Clinical Nutrient, Kalinga De Silva – Founder, Grow Your Own Food (GYOF) were interviewed to find out the national organic program and current usage of organic. Further ten interviews were conducted with unhappy consumers who are victims of poisonous chemicals, Home- growers who want to earn an income and consumers who seek organic foods. The questionnaire was filled by 61 consumers and 25 home growers which is 60% response rate. The data analysis was done using excel and interpretations were based on analyzing various factors.

3. FINDINGS

Out of the 86 Sri Lankan respondents (both consumer and home grower), majority of the respondents are between the age of 20-30 years of age and located in Colombo. 73% of the respondents believe that organic food is much healthier and the remaining 18% respondents are unsure about it. They also feel safer about the idea of purchasing organic produce straight from the garden as it is healthy and contains no chemical fertilizers. The findings showed 73% consumers perceive organic food contains more nutrient compared to conventional food which proves the findings of Lockie et al (2004).

Organic produce is considered somewhat expensive; it was learnt that out of 61 respondents the infrequent organic purchaser felt organic food was more expensive as opposed to frequent purchaser who considers quality factor. This is one main reason as to why people opt not to purchase organic food as it acts as a barrier as proven by Dickieson and Arkus, 2009.

There is a major concern for food safety. Majority (42.60%) of the respondents are well aware of the harmful effects of poisonous chemicals present in the conventional produce and in the genetically modified food. Respondents were more concerned over pesticide contamination in their food. It was also learnt that infrequent purchasers of organic food are less concerned about food safety which supports Dickieson and Arkus, 2009.

Following figure 2 shows the likelihood of consumers helping each other by selling and buying organic produce and raising awareness. The results show that 54.1% of the consumers/home-gardeners would buy

and sell organic produce from the closest neighbor and will help create awareness.

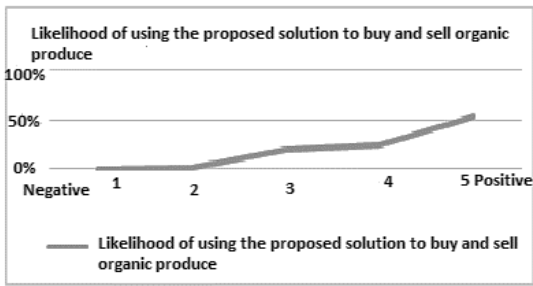


Figure 2. Likelihood of using the proposed solution to buy and sell organic produce to help the community

10% of the respondents trust organic labeling and marketing which is the certification before purchasing organic produce. This shows that consumers are very concerned when purchasing organic produce from shops and request to produce a certification as evidence

65.6% of the respondent (both consumers and home-growers) strongly prefers organic produce over non-organic food. 24.6 % of the respondents agree over organic produce preference and 9.8% of the respondents remain neutral insisting they prefer both organic and non-organic produce and none of the respondents preferred non-organic produce over organic produce as shown in figure 3. Hence showing that majority of the respondents feels that organic produce is better than non-organic produce and thus showing more preference towards it and the minority feels there is no difference as shown in Figure 3.

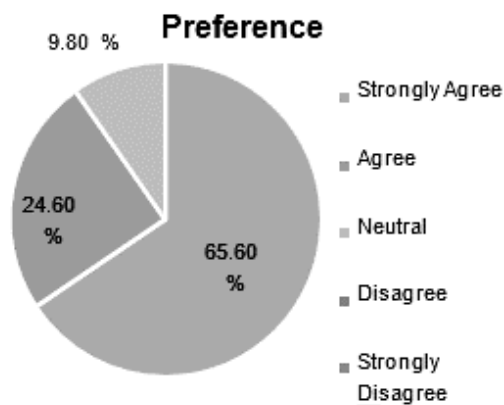


Figure 3. Preference

Majority of the respondent (27.90%) are unsure if organic produce is only meant for rich and health conscious people or for all. 18% of respondents strongly feels that organic produce are only meant for

rich and health conscious people while 19.70% respondents strongly feels that organic food is meant for all consumers whether rich/poor, health conscious/not as shown in Figure 4.

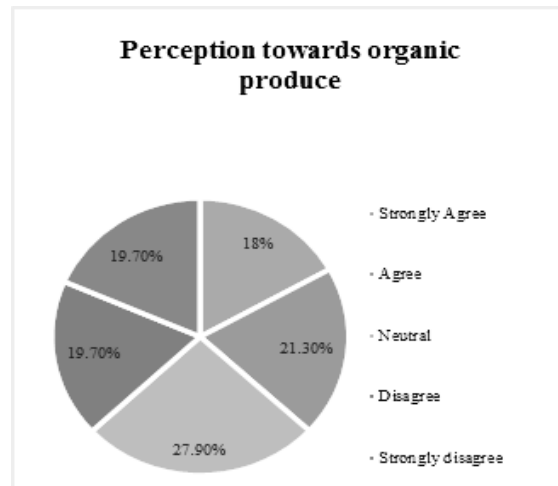


Figure 4. Perception towards organic produce

Majority of the respondents showed interest in gardening and 27.9% remain neutral about gardening while the rest shows disinterest in gardening which shows the perception of respondents towards gardening. Respondents even though they lack knowledge on gardening show an interest towards learning gardening while minority of the respondents shows a negative interest toward gardening.

Consumers are aware of the presence of chemicals in the food they eat and yet they are somewhat unwilling to put in an extra effort to buy organic produce indicating an unwillingness to put in any extra effort above what was required to purchase conventional food. This research also shows majority of the consumers possess no knowledge of places where organic produce could be bought in Colombo. This has led the consumer to purchase conventional produce which is readily available in the market as shown in Figure 5.

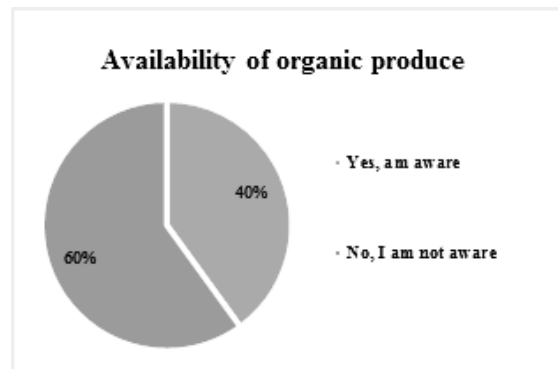


Figure 5. Knowledge on availability of organic produce

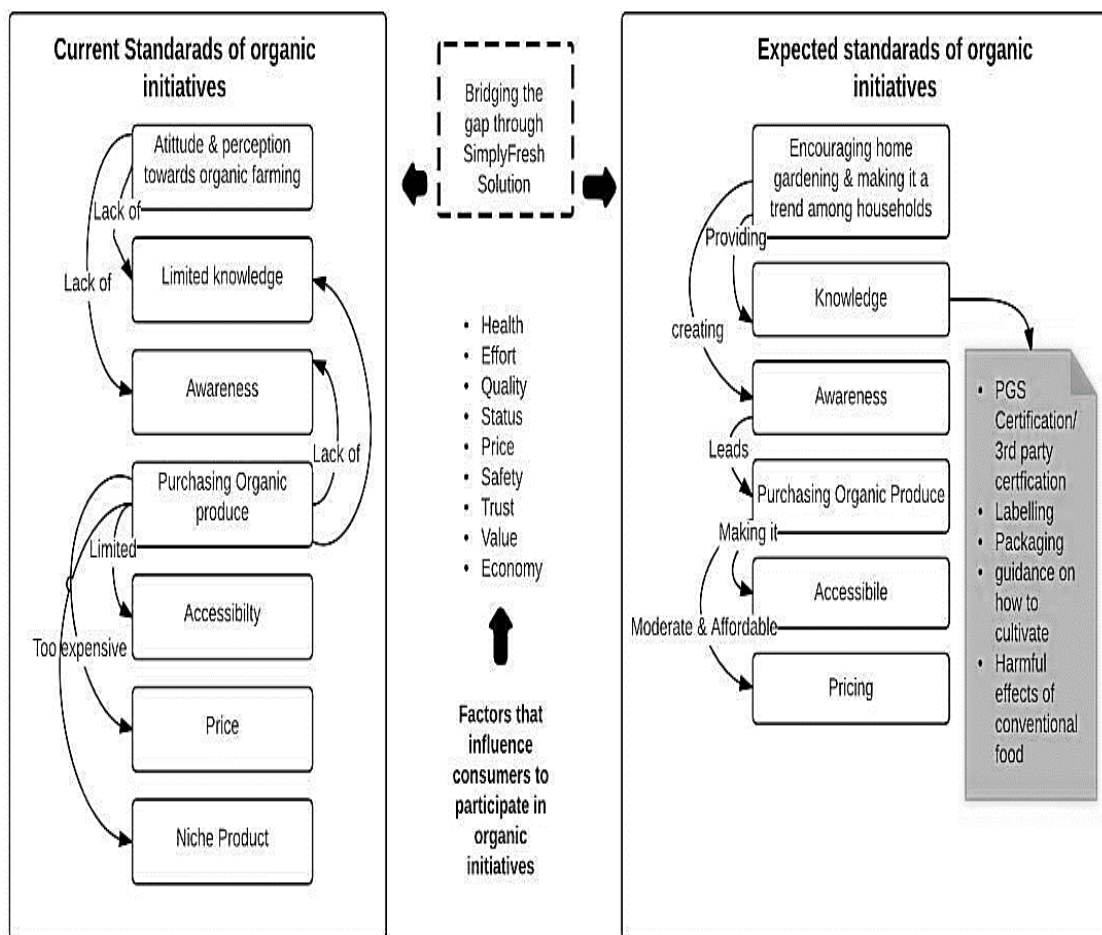


Figure 6. Factors influence consumers' involvement in organic initiatives

4. DISCUSSION

Sri Lanka has come up with various organic initiative programs but they are not effective and does not reach all consumers or encourage all consumers to participate. This has led to consumers being dissatisfied with the current programs and conveniently opted to continue purchasing conventional food.

There were seven main issues with the current initiative that were identified through questionnaires distributed and interviews conducted which are shown on below figure 6.

A IT solution 'SimplyFresh' proposed to bridge the gap between the current initiative program and expected initiative program which is shown in figure 5. This proposed 'SimplyFresh' mobile application focuses on efficient and effective ways to encourage consumers to purchase and home grow organic produce. This solution includes awareness of organic food benefits and home-grown cultivation, market place to purchase organic food either on-line or firsthand experience of plucking fresh food from the closest garden and receiving ratings and reviews which are used to identify the best home-growers in the country. This will motivate the home-growers to highly engaged in the organic initiative program.

4.1 Solution

SimplyFresh mobile application focuses on providing an intelligent IT solution for the consumers by acting as a platform to buy and sell home grown fresh organic produce for an affordable price by showing the closest neighbor whose growing organic produce and aims to increase awareness on the benefits of consuming organic food and harmful effects of consuming conventional produce. SimplyFresh guides and educates small scale home growers on cultivating organic produce. This mobile solution allows the buyer to experience hand plucking fresh organic produce during the harvesting period. It also has a community where local small scale home growers can communicate with each other sharing tips and providing information. SimplyFresh also shows what local food are in the season and provides seasonal recipes to best use the fresh local ingredient.

SimplyFresh also addresses one main issue faced by the society today which is unemployment. There are many consumers who are single parent, house wives and retired who are struggling to earn an income. SimplyFresh helps them start up their own farming plot in small scale and then later expand. It will act as the source of income for individuals, stay at home mothers, retired people and etc.

SimplyFresh thrives to motivate users by making it fun and easy for consumers to cultivate their own organic and healthy produce and making it available for consumers while helping the home growers to earn an income. It focuses on small scale gardening and later expanding as time goes on.

Table 2. Evaluation of existing solutions

	Simply Fresh (England)	Kitchen So (Kenya)	Farm 2K (India)	Organic Guru (Sri Lanka)	SIMPLY FRESH (Sri Lanka)
View the closest home gardener selling organic produce	No	No	No	No	YES
View location of organic stores	Yes	No	Yes	No	YES
Sending daily educational SMS notification to the users phone	No	No	No	No	YES
View article on home-gardening methods, organic benefits etc.	Yes	No	No	No	YES
Select garden visitation to experience hand plucking produce garden visitation	No	No	No	No	YES
Sells organic produce organic	Yes	Yes	No	No	YES
Home delivery	Yes	Yes	No	yes	YES
User can rate and review farmer	No	No	No	No	YES
User can view prices		Yes	No	Yes	YES
Available on mobile app	No	No	No	No	YES
Share, view and comment on recipes on organic produce	Yes	No	No	No	YES

4.2 Evaluation of existing solutions for organic initiatives

There are many countries that have implemented IT solutions that sells organic produce and home delivers it around the world. But there are also many short comings in these solutions that have not addressed the main issues.

SimplyFresh mobile app is first IT solution in Sri Lanka that aims to increase consumer participation and to create awareness while ensuring that all consumers have access to organic produce. In order to further justify the novelty and uniqueness, a comparison of SimplyFresh mobile app features and other systems have been carried out as shown in table 1.

4.3 Alignment of proposed IT solution features with problem domain

The proposed IT solution is developed as a hybrid mobile application that could be distributed for Android, iOS and windows mobile platforms. This is because to provide convenience for users to purchase and access organic produce where ever they are.

In addition, SimplyFresh mobile application uses Social Network Technology where consumers and home-farmers can create profiles and interact with each other by sharing recipes and providing ratings and reviews to home grower, so that users could select to purchase from a specific home grower based on the ratings and reviews. Table 2 below illustrates how the problem domain has been addressed by the features of the proposed IT solution.

Table 3. Alignment of proposed IT solution features with problem domain

Problem domain	Functional Requirement		Features in the mobile app
Awareness	F1	Upload articles, news feed, stories	The app ensures that awareness is created among user by sending daily messages to the user's phone about the harmful effects of chemical fertilizers and also guides user to start their own organic home cultivation
	F2	view articles, news-feed and discover stories	
	F3	Share articles, news-feed and discover stories	
	F4	Receive daily message on awareness of organic produce on his/her phone	
Attitude and perception	F2	view articles, news-feed and discover stories	The app ensures that users attitude & perception towards organic

	F5	Receiving ratings and reviews based on the service provided	produce is changed by educating users through related articles and stories.
	F6	Generate sales and revenue	Also receiving ratings and reviews, and generating revenue encourages home growers to involve in home organic cultivation
Accessibility	F7	view the closest neighbor selling organic produce	The app ensures that consumers can access organic produce with little effort. The app also acts as a platform for sellers to sell their home grown excess organic produce
	F8	View the consumer location	
	F9	Search by preferred product/ location/ closest home grower by preferred / closest	
	F10	view list of organic produce	
Price	F11	Admin shall maintain prices for all organic produce sold on the app	The app ensures that the organic produce sold through the proposed solution will have the same price as the conventional produce
Certification	F12	View organic certification of each home grower	The app ensure that users can view organic certification of each home grower in order to build trust. Also the app ensure to educate user on different organic certification available and the process to get certified
	F13	User can learn how to certify his/her products	
	F14	Admin shall upload articles, news feed, discover stories related to organic produce	

5. CONCLUSION

As proven in this research, there is a big gap in the current organic initiative programs that has not been addressed yet and a new solution would be a big breakthrough as it solves many issues. The key barriers identified are resolved through an effective mobile based IT solution by creating a platform where consumers and home –growers can buy and sell organic produce, and by creating awareness and making sure that all consumers are given a choice by making organic produce available at their finger tip. This proposed solution will have a rippling effect in the health sector, productivity and economy of the country.

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SOFTWARE ENGINEERING AND EXPERT SYSTEMS

A Review of Modelling Experts in Question & Answer Platforms

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ABSTRACT 2-1

Question and Answer (Q&A) platform are a growing mode sharing knowledge. Where a person can ask questions and one or many experts can provide answers to that, but with the growth of user engagement in such platforms the experts who provide answers to the questions have reduced. Due to this the quality of an answer completely depend on an expert so to overcome the challenge of finding experts based on their interest and willingness to answer questions have become commonly discussed topic. For a question asked the system should provide a group of the most appropriate experts who are in the domain of the question but also the likeliness of an expert to answer that type of a question.

Keywords

Expert Identifications, Question and Answer platforms, Expert finding

1. INTRODUCTION

With the growth of question and answer platforms more and more user engagement while sharing the knowledge as well as gaining reputation among users. "Since the early 2000s, online Question and Answer (Q&A) services have become popular on the Web and, according to a Hitwise report, there was an 889% increase in visits to online Q&A services between 2006 and 2008 within the U.S" [2]. Since the popularity of these services different types of Q&A platforms have emerged and they are helping the community to fulfill the need for information [2]. These Q&A platforms "acting not only as a medium for sharing technical knowledge, but as a place where one can seek advice" [1]. Every day, there is an enormous amount of knowledge and expertise sharing exchanged online [1]. As stated by Choi, [3] there are mainly four types of Q&A services considered with the unique characteristics exposed these are, community-based (e.g., Yahoo! Answers, StackOverflow), collaborative (e.g., WikiAnswers), expert-based (e.g., digital reference service), and social Q&A (e.g., Facebook).

As the number of questions grow the users who are capable of answering should be also kept enthusiastic to answer. Enthusiast crowds are considered valuable,

scarce resource in Q&A platforms [4]. Also there are various techniques that Q&A platforms use to keep users engaged, one such way is that adding game mechanics with the help of a reputation system to make a competitive environment to the experts [9].

As said by Yang et al., [12] that the nature of experts, their activity behavior place a major role when answering the questions.

So to find experts and match them with the questions asked will be a sustainable way for Q&A platforms to get a good rank among the others. But finding experts is not an easy task where we can consider a few parameters and weight them, this classification should be done considering their expertise area, behavioral patterns, rankings and many more related criteria's. The topics of finding experts, expert modelling and analyzing of user behavior in Q&A platforms is a commonly discussed area by the researchers but it needs to be improved with the current growing trends and techniques of data modelling rather than the traditional methodologies.

2. DIFFERENT METHODS FOR MODELING EXPERTS IN Q&A PLATFORMS

Modeling of users has been studied widely and different methodologies have evolved with the aim of solving the problem of finding experts in Q&A platforms. As stated by Li, Jin and Li, [7] the methods of modelling users can be categorized into two link based and topic based. Link based methods graph the users according to the structural properties and the ranked according to a set of pre-defined rules [7]. Topic based methods captures the topic information and then evaluates the interests of the user.

A common format of a post in a Q&A platform consists of the following components,

- Post title/topic
- Content (question body)
- Author of the post
- Users engaged, who we called experts
- Post tags
- Votes

Research work is done using one or more and combinations of different components to weight and model the experts in such platforms.

2.1 Link Based Models

Link analysis can be considered a very important data analysis technique, and the two most used link analysis techniques are PageRank [10] and HITS [5]. Where PageRank will measure the importance of a single page and its linked pages and HITS will score the value of the content and the score the value to its links.

Jurczyk and Agichtein, [5] presented an adaptation of HITS algorithm which summarizes the user relationships in a multi graph. They have only have taken the links between the experts into consideration and not the history of the feedback attributes like votes or selection of best answer to calculate the authority estimation. As a query topic the question category is used and then calculate the hub and the authority values of an expert.

A PageRank [10] like algorithm called ExpertiseRank was proposed by Zhang, Ackerman and Adamic [13]. They constructed an algorithm which measures the number of experts linked also with the relationship among the question author and the expert. The proposed system was tested and evaluated on Java Forum network and they concluded the research with the simplicity of ExpertiseRank algorithm which was nearly good as a human rater.

As Zhou et al., [14] states that link analysis techniques are not effective since it ignores important factors like expertise, interests and reputations. Where Jurczyk and Agichtein, [5] also concluded their research by proving that the link analysis technique used have performed well for some categories and not for some, this clearly shows the failure when modeling experts in Q&A platforms using the link based HITS algorithm.

2.2 Topic Based Models

Topic based expert modelling techniques uses the topic of a question as the deciding factor to find expert interests and rank them accordingly. Topics play a major role in Q&A platforms which are used to clearly distinguish unique questions [9] and these platforms have enforced various techniques to prevent duplicate topics to be discussed.

Zhou et al., [14] proposed a topic sensitive probabilistic model for modeling and finding experts in Q&A platforms. Their goal was to measure the topical similarity among the experts and the question authors with the proposed solution which mainly focuses on the following,

- **Topic distillation** to identify the experts based on the interest in topics
- A **topic sensitive** method to find experts(model) that uses topical similarity and link structure
- **Ranking of experts** on a probabilistic model taking user expertise and reputation into consideration

The researchers Zhou et al., [14] did not use Latent Dirichlet allocation (LDA) which represents content as a mixture of topics for distill the topics since the questions tend to be very short. They proposed a user-topic model which topics are linked with a user also the users who are linked with a topic, a topic sensitive random surfer model (TSPR) which constructs a relationship between authors and experts with the topic-sensitive question-answer. Then the candidate experts are ranked according to expertise and reputation where a good expert is considered where there is a balance between the expertise and reputation.

The topic sensitive approach by Zhou et al., [14] has clearly outperforms the standard LDA approach where each question was treated as a separate document.

2.3 Hybrid Models

As topic-based models are imperfect since the length of the topics are not convincing enough and they lack of meaningful words [7] and the link based models lack important factors the researchers had started hybrid models to overcome the fallbacks of traditional methods.

One such hybrid model is proposed by Li, Jin and Li, [7] which is called hybrid analysis model (HAM). This model is a combination of several models and techniques overcoming the issues with them. HAM analyses the tag of question first but it uses similar words for the tags taken from Wikipedia¹ dataset, also with tag-LDA it leverages the efficiency of tags and words distributed in a topic. Also HAM uses the best answers and the votes to consider in link analysis making it a combination of PageRank topic-sensitive algorithm and tag-LDA to calculate the score for each user.

Also Kao, Liu and Wang, [6] came up with another novel hybrid model which only consider the user(expert) authority including user reputations, category based authority and subject relevance.

The proposed framework can be broken into three scoring approaches,

- **Knowledge score** – user knowledge profile and user reputation
- **Authority score** – user authority

¹ <https://wikipedia.org/>

- **Expert score** – combination of knowledge and authority

Initially a knowledge profile is created for each expert on a category basis where an expert can have knowledge in more than one domain, this profile is build weighting the votes, evaluation and the time factor. Time factor is a very unique attribute considered by Kao, Liu and Wang, [6] which weights according to the time the question and answer was posted. Then the authority score is calculated with a link analysis of the category using the HITS and PageRank algorithms. Finally, the expert score is calculated using the expert's knowledge score and reputation on the targets subject domain. This research work can be considered as improving the quality of expert profile modeling techniques which were carried out on previous work.

Another approach was taken by Hanrahan, Convertino and Nelson, [4] which combines expert ranking and the Z-score as stated by Zhang, Ackerman and Adamic, [13]. In this study the expertise was calculated in different roles like "Questioner expertise, Accepted Answerer expertise, etc."

The authors Li, Jin and Li, (2015) [7] prove that there is around 7.79% improvement with the hybrid analysis model with the same dataset which was used for previous experiments. Kao, Liu and Wang, [6] proves that an experts knowledge profile is more important that the reputation on the selected subject domains. Also the subject relevant scoring contributes more in expert finding that the authority score derived from link analysis.

2.4 Other Models

Pal, Harper and Konstan, [11] presented a new measure called question selection bias to study the user behavior and modelling. This simply indicates the preference of an expert to answer questions in different stages of completeness. The study presents a psychological side of the experts which states scenarios where some users prefer to answer questions with few good answers (existing values) and some consider to answer low existing value question which can be analyzed with the past behavior of them. Also this study uses techniques to analyze the emotions positive/negative of the content in posts where it is weighted and added to bias-based learning model. The authors have found out experts have high probability of answering questions with low existing values and that selection bias can be effectively used to identify potential expertise in their early stages of engagement.

A study by Liu, Croft and Koll, [8] has experimented with information retrieval (IR) techniques to build user profiles in order to find experts in Q&A platforms depending on the text that is used. It is a characterization derived from the previously answered questions.

2.5 Comparison of Models

Table 4. Comparison of existing approaches

Methods	Authors	Method/s	Attributes	Conclusions
Discovering authorities using Link Analysis	Jurczyk and Agichtein [5]	Link Analysis - HITS	Relationship (links) between users	Not effective since it ignores important factors like expertise and reputation
Expertise Rank	Zhang, Ackerman and Adamic [13]	Link Analysis - Adaptation of PageRank	Relationship among the question author, the experts and vice versa	Simple adaptation of PageRank algorithm was
Topic-sensitive probabilistic model	Zhou et al. [14]	Topic based	Topics that users are interested	Outperforms the standard method LDA
Hybrid analysis model (HAM)	Li, Jin and Li [7]	Hybrid. Combination of topic-sensitive PageRank algorithm and tag-LDA	Tags and 10 similar words, topics	Improved of the topic-sensitive algorithm has showed a 7.79% improvement
Novel hybrid approach	Kao, Liu and Wang [6]	A hybrid approach combining knowledge, reputation and authority of an expert	Quality measures such as time factor, voting, evaluation and user authority	Subject relevant scoring contributes more in expert modelling

Question selection bias	Pal, Harper and Konstan [11]	The experts psychology aspects are taken into consideration and identifying of the user preference in the existing answer state	Previous answers, emotions in text	Experts show high probability of choosing questions with having low existing value
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3. PROPOSED HYBRID SOLUTION

With the review of the previous work it is clear that the traditional techniques of experts finding is not efficient and accurate. Also by considering few factors and weighting an expert in the present is not the correct way to go. Topic or Link analysis models are also outdated now since there are drawbacks. So we propose a hybrid model, it is clear that the hybrid model is efficient than the link analysis and topic analysis. Also the bias method shows that identifying expert's behavioral patterns plays a major role as well unlike the knowledge and the rankings.

With the following factors considered the solution is more accurate and efficient in the present Q&A platforms.

1. Expertise of an expert in a domain
2. interest Tag based score
3. Topic based interest score
4. Expert score
5. Selection bias

3.1 Domain Expertise

The domain expertise is captured using the tags an expert has provided answers on and the number of votes he/she has taken from a particular tag. So a weight of this is calculated and ranked accordingly. These tag will be the parents tags not the sub tags in a Q&A platform.

Ex: 5 Answered on Java tag and 10 up votes, 3 answers on MySQL tag and 50 up votes. So we weight them such that votes take a majority than the number of answers provided (60%)

As soon as a new question is posted this calculation can be taken into consideration as one factor among the other four proposed rankings. We will call this weight factor as "D" in calculations.

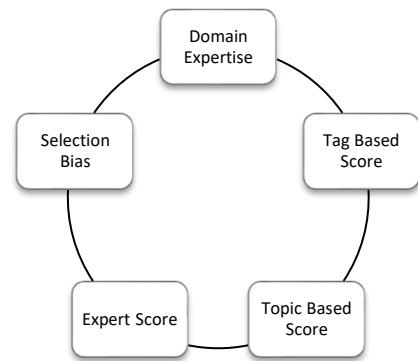


Figure 7. Proposed hybrid model components

3.2 Tag Based Interest Score

With the learning of [7] (HAM) using the model of tag-LDA each tag will be matched with 10 similar words from Wikipedia and then weighted on the user interest per tag. The difference between the domain expertise (3.1) and tag interest is that a tag like Java can have inner tags such as Swing, JVM, JDBC, Java FX etc.

3.3 Topic Based Interest Score

This is where most of the previous work has been circulated. Topic based ranking is not efficient enough when taken into consideration as the only factor when finding experts so we use Latent Dirichlet Allocation (LDA) to identify the topic data. Since the topics are usually small in length the difficulty of approaching on a good accuracy level. So with the study of Zhou et al. [14] has proposed the user-topic model which has proven to increase the accuracy we will be using their approach for topic sensitive interest score.

3.4 Expert Score

Using a link analysis technique, we can rank the experts by capturing the involvement and its relations with questions. So we get a score called user authority where it clearly represents where a user ranked among thousands of others. So with approaches HITS and PageRank [10] we can get this authority score which be used to sort the final list of experts selected among the set who are scoped down.

3.5 Selection Bias

This is the most important factor in our research we consider. Unlike the predefined and the hierarchical ranking the selection bias is where a user behavior is captured, so an expert can be taken with his/her previous activities into two main areas.

The likeliness,

1. To answer a question with existing answers (where we call them values)
2. To answer a question with high existing values

So the chances of suggesting questions to an expert can be widely considered in this behavioral fact which is a complete motivation to an expert and increase the quality of a Q&A platform.

So this is considered a potential characteristic where we can capture in the early stages of a user's engagement unlike the others scores.

4. CONCLUSION

In this paper we proposed a hybrid approach to finding experts on Q&A platforms. The most important learning was that unlike the traditional approaches like topic analysis and link analysis, the user behavioral aspect helped a lot when the scoring took place. And we can consider that suggesting the preference of an expert is more important than all the rankings and votes to be considered.

Since the already tested approaches cannot be left aside we came up with the hybrid solution where five main characteristics are scored and then the selection is processed. An expert's domain areas, tag interests and rankings may vary with time but the behavioral facts are not easily changed since they are not bind directly with the question or answer but with the user thinking. So this can be considered as an improvement to the existing approaches but in a more human-touch approach with high level of behavioral capturing.

5. FUTURE WORK

This can be considered as the first step for a hybrid model considering the behavior aspect of an expert. As an extension of this work we would like to improve more factors on the selection bias aspect making it more human based rather than the link based. Also to consider the content of a question to the process as well. So those factors can be added more value when it comes to finding experts in Q&A platforms.

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Scaling of Applications via Concurrency Control: A Review on Existing Approaches and Techniques

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ABSTRACT 2-2

With the advancement of the computer science domain, multi-threaded applications have incurred in order to handle multiple requests or execute multiple tasks simultaneously. Multi-threaded applications are capable of taking the maximum advantage of the environment resources, but are highly optimized for specific workloads. In certain workloads, the resources can be underutilized or over utilized as a fixed number of active threads cannot fit all workloads due to the shifting nature of the workloads overtime. Thus, it is desirable to adapt the appropriate number of threads for a by analyzing workload dynamically. This paper studies existing approaches to identify the workload dynamically and adapt the threads accordingly by critically evaluating researches carried out in the domain.

Categories and Subject Descriptors

D.2.11 [Information Communication]: Cluster Computing & Performances.

Keywords

Application scaling, Multi-threading, Concurrency, Parallelism, Software performance

1. INTRODUCTION

Interactive applications in real world employ a scalable approach to satisfy users with quick responses [8]. These applications are often subjected to variations in workload overtime [1, 8, 13, 14]. The shifting of workload is mostly due to the unpredictable bursts in the user requests. The shifting of workloads results in frequent changes in the resource requirements of the application.

In order to handle these requirements, the application can be scaled up or scaled down appropriately. The two mechanisms for scaling applications are horizontal scaling and vertical scaling. Adding or removing new server instances and load balancers in order to distribute workload among available instances is known as horizontal scaling, and changing the assigned resources of an already running instance is known as vertical scaling [10]. Table 1 gives a brief

overview on the advantages and disadvantages of the two scaling mechanisms [11, 12].

As clearly shown in the table, due to the complications of vertical scaling, most of the Infrastructure-as-a-Service (IaaS) providers only offer horizontal scaling [6]. The framework proposed in this paper handles most of the complications listed in vertical scaling, making it an easy task.

1.1 Motivation

By doing further research on the domain, it was evident that concurrency control, a vertical scaling technique can be used to scale application in the runtime without a down time [15]. Concurrency control can be achieved by manipulating the number of active threads at runtime based on the workload. If designed appropriately and applied properly, the light weight nature of threads in a multi-threaded application are capable of utilizing the environment resources to yield a high performance [7].

However, in most of the cases applications are fine tuned to handle specific workloads, i.e. applications exhibit high performance under optimized scenarios [13, 14].

Although the concept of manipulating threads at runtime to avoid over utilization and underutilization of threads had been in discussion, only a few researches were conducted in the domain. Main reasons behind this is lack of technical expertise to understand the thread behavior and inability of application to determine the workload [5].

In this paper we study existing auto scaling techniques, and researches on applications that can monitor or predict its workload. We compare and contrast the techniques they have utilized and finally adapt the learnings to a solution we hope to propose.

2. APPROACHES ANALYZED

Scaling of applications can be achieved by means of vertical or horizontal scaling as mentioned above. During the study it was evident that many of the researches have used the workload or a factor of

workload or shifting of workload to scale the application in real time.

Table 5. Horizontal scaling vs Vertical Scaling

Approach	Advantages and disadvantages
Horizontal Scaling	<p>Advantages</p> <ul style="list-style-type: none"> • Provides the ability to increase capacity on the fly. • Only limited to how many instances that can connected successfully. <p>Disadvantages</p> <ul style="list-style-type: none"> • Licensing costs for the additional instances. • The operation cost for powering and cooling instances.
Vertical Scaling	<p>Advantages</p> <ul style="list-style-type: none"> • Increases capacity by adding more resources into the application. • Only limited to how many instances that can connected successfully. <p>Disadvantages</p> <ul style="list-style-type: none"> • Requires downtime while new resources are being added. • Limitations are defined by hardware.

The underlying theories or techniques in scaling for both vertical and horizontal are the same. For the best of our findings, there was no clear work classifying the techniques that can be used for scaling. The closest related work was [10]. The following are some widely used techniques to scale applications.

2.1 Threshold-based policies

Threshold-based rules or policies are the most popular scaling technique among cloud service providers. The simplicity of these rules makes them very appealing and easy to understand to the users. However, setting thresholds must be done in a per application basis, requiring a deep understanding about the workload patterns and shifts.

2.2 Reinforcement Learning

Reinforcement Learning (RL) is a technique of automatic decision-making. It can capture the performance values (e.g. throughput, latency) without any prior knowledge. The technique is such that, the model will learn from the past decisions as it will be awarded for the correct decisions it will make.

2.3 Queuing theory

The classical queuing theory has been widely used in many applications to scale. The theory estimates a few performance metrics of the application (e.g. queue length, response time) prior to making the scaling decision.

2.4 Control theory

Control theory is widely applied to in data servers and storage systems to automate the management of the servers/systems. The technique shows interesting results on cloud computing platforms. This technique is primarily reactive.

2.5 Time-series analysis

Time series based auto scaling is commonly used in the domains of finance, engineering and economics. The technique represents the change of measurement over time. This technique analyzes the repeating patterns in the input workload and to tries to predict the future values.

Below listed are, several existing works on the areas of concurrency control management in databases, transactional memory and multi-tier cloud applications that utilizes the concept of workload and its fluctuations to scale.

1. Adaptive concurrency control: despite the looking glass, one concurrency control does not fit all [14].
 - The researcher proposes a solution to dynamically select the appropriate concurrency control protocol in accordance to the shifting of workloads.
 - The solution dynamically clusters data to select the optimal protocol. Data used for clustering contains details on core allocations, synchronization overheads and workload.
 - The requirement addressed in the research has a similar context to the requirement addressed in this paper as the solution triggers a change upon the fluctuations in workloads.
 - The parameters used for clustering can be adapted as parameters for the learning framework as they are justified.
2. Weighted adaptive concurrency control for software transactional memory [1].

- The solution by the researcher, utilizes a weighted adaptive concurrency control approach to exploit the variance in available workload between threads. The solution deactivates threads when available workload is low and vice versa.
 - In his works, he implements four weighted algorithms (WBEST, WFIT, WOPTIMAL and WCOMPLETE) and evaluates them.
 - It is also stated that by following a weighted approach, 10-30% of improvement was gained in the net transaction commit ratio.
 - The motivation behind the research is quite similar to motivation and purpose of this research.
 - A comprehensive study on the four algorithms, their parameters and differences are required to adapt them into the proposed solution.
3. DCM: dynamic concurrency management for scaling n-tier applications in clouds [3].
- Research tries to address the issue of under or over utilizing bottleneck resources of the system by appropriate adaptation of threads and connection pools (soft resources).
 - A dynamic concurrency management (DCM) framework that integrates allocation of soft resources for system scaling management was developed.
 - Measurements used to determine the near optimum concurrency can be utilized as learning parameters for the framework after a study on its relevancy as it is not outlined in the research.
 - The research does not specify the bottleneck resources of the system or on how the solution improved them.
4. HybridScaler: Handling Bursting Workload for Multi-tier Web Applications in Cloud [15].
- Horizontal scaling of applications generally results in an extra cost and considerable overhead for short-term bursting workloads. This research focuses on dynamically allocating the appropriate amount of resources at the appropriate time to handle the bursting workload.
 - The solution implemented is based on resource pressure model which combines long-term predictive horizontal scaling and timely reactive vertical scaling.
 - Research concentrates more on horizontal scaling in comparison with vertical scaling. The parameters or data used on the processed are not documented.
- The evaluation of the approach has demonstrated effectiveness and efficiency as a decrease in response time by 16-39% is observed in comparison with the mainstream auto scaling methods.
5. On Efficiency and Scalability of Software Defined Infrastructure for Adaptive Applications [2].
- A layered performance model to meet the user defined SLO efficiently by runtime vertical scaling is presented.
 - The model automatically extracts relevant details using resource demand estimation techniques, and uses it as feedback controller to dynamically adapt resources.
 - Factors on application architecture, system configuration, and workload demands can be used to model the complex relationship between the application performance and the resource allocation.
- In the works carried out by Tang, Jiang and Aaron [14], no justification for the usage of the clustering algorithm or detailed description on its implementation is provided. Ansari [1], in his works tries to solve the exact problem we address here, by using weights on each thread. An analysis of fine-grained measurement data (response time, CPU utilization and processing queue length) and a combination of operational queuing laws are utilized to determine the near optimum concurrency setting in the works presented in the works of Chen et al [3]. The lightweight and timely nature of vertical scaling is utilized to change the allocations of the resources in the works of Wu et al [15]. Beigi-Mohammadi et al in their work [2], tries to address the issue of full resource allocations to gain performance on Service Level Objectives (SLOs).
- The research carried out by Islam, Shezan and Shahriyar [9], the potential of approximate computing has been utilized to obtain an approximate value for the workload of the application, based on a user defined error. It is also stated that, this technique is faster than conventional computing.
- Chen and Zhuang in their work [4] try to address the issue, lack of adaptability in the existing concurrency control algorithms by proposing an Adaptive Decision Concurrency Control Algorithm (ADCC). The ADCC algorithm tackles the issue by dividing the process into two phases execution authorization and strategy selection.
- After analyzing all details of approaches mentioned above, we were able to identify an appropriate solution to scale applications in real time by manipulating threads.

3. SOLUTION: PROPOSED FRAMEWORK

Recent researches in the domain has observed an improvement in performance by reducing the threads when the workload is low and increasing the threads when the workload is high. Some of the experiments have also shown degradation in performance when handling small workloads with a high number of threads at runtime [1, 3]. As per the analysis by [9], this degradation is noticed due to the overhead on resources by the idle threads at runtime. Adapting the threads at runtime is a challenging task to the fluctuations in the workload.

This leads to a requirement of a technique or mechanism to analyze the workload of an application, analyze its fluctuations, identify the appropriate number of threads required to handle the workload and adapt the appropriate number of threads at runtime [16].

In order to address the requirement, this paper proposes a learning framework that learns the workload and the behavior of the application. It also learns the fluctuations in the workload and adapts the optimum number of threads after determining it.

Based on the existing approaches following are some identified features the framework should be capable of:

- Determining the workload of the application in runtime.
- Identifying the fluctuations in the workload.
- Determining the optimum number of threads required to handle the new workload.
- Adapting the threads of the application in runtime according to the optimum number determined.

3.1 Analyzing workload

Traditional applications expect a peak workload. However, this approach suffers from inefficiencies due to the over-provisioning of physical resources and the limited flexibility to cope with unexpected workload bursts, which makes monitoring of the workload is the central operation of the framework.

A resource demand estimation technique similar to the one used in [2] can be used for this. A learning mechanism that clusters the workload similar to [14] can be used to predict the workload and detect anomalies, if any.

3.2 Adapting the Appropriate number of threads

The approach of adapting of threads should be trigger based. This should be done in such a way so that unnecessary reconfiguration threads are avoided. The framework should be able to dynamically find the optimal number of threads at runtime, by maintaining

close values for user defined service level objectives such as throughput and latency.

Some of the parameters that can be utilized to identify the optimal number of threads are information application architecture and system configurations. However, the optimal values for these parameters are application-specific and no general guidelines should be determined.

The framework should be able to increase the number of active threads when the workload is high and should be able to decrease the number of idle threads when the workload is low. Transition in the thread count should also not disturb or hinder any critical operations of the application.

It would be quite interesting to see how the framework manipulates the application threads for out of order values in the fluctuation of the workloads.

4. CONCLUSION

This paper starts by introducing the two scaling mechanisms (horizontal scaling and vertical scaling), reasoning out their advantages and disadvantages. Then, the motivation come up with a learning framework that is capable of adapting threads at runtime with regards to the workload is specified. The information evaluated have been structured in manner to highlight the need of the framework and possible approaches to implement the framework.

After the evaluation of the existing researches in the domain, it is evident that more weight has been given to horizontal scaling of applications rather that vertical scaling of applications. One of the main reasons for this is that the applications are designed in such manner that it cannot change the number of threads at runtime without restarting the application [10, 12].

It is strongly believed that the way forward to fulfill the requirement is through continuous learning on the workload handled by the application by monitoring it detecting out of order events, i.e. fluctuation in the workload. This is a good starting point for further investigation and evaluation.

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DelayMIN- A Case Based Reasoning Approach for Knowledge Transfer Process Automation

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ABSTRACT 2-3

Nowadays the senior staff in the industry has busy schedules and tight deadlines. Under these situations they might forget the new employees who are willing to get some knowledge on previous work and existing practices that are currently happening in their work place. So this will lead to many complications because the newly employed people might not be able to proceed with work due to the unclear areas. The main intention of this paper is to introduce a convenient way of providing the manual knowledge transfer process. Simply this solution - DelayMIN automates this manual KT process in a reasonable manner. DelayMIN is designed to automate the manual Knowledge Transfer process. This product uses several technologies, mainly Case Based Reasoning, Fuzzy Logics, NLP and Levenshtein Similarity. For demonstration purposes Software Project Delays have been considered. The data relevant to the previous delay cases are stored in 4 main case bases named Client, Management, HR and Equipment related delays. This case base has a structure and more about this structure is discussed under the Methodology Section B. The fuzzy module is proving a confident value based on the user's sub solution area selection which is derived by analyzing the problem definition. This value is used to link the user selections with the case base. Based on this value the data retrieval will take place. This fuzzy module will filter out all the relevant records for a particular sub solution area. Then the Levenshtein Algorithm involves. This mechanism is used to obtain the similarity score between the keywords in the user problem and the keywords stored in the case base. The articles with the highest relevant score will be accessed and it will be saved in PDF format and the location will be provided to the user.

Keywords

Software Project delays, Case Based Reasoning, Fuzzy Logics, Levenshtein Similarity

1. INTRODUCTION

Knowledge Transfer Process is a well-known fact sharing mechanism in the IT industry. However, this process is a time consuming task where the senior level employees will have to allocate some time from their busy schedules. Sometimes the same KT session will be given to several new employees in the same day, which would be a hectic task for the KT donor. So as a solution DelayMIN will replace this manual KT process in an efficient manner.

This solution will be addressing the above mentioned process and to demonstrate the above tool Software Project Delaying factor minimizing methodologies have been considered. This product is a combination of several technologies named, Case Based Reasoning, Fuzzy Logics and Levenshtein Algorithm. A working prototype has been completed and future enhancements will be acknowledged.

In the below context, main technologies used in implementation have been addressed. Under the Methodology Section A, Software project delays and its impacts are discussed, Methodology Section B is consist of the Mechanisms behind Case Based Reasoning, Methodology Section C provides more details regarding the fuzzy module and Methodology Section D Provides the relevant information regarding the Levenshtein Algorithm.

2. RELATED LITERATURE

A software project delay can also be described as a failure of meeting a deadline or failing to deliver a deliverable on the due date. Software Project can be delayed due to many causes. Inadequacy of project planning, cost estimating, measurements, milestone tracking, quality control and Ineffectiveness of change control can be listed as some software project delaying factors. [4]. Previous researchers have shown that Average overrun on budget is 18%; average overrun on schedule is 23%; average underachievement on scope/functionality is 7% [3].

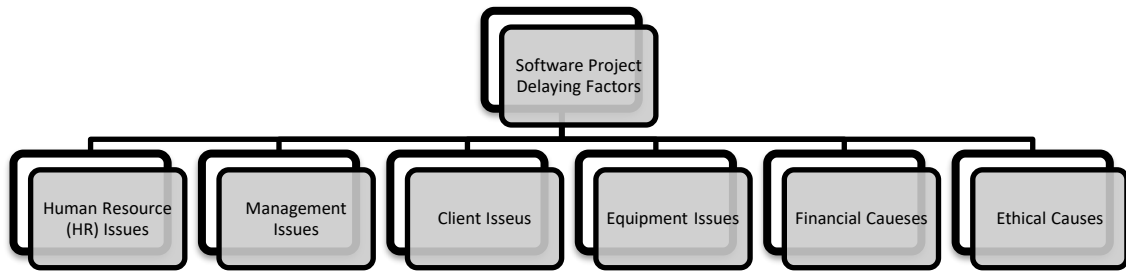


Figure 8. Software Project Delaying Factors

Due to a project delay many consequences may occur, either it will be a blame to the company's reputation or to the PM of the project. And also it will lead to a cost overrun as well as to a schedule overrun. It has been hypothesized that poor quality control is the prime contributor to cost and schedule overruns and poor project management will be a foremost cause of inadequate quality control [8].

Previous studies have shown that a delay in a software project will lead to an increased budget and decreased scope and excellence of product launch activities. Which can be further elaborated as when a deliverable is delayed then in order to complete that the development team will have to consume more time which is allocated for a different task then that scheduled task will also be delayed which will result an overall delay in the final product launch. Since more time is consumed the cost is increased which will lead to an increased budget and since that the team will reduce some features of the deliverable which will cause a shrink in the scope and this will affect the overall excellence of the final product. To overcome this matter the team should come up with an updated and realistic master schedule and then the scope should be acknowledged immediately among all the involved parties. This may be beneficial to limit the escalation of negative impacts into the product launch. Moreover the managerial level should be able to identify the impacts caused by a delay and should be able to manage them holistically from the whole company's perspective, instead of individual departments' perspectives [9].

Amongst many Software Project Delaying Factors the below graph will elaborate few major delaying factors:

As shown in Figure 1, a Software Project may get delayed due to:

1. HR Related Issues:
 - Conflicts among team members
 - Lack of skilled employees
2. Management Related Issues:
 - Inefficient Time Frames
 - Inefficient Resource Allocation
 - Unstable Design
3. Client Issues:
 - Ambiguous Requirements
 - Lack of Communication

4. Equipment Related Issues:
 - Server Errors
 - Physical Damages caused to devices
5. Financial Causes:
 - Payment Delays for Change Requests
6. Ethical Causes:
 - Gaining Permissions necessary for the Developments

By considering the above points and by combining a machine learning technique known as 'Case Based Reasoning (CBR)', the implementation of the proposed solution will be carried out. A typical CBR system will be using prior experiences stored in a case repository for solving problems caused in the future.

As mentioned main technology used for this solution will be 'Case Based Reasoning'. Other than that the proposed solution will also be using Levenshtein Algorithm for measuring keyword similarity and Fuzzy Logics for accessing the necessary sub solution area as by analyzing the user's problem description.

CBR process is consist of 4 main phases. Figure 2 represents those phases involved in CBR.

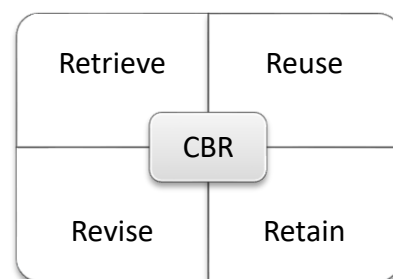


Figure 9. Phases of CBR [7]

First Phase of CBR is 'Retrieve'. First of all, the situation or the problem is assessed. Then the retrieve takes place. During this the most similar case/ cases are retrieved by comparing the past Case Library and an approximate solution is retrieved. Thereafter the retrieved case is 'Reused'. This Reuse phase will adopt the previous solution according to the current problem. Then the 'Revise' phase takes place. During this phase the proposed solution is revised if required. Finally, the 'Retain' phase is

involved. Which will retain the new solution as a part of a new case. By fulfilling this 4 phases the CBR process can be done successfully.

Contribution of fuzzy logics towards the proposed system is it helps the system to identify which Sub solution area needs to be accessed based on the user's problem definition. Even though there are several other methods Fuzzy Logics would be the most suitable mechanism due to its capability of handling nonlinear situations. Fuzzy logic is based on the theory of fuzzy sets, which is a generalization of a classical set theory [6]. Figure 3 represents the classical set theory of the Fuzzy Logics.

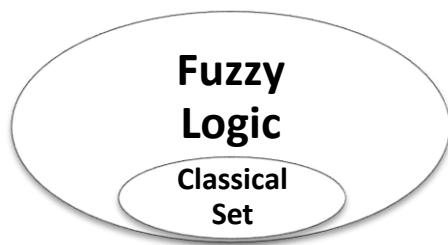


Figure 10. The classical set theory is a subset of the theory of fuzzy sets" [6]

Levenshtein Algorithms involved in calculating the similarity between the keywords in the user problem and the key words in the case base.

As mentioned in the above context this project will be focusing on Software Project Delaying Factors in the software industry. As causes of delays it will only be considering the delays caused by HR, Management, Clients and Equipment. Financial and Ethical causes will be considered as outer scope. Similarly, the project delays only among the Software Industry will be considered as the impact on the project performance.

3. METHODOLOGY

Intended methodology to be followed is explained below in relation with the research objectives. Respective research objectives to be satisfied will be discussed in the below content with foreseen evaluating approaches.

3.1 Software Project Delaying Factor Identification.

This has been achieved during the preparation of the Literature Review. As mentioned earlier a software project delay can likewise be depicted as a disappointment of meeting a due date or neglecting to convey a deliverable on the due date. Previous studies have shown that a delay in a software project will lead to an increased budget and decreased scope and excellence of product launch activities. Which can be further elaborated as when a deliverable is delayed then in order to complete that the

development team will have to consume more time which is allocated for a different task then that scheduled task will also be delayed which will result an overall delay in the final product launch. Since more time is consumed the cost is increased which will lead to an increased budget and since that the team will reduce some features of the deliverable which will cause a shrink in the scope and this will affect the overall excellence of the final product. To overcome this matter, the team should come up with an updated and realistic master schedule and then the scope should be acknowledged immediately among all the involved parties. This may be beneficial to limit the escalation of negative impacts into the product launch. Moreover, the managerial level should be able to identify the impacts caused by a delay and should be able to manage them holistically from the whole company's perspective, instead of individual departments' perspectives [9].

3.2 To broaden the knowledge on Case Based Reasoning.

In early eras one of the most visible developments in AI research was the emergence of rule-based expert systems (RBES). These programs were applied to more and more problem domains requiring extensive knowledge for very specific and rather critical tasks including hardware troubleshooting, geological exploration and medical diagnosis. In general, the RBES should be based upon a deep, explicit, causal model of the problem domain knowledge that enables them to reason using first principles. Even though this mechanism was successful at the latter part the researchers thought to move on since this was difficult and time consuming [13].

As a solution to above problems researchers came up with the new mechanism named 'Case Based Reasoning' (CBR) which solves new problems by adapting previously successful solutions to similar problems.

In CBR a case can be termed as several features describing a problem plus an outcome or a solution for a problem. Cases can be in multiple forms there is no specific form. It can either be text, numbers, symbols, plans or multimedia. These cases are records of real events and are excellent for justifying decisions. A Case Base can be referred as a collection of cases. A case base is usually a flat file or a database [2].

CBR draws attention because it doesn't require an explicit domain model and so elicitation becomes a task of gathering case histories. Implementation work is reduced since it doesn't require an explicit domain. Most importantly CBR systems can learn by acquiring new knowledge as cases. When CBR is combined with a Database Technique it will be a great help to maintain large amounts of information [12].

As above mentioned this solution will be focusing on identifying software project delaying factors in the software industry and will also provide some efficient ways in order to overcome them. This solution will be consisting of four Case Repositories namely, Management, Client, HR and Equipment. Each case base will be consisting of project delaying factors and methodologies to overcome them.

Table 6. Storage Structure of CB

RefID	Keywords	Path

The storage structure of the case bases are as follows: RefID field is for unique identification of records. The Keywords column will be consisting of the keywords included in the solution documents. Path column will be consisting of the stored locations of the Solution documents.

In the proposed solution the user will be able to select the necessary solution area and then enter their problems. For the time being the user will only be allowed to select only one solution base and problems can belong to only a one sub solution area.

Then with the use of fuzzy logics the system will identify which articles to be accessed. ‘Bag of words’ algorithm will be used for keyword identification. Then those identified keywords will be mapped across the key words column, and thereafter the relevance score will be analyzed. Records which has the highest relevance score will be considered and then the given path will be accessed.

This is how the ‘Retrieval’ process takes place. After retrieval the system will analyze the retrieved solutions. Then with the use of ‘Meta Summarization’ a reasonable solution will be presented to the user, this is where the ‘Reuse’ occurs. Case base adoption will be handled by the ‘myCBR’ tool.

Then the adopted solution will be displayed to the user and if they are satisfied the solution it will be stored in the relevant case base, which is where the ‘Retain’ takes place.

3.3 To learn how to use Fuzzy Logics for Relevant Article Mappings

Main contribution of Fuzzy Logic towards the community is that “it’s ability of computing with words” [14]. Fuzzy Logic is the only methodology that caters the above purpose.

In traditional terms ‘Computing’ was referred to as manipulation of digits and characters. As defined by the human kind ‘Words’ is consisting of fuzzy

denotations. The same applies to the role played by Words in Computing. A key aspect of computing with words is that involves a fusion of natural languages and computation with fuzzy variables.

Foremost advantages of Fuzzy logic incorporate its straightforwardness and adaptability. Fuzzy Logics can deal with issues with uncertain and inadequate information and in addition it can show nonlinear elements of self-assertive many-sided quality.

Contribution of fuzzy logics towards the proposed system is it helps the system to identify which articles to be accessed based on the user’s problem definition. Even though there are several other methods Fuzzy Logics would be the most suitable mechanism due to its capability of handling nonlinear situations.

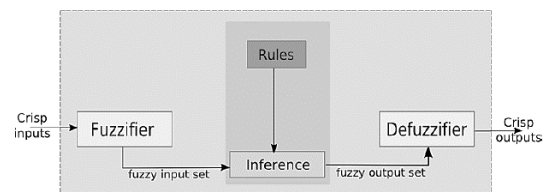


Figure 11. A fuzzy logic system

For the proposed system the crisp input will be the result of the bag of words module which means the relevant sub solution area and the crisp output is the reference value to access the necessary record ID (article).

3.4 To gain knowledge on Levenshtein

Algorithm for similarity calculations

Levenshtein Similarity is a measure used to calculate the similarity between 2 strings. It returns the number of edits which means the insertions, Deletions or the substitutions needed.

If the levenshtein distance is high the strings are more different.

4. RESULTS & DISCUSSIONS

In the intended system user should select the main solution area and enter the problem. Then those inputs are captured for further analyzing. Problem definition will be sent to the bag of words and then it will identify to which sub category does the problem belongs to, then that sub category will be sent to the fuzzy module and the problem definition will be sent again to the Levenshtein similarity module. Fuzzy Module will generate the confidence value and then the relevant articles will be accessed based on the confidence value. Levenshtein similarity module will generate a similarity score and the article with the highest score will be accessed and finally the results will be saved in a PDF document. DelayMIN holds an accuracy of 83%, which means this system has been tested for 23 different test cases and only 4 has not met the

expected output, percentage of the passed test cases has been summed up to 83%. Figure 5 depicts the overall system flow.

4.1 Expected Advantages:

Expected advantages of the proposed system is as follows:

- Can be used as an automated Knowledge Transfer tool in the industry.
- Can be used as a source of knowledge to learn about software project delays.

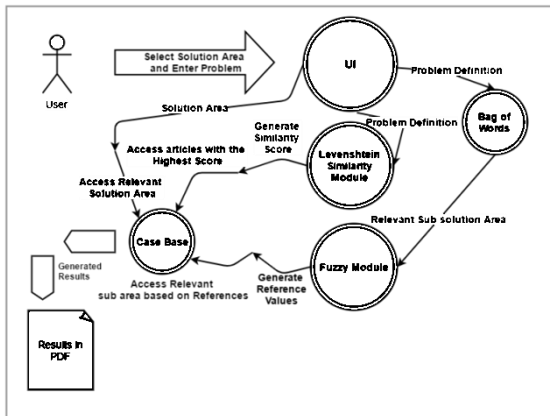


Figure 12. Overall Flow of the system

5. CONCLUSION

Combining the results from the analyzing of existing solutions identified in the literature survey with the knowledge gained by the questionnaire, following conclusions were derived.

Majority of the senior level employees in the software industry are with tight schedules so they may not have enough time to spend on KT sessions.

There are ample solutions done using Case Based Reasoning but the problem domain is differed. So therefore this solution would be providing some reasonable clarifications to the IT personals.

As mentioned in the above context with the use of Fuzzy Logics, Levenshtein Similarity and CBR methodologies this could be completed successfully. Currently a working prototype is available.

To demonstrate this automated knowledge, transfer tool software project delays have been considered as

the domain. This project could be a valid solution for the IT personals who are seeking to overcome project delays in the Software Industry.

6. ACKNOWLEDGEMENT

I would like to convey my sincere regards to my supervisor Mr. Kaneeka Vidanage for the tremendous support given to me throughout in order to make this task a success and to all who contributed mainly Informatics Institute of Technology and its staff to the successful realization of my research.

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Visual Design Platform for Wireless Sensor Network

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ABSTRACT 2-4

Wireless Sensor Networks (WSN) are being widely used for sensing physical parameters in a broad geographical area. The person who needs WSN will have a pictorial idea about the sensor network. The problem in the traditional method is that the person who needs the WSN should explain the pictorial view of the sensor network to a commercial vendor and buy it from them or they should design it from the scratch. What we proposed in our solution is to develop a platform so that the person who needs the WSN can directly draw the pictorial view on a canvas and then it can automatically generate all the required firmware for the microcontrollers and wiring diagrams. The user is then required only to follow few instructions to complete the real world implementation of WSNs. This paper is about developing a visual platform to design WSNs. The WSN designing platform was built as a web application, so it can manage a large number of supported sensors and microcontrollers. This means that if one user adds the device driver for any sensor or a microcontroller the other users can directly use it from the WSN design platform without worrying about hardware programming. Further, if anyone needs a new sensor or microcontroller to be supported by this visual design platform, this design tool will have interfaces to directly add new sensors and microcontrollers. The proposed method is affordable for developing custom wireless sensor networks.

Keywords

Wireless Sensor Networks, Visual WSN design platform, Sensors, Microcontrollers

1. INTRODUCTION

A Wireless Sensor Network (WSN) [1] is a densely deployed wireless network of small, inexpensive, low-power wireless sensor nodes designed to monitor given phenomena. Wireless Sensor Nodes are devices where you can plug various sensors and transmit the sensor data to a base station using wireless communication. Sensor networks are extremely useful in, agriculture sector and animal husbandry, air and water quality measurement, wildlife movement tracking and disaster management etc.

It is a fact that sensor networks are really helpful in creating a better human life. Most of the time, the required number of sensor nodes for a given phenomenon is extensive. Given the wireless nature of sensor nodes, they should be powered by batteries. The WSN should have low-power, low-cost and reliable sensor nodes and also protocols that would make the communication between sensor nodes more efficient for both power and computation.

The major problem in the traditional wireless sensor network designing process is that there are no common platforms available to design a wireless sensor network. The term 'common platform' means that a platform which is compatible with any commercially available sensors and microcontrollers. Since there are no common designing platforms available to design sensor networks, it takes a huge amount of time and money to develop a wireless sensor network. Also, there is no way of reusing the existing WSNs. The goal of developing the WSN design platform is to let users easily design custom WSN using a graphical user interface. The wireless sensor network designing platform was designed as a web application so that users can simply log into the web application and use this platform to design the required sensor network. After designing the network,

users are provided with automatically generated firmware and instruction to deploy the actual sensor network. Anyone with little computer knowledge can develop a simple wireless sensor network, while professional designers can use this platform to design complex wireless sensor networks with lesser complexity.

2. RELATED WORKS

WSNs are widely used during last decade for sensing physical parameters and they are really useful in our day-to-day life. Since it has a history of past decade, lots of research have been conducted to find out how to make these sensor networks power efficient and cost-effective.

‘Firefly’ is a cross-layer platform for WSNs, one of such monitoring platform for sensor networks [2]. Although this platform is commercially available, this platform is not widely used in developing countries since these devices are relatively costly to deploy in mass scale.

Wireless Sensor Nodes can be divided into two main sections for ease of understanding, following section will describe how previous researches are related to each section.

2.1 Sensor Node Hardware

Sensor node hardware is a combination of microcontrollers, wireless communication modules, sensor interface and sensors. Operating current, sampling rate and signal types of sensors are generally restricted by the sensor node device. Reconfigurable smart sensor interface [3] is a solution which solves the above problem. Reconfigurable smart sensor interface is a complex programmable logic device (CPLD) which adopts the standard of IEEE1451.2 intelligent sensor [4] interface specification. Universal Micro-Sensor Interface (UMSI) [5] chip is another generic interface. This interface implements a new power-conservative network-capable sensor bus, integrates programmable readout circuits for multiple signal modes, and includes a standard interface for application-specific peripherals. Although UMSI interface is a common platform which can be programmed to plug a wide range of sensors, it is only a solution for low-level hardware of the WSN sensor node. Proposed WSN design platform is capable of handling any sensor node hardware if one could write a software device descriptor for the WSN design platform.

2.2 Firmware Running on Sensor Node Hardware

A firmware is a software that runs on the microcontroller of the sensor node. To develop a low-powered low-cost sensor node it is a primary requirement to develop a stable power efficient firmware. Previous researches have been conducted to develop the firmware that runs on sensor node which

is power efficient for battery-powered sensor nodes. One such operating system is TinyOS, which is a specialized component model exploits advanced compiler technology to simultaneously provide efficiency and reliability in microcontroller [6]. Nano-RK [7] is a reservation-based real-time operating system (RTOS) with multi-hop networking support for use in wireless sensor networks. Arduino Service Interface Programming (ASIP) [8] model is a Service abstraction to easily add new capabilities to microcontrollers, including socket connections, bridging devices, MQTT-based publish-subscribe messaging, discovery services, etc. The WSN design platform was proposed for auto-generating firmware for the nodes. The auto-generated firmware codes are generated with the capability of managing power in the microcontroller efficiently.

3. METHODOLOGICAL APPROACH TO DEVELOP WSN DESIGNING PLATFORM

This paper is about developing a WSN designing platform, the platform was designed to connect any sensor to a supported microcontroller. To achieve such target, the platform should be able to manage the details about sensors and microcontrollers. The following subtopics are the main design submodules in the design, following sections will explain how this platform works with any sensor that is supported by a specific microcontroller. The following subtopics will briefly explain the top level view of the whole project.

3.1 Managing Sensors

Since this paper describes creating a common platform to develop wireless sensor networks, it should support a wide range of sensors and microcontrollers. The basic idea here is to maintain a database for sensors descriptors. The WSN design platform was designed to auto-generate all the required firmware for each node in the whole wireless sensor network. In this process, the database entry of a sensor is used to auto-generate the firmware. Users can easily browse through the available sensors and choose one. If the specific sensor is not found, they can simply add a new entry to the database. WSN design platform contains interfaces to add new sensors through this WSN design platform. So each new entry of database should contain the required details about the sensors. Figure 1 will illustrate about the details of database entry which is described in section 4.1.

Sensor Name	Sensor Description	Connection Pins	Power Supply
Software Function for Sensing (compatible with Arduino)	Software Function for Sensing (compatible with Raspberry-Pi)	Software Function for Sensing (compatible with n th microcontroller)	

Figure 1. Database entry for a sensor

The database entry for a new sensor can be divided into two parts for ease of understanding. First, the basic information about sensors such as voltage, current, and pins needed to communicate. The second part is the software function which is the most important part when it comes to generalizing the platform to work with almost any sensor. For achieving such a task standard procedures should be used when writing the functions. Basically, the users are advised to write the software functions which deals with the sensor hardware and returning the sensor data according to the predefined format. The most important thing to note is that this database entry can be used by the rest of the world even without knowing how the programming of the sensor with the microcontroller works.

3.2 Managing Microcontrollers

Microcontrollers are acting two roles when it comes to Wireless sensor networks, first as sensor nodes and secondly as base stations. In this WSN design platform, it supports both the settings. The design platform contains a database which stores the information about the supporting microcontrollers, so the users can browse through the available microcontrollers and choose the required microcontroller and start creating a sensor node or a base station. If the microcontroller that user requires is not found in the existing database, they can create a new database entry for the specific microcontroller. Figure 2 illustrates the structure of the database entry which is described in section 4.2.

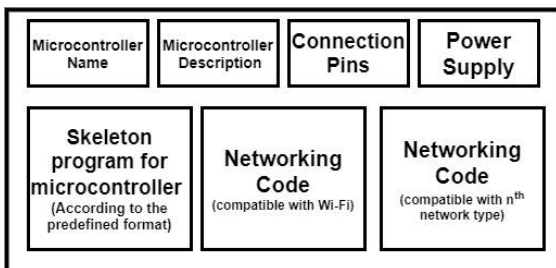


Figure 2. Database entry for a microcontroller

3.3 Configuring Networking

The networking between the sensor nodes and base stations can be configured dynamically using our WSN design platform. The users can drag and drop the created sensor nodes and base stations to the canvas and build the network. The users are required to draw lines as they want between the nodes that are to be connected. The back-end of the WSN design platform will be responsible for creating the firmware according to the user configurations. The back-end of the WSN design platform will validate each and every connection that is created and it will notify the user if anything is wrong, otherwise, the backend will automatically generate the firmware using the user's configuration. Finally, after user finalizes the WSN network it will make the generated code available for download. Figure 3 shows a diagram of sample WSN.

Users are expected to draw a WSN configuration like in Figure 3 in order to create a WSN.

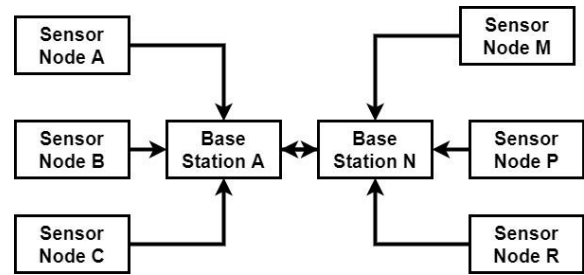


Figure 3. Sample Network Configuration.

3.4 The automatic firmware code generation

The core idea of this project is that this WSN design platform will generate all the firmware codes that are needed to deploy the wireless sensor network. Also, the WSN design platform will provide the wiring diagrams that are needed to deploy the WSN. The firmware at each node is generated step by step. The auto firmware generation starts while creating the sensor node. Then it aggregates all the networking configuration. Figure 4 explains the aggregation of the firmware during the design process of the WSN.

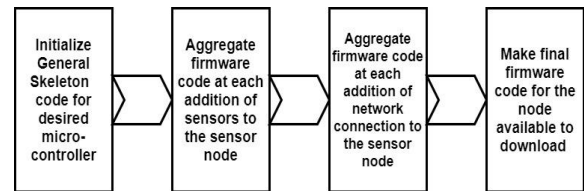


Figure 4. Automatic Firmware Code Generation

4. IMPLEMENTATION

Figure 5 is a screenshot of the user interface (UI) of the design platform. The front-end was designed to send a request to the back-end to validating each sensor connection. The users can work on the same UI from the starting of designing the sensor node to deploying the final design of wireless sensor network.

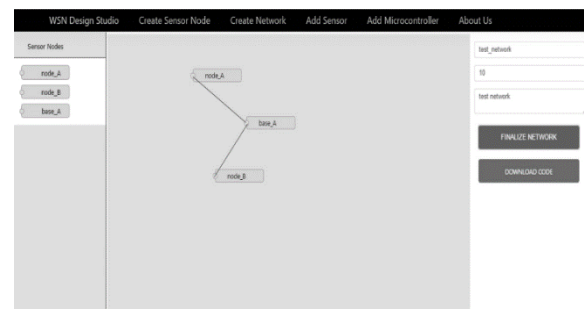


Figure 5. User Interface.

4.1 Implementation of Adding New Sensor Feature

As explained in the Methodology section 3.2 each sensor will have a database entry. The details of the sensor database entry will be discussed in the following section. If a sensor is not already registered in the database, users can add a new entry to the database. The steps of adding a new sensor to the WSN design platform is illustrated in Figure 6. If a user fills the following details in order as in Figure 6 correctly and saves the sensor, then that sensor will be added to the WSN designing platform.

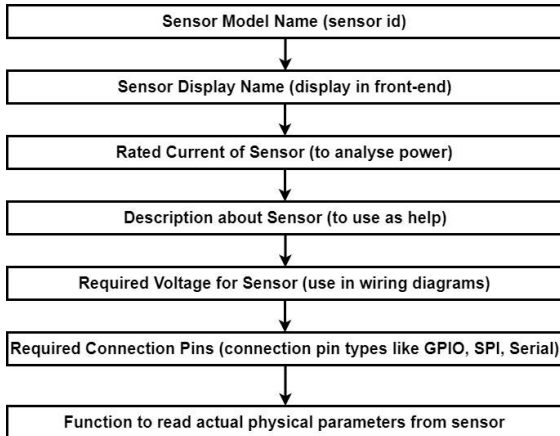


Figure 6. Requirements for adding new sensor

All the detailed requirements will be available in the application itself. The users should pursue the following standards,

- Include libraries that are needed should be uploaded with the names of the libraries.
- If there is a requirement to initialize the sensor, that code should enter in the given field while adding the new sensor.
- Should enter a function(s) for each microcontroller which measures and output the sensor values in 'String' data type (If there are multiple outputs, the function should return all the outputs separated by '&&' sign).
- The user may input multiple functions for microcontrollers as per the requirement.

4.2 Implementation of Adding New Microcontroller Feature

WSN design platform supports Arduino, ESP8266-12E and Raspberry Pi boards by default, which means that the WSN design platform already contains three entries in the microcontrollers' database. If a user needs to integrate a new microcontroller with the WSN design platform, the user can use the built-in feature to add a new microcontroller to the design platform.

To register a new microcontroller with the WSN design platform users should fill the following requirements illustrated in Figure 7.

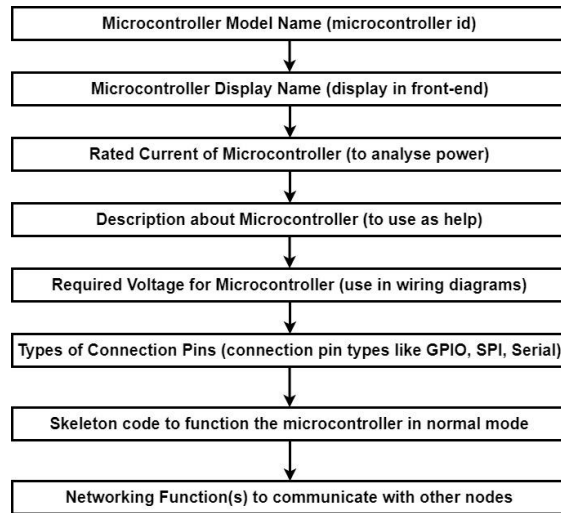


Figure 7. Requirements for adding new microcontroller

The last two steps in Figure 7 will further discuss in section 4.2.1 and 4.2.2 respectively.

4.2.1 *The following standards should be followed by the users while writing skeleton code for microcontrollers,*

Skeleton code for the microcontroller is the most important part in the microcontroller database entry. This skeleton code should contain the following tags in the relevant places,

1. <includes> - Where to insert the other 3rd party libraries that are needed for the functionality of the sensors and microcontroller.
2. <init> - Where the initialization codes should reside.
3. <loop> - Location of the main loop.
4. <end> - Where the end code locates.

Without these tags, the skeleton code should compile and run on the relevant microcontroller and it should run in an infinite loop without any functionality. Figure 8 shows the examples written for ESP8266-12E and Raspberry Pi.

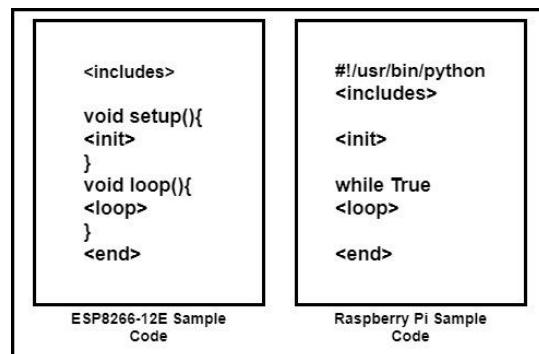


Figure 8. Sample Network Configuration

4.2.2 Networking function(s) that is written to connect with different types of networking technologies

Network function should be written using three parts

1. Network initialization code - this code should run while the microcontroller is at initialization stage and it should basically connect to the given network.
2. Data sending function - this code should run in the loop and should be capable of sending the given string through the network.
3. Data receiving function - This code should also run in the loop and should be capable of receiving any String through the network.

Note that if the user needs another type of networking technology (for example if the user wants to use RF communication instead of WiFi), the user should write the network function separately and insert it to the WSN design platform while adding the new microcontroller.

4.3 Implementation of automatic code generation module

This is the most important module of the WSN design platform, this module handles the logic of generating the firmware including all the user configurations. The following steps are the process that generates the firmware codes that are required to generate the WSN.

4.3.1 Initializing the Node Firmware

Sensor nodes usually contain microcontroller and sensors. If a user drag and drop a microcontroller into the sensor node designing canvas, then the automatic code generation module will call the database and retrieve the skeleton code. Then the skeleton code is loaded into the memory.

4.3.2 Developing the Firmware when new sensor is added

Since there is a microcontroller in the sensor node designing canvas, it is already loaded with the skeleton code in the memory. As user keep on adding new sensors the code generator will aggregate the firmware by adding each sensor to the firmware of the node. This procedure is illustrated in Figure 9.

As shown in Figure 9, there is a step for validating whether each sensor can be really accommodated at the node and it is a really interesting problem to solve. A mathematical approach was used to solve this problem. The mathematical solution will be scalable for any microcontroller and also for any sensor. Also, the wiring diagrams can be obtained from this mathematical method. Basically, there is a matrix generated each time when a sensor node is initialized, that matrix contains the available number of pins in different categories. Initially, the matrix would be the same as the available pins in the microcontroller, then while adding each sensor the main matrix is

subtracted with the sensor's required pins matrix. If any column gives a negative number, then it is clear that the sensor cannot be accommodated at the microcontroller. If both matrices subtract without giving a negative number, it means that the sensor can be accommodated. Figure 10 shows a simple example of successful and an unsuccessful sensor addition.

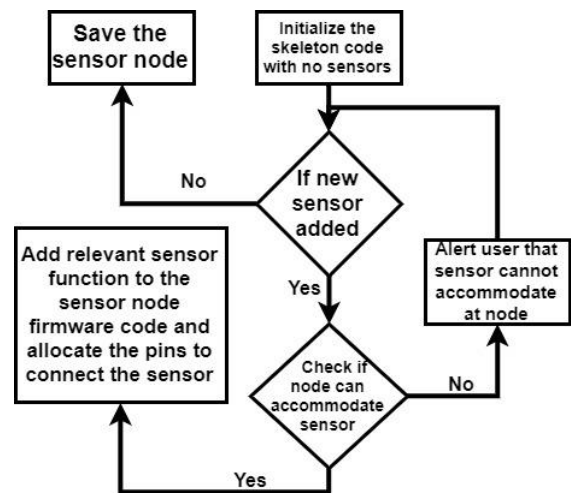


Figure 9. Code Generation Procedure

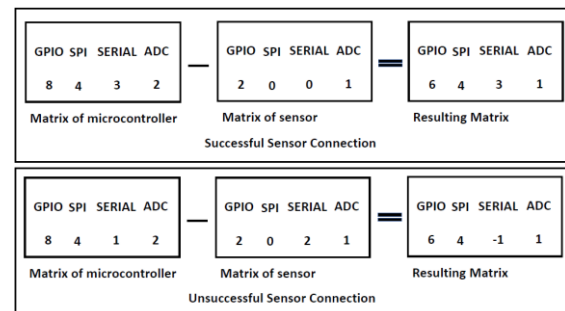


Figure 10. Sensor Addition Example

4.3.3 Generate Node Firmware for the networking

After the user created a Wireless Sensor Node, the memory already has the firmware with sensor functions. Now the user will be able to design a network between sensor nodes and base stations, for that user can use the already created sensor nodes. The user is expected to drag and drop the created sensor nodes into the canvas and design the network by drawing lines in between them. While the user keeps on dragging and dropping the nodes into the canvas and connecting them with wires, the program backend will validate each network connection and keep aggregating the code with the network configuration setting at the firmware code. Figure 11 shows a networking setup for simple sensor network with four nodes.

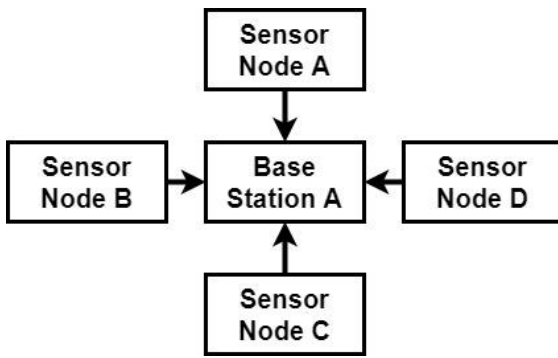


Figure 11. Networking Setup

5. RESULTS AND ANALYSIS

The auto-generated firmware codes will be discussed in the results and analysis section. Table 1 shows the sensors that are supported by the WSN design platform by default.

Table 7. Summary for sensors

Sensor Name	Hardware interface	Supported micro-controllers
DS18B20	GPIO	ESP8266, Arduino, Raspberry Pi
LIDAR-Lite v3	I2C, PWM	Arduino, Raspberry Pi
HX711	GPIO pins	Arduino, Raspberry PI, esp8266
MPU-6050	I2C	Arduino, Raspberry PI, esp8266
DHT-11	GPIO	Arduino, Raspberry PI, esp8266

5.1 Results

An experiment was carried out for measuring humidity using a WSN. The firmware for sensor node with DH11 humidity sensor was generated from WSN design platform. ESP8266 was used as the microcontroller for this experiment. The user is expected not to write any code but, draw the network configuration in the WSN design tool canvas. The network was designed using WiFi connections. Then the auto-generated firmware was then compiled and loaded into the microcontroller.

5.2 Analysis

The automatic code generation module uses the database entries of each sensor that is being used. The functions that are written for each sensor contains XML tags. The connection pins are not hard-coded in the sensor function (in the skeleton sensor function the pins are assigned as <DIGITALINPUT1>, <DIGITAL-INPUT2>, <ANALOG-INPUT1>). These tags are replaced by the automatic code generation module. Figure 12 illustrates the macros that were generated by the WSN design platform. From this method, it is possible to make any sensor works with any supported micro-controller. Figure 12 shows how the tagged pins are replaced using real pins (D0, A0, and D1).

```
#define ANALOG_INPUT_NEW_1 A0
#define DIGITAL_INPUT_NEW_1 D0
#define BASE_STATION_SSID_NAME "BASE_STATION_1"
#define BASE_STATION_PASSWORD ""
#define DEVICE_NAME "node_a"
#define DEVICE_ID "1-2"
#define BASE_STATION_IP_ADDRESS 192,168,1,1
#define WIFI_SERVER_PORT 9001
#define SENSOR_DATA_MESSURING_INTERVAL 1000
```

Figure 12. Auto-generated Defines

Figure 13 shows how a function from database entry (DH11 humidity sensor) is used to generate the firmware code for the sensor node.

```
String gethumid() {
    dht DHT;
    String output = "";
    int chk = DHT.read11(DHT11_PIN);
    output.concat("{\"sensor\":\"HUM\" , \"value\":");
    output.concat(chk);
    output.concat("}\n");
}

return output;
}
```

Figure 13. A sensor function is inserted to firmware

Figure 14 shows an auto-generated loop code with the tag of <SENSOR DATA MEASURING INTERVAL>. The data measuring interval will directly replace according to the user's preferences. Also, the function call is done within this loop.

```
void loop() {
    SetJSON();
    temp_sensor_data = getHumidity();
    dataMessage=dataMessage+temp_sensor_data;
    dataMessage=dataMessage+",";
    if (Count%256==0) Count=1;
    else Count++;
    SendMessage();
    delay(SENSOR_DATA_MESSURING_INTERVAL);
    TKDRequest();
    delay(1000);
}
```

Figure 14. Auto-generated code for the main loop

Finally, Figure 15 shows the sample outputs from the WSN. The output format is a standard JSON object. The output JSON object can be used to transfer the sensor data to any remote location for further processing.

```
.DEBUG - DATA PACKET IS RECEIVED
"TIME":"3705371863","DATA":[{"DEVICE NAME":"NODE_BETA",
"DEVICE ID":"343734","COUNT":"39","SENSOR VALUES":
{"sensor":"TEMP" ,"value":27C}, {"sensor":"HUMID" ,"value":68%}]
```

Figure 15. Structure of the output data format

6. CONCLUSION

The primary aim of the project was to build a common platform to design and develop WSNs. Although there are a lot of commercial wireless sensor nodes available in the current market, still there is no common platform to connect sensors and microcontrollers through a graphical user interface. This project is developed to make the development of wireless sensor networks easy. This WSN design platform is designed in a way that, anyone with moderate computer literacy can design their own WSN network within a short period of time. The WSN design platform has basically developed as a web application, a web application can be deployed on a server and users can log into the WSN design platform from anywhere and start developing the desired wireless sensor network. Since the web application is centralized, the design platform can increase the number of supporting microcontrollers and sensors as users add new sensors and microcontrollers to the system. The web application has designed using responsive front-end and RESTful backend.

7. ACKNOWLEDGMENT

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Analyzing and predicting surface land temperature using machine learning techniques

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ABSTRACT 2-5

The paper focuses on the use of machine learning techniques in the data analysis. The, data classification algorithms, i.e. Decision Tree and k-Nearest Neighbor algorithms are used to carry out the research. The models built upon the algorithms predicted the land surface temperature from 2017 to 2020 for eight UK cities. The temperature data sets, used for the predictions, are collected between 1992 and 2016 from eight UK cities, London, Aberdeen, Basildon, Belfast, Birmingham, Blackburn, Blackpool, and Bolton. Further the paper discusses about the modification of Decision Tree and k-Nearest Neighbor algorithms. The models, from the training data set have developed. The performances of these models are compared and contrasted using the standard performance metrics. The results are checked with the test data for the predicted periods. A predictive Decision Tree and k-Nearest Neighbors models are used to predict the land surface temperature values. Furthermore, the data sets (1992-2016) are visualized to gain more insight knowledge. The results indicate, the combination of historical temperature data and machine learning techniques have a great deal of importance for temperature value predictions and, therefore further studies of the climate changes.

Categories and Subject Descriptors

H.2.8 [Database Management]: Database Applications---*Data mining*; H.2.1 [Database Management]: Logical Design---*Data models*; I.2.8 [Artificial Intelligence]: Problem Solving, Control Methods, and Search---*Heuristic methods*; I.2.6 [Artificial Intelligence]: Learning---*Knowledge*

acquisition, Parameter learning; I.5.2 [Pattern Recognition]: Design Methodology---*Classifier design and evaluation, Pattern analysis*

Keywords

Data mining, machine learning, Decision Tree algorithm, k- Nearest Neighbors algorithm, MATLAB MathWorks, land surface temperature, data visualization, data analysis, climate change, global warming. Tableau Desktop software.

1. INTRODUCTION

The procedure of searching through data and discovering hidden knowledge and using it to predict the future trends has a long history. Often, it's cited as "knowledge discovery in databases," but the term "data mining" hasn't originated until the 1990s (SAS Institute Inc, 2017). The base of data mining consists of three intertwined scientific disciplines: statistics, artificial intelligence, and machine learning. The old methodologies have come to the stage again as data mining technology. This keeps improving to go along with the limitless possibility of big data and affordable computing power (SAS Institute Inc, 2017).

The increment of the land surface temperature has been at an unequaled rate for the past decade (Ji et al., 2014). According to the data gathered from the Intergovernmental Panel on Climate Change working group (IPCC, 2017), the College of Earth and Mineral Sciences of the Pennsylvania State University (2017) has conducted a research, and have discovered that, the land, sea, and air are all warmer now compared with the data before 1961–1990. Also, the temperature had

been increasing fixedly and expeditiously over the last few decades. It further notes that, the rate of increase is rapid. According to the research carried out by the Centre for Ecology & Hydrology, Wallingford, and the Met Office Hadley Centre, Exeter, UK (Harris et al., 2014), the researchers have found progressive evidence that European summer temperature extremes are increasing, and can be enhanced by soil moisture-induced land-atmosphere feedback. Furthermore, the research predicts that the heat wave events could become more frequent in the future, using the climate model projections.

In their book, Han, Kamber and Pei (2012, pp. 5-6) argue that the term data mining does not describe all the major aspects into the picture. To enrich their argument, they describe that when referring to the mining of gold from rocks or sand, the term is gold mining not rock or sand mining. Parallely, they argue data mining should have been more appropriate if it's named "knowledge mining from data," which is quite long. But the use of the shorter term, knowledge mining might not indicate the significance on mining from large amounts of data. Regardless, mining is a fascinating term distinguishing the procedure that finds a small set of valuable chunks of knowledge from a huge amount of raw materials. Consequently, such a misnomer carrying both "data" and "mining" became famous. Furthermore, they describe that there are many terms which has similar meanings to data mining, such as knowledge mining from data, knowledge extraction, data/pattern analysis, data archaeology, and data dredging. The "knowledge, discovering from data" (Kamber et al, 2012) is currently used within diverse industries and disciplines, the recent report from SAS Institute describes, the data mining is at the heart of analytics efforts (SAS Institute Inc, 2017).

According to Ritter (2009, p.11), one of the advanced scientific debates of this time is whether the global warming originating from human activities. If, the global warming really occurs from the human activities, the critical questions are what the effect will be and is there anything anyone can do about it. Conventional, climate scientists' idea is that the global warming is continuing as a result of man's inappropriate deeds. But a few global-warming cynics argue that there is still a lot of guesswork in how some scientists came to this interpretation. At the bottom of this argument is a lot of good science, science that is still hidden. There is no doubt that Earth's atmospheric carbon dioxide concentration has been increasing since the Industrial Revolution began in the late 1700s, and with most of the rise coming since 1950. And there is accordance that the emissions from burning fossil fuels increase the CO₂ percentage. Also, everyone agrees upon the fact that the global average temperature has risen since 1850. After, reliable instrument temperature measurements began, the scientist has identified that most of the warming has occurred since 1970. Ritter further pin points (2009, p.

11), at this point that the gracious agreements stop. At the root of the global-warming discussion, which argues whether that the global warming is done by humans, by increasing anthropogenic CO₂ levels or whether it is simply part of Earth's natural climate variability. Ritter reviews (2009, p.11) the majority opinion propagate in peer-reviewed reports over the past 20 years by the Intergovernmental Panel on Climate Change (IPCC). It is an entity established by the United Nations Environmental Program and the World Meteorological Organization. In IPCC's fourth assessment, "Climate Change 2007," infer that "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." The assessment specifies that "most of the observed increase in global average temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations." For IPCC, the meaning of the words "very likely" is more than 90% statistical certainty.

Ritter argues (2009, p.11), that if IPCC's 90% statement were looked from a different perspective, it means that there is a 10% likelihood that the current warming trend might arise from natural climate divergence. Therefore, there are minority of climate scientists, along with the scientists from different areas, non-scientists and the organizations that support the idea that the global warming is from natural climate divergence and stand behind that 10%.

Per Ritter (2009, p. 11), one way or another the global warming is an ongoing process. And the focus of this paper is to use the classification algorithms to predict the land surface temperature, then the results of the research could, eventually, can provide concrete evidence upon the discussion of "Global Warming".

The description of the classification algorithms says, their nature is to get a coherent approach to build classification models from sets of data. As an example, decision tree classifiers, rule-based classifiers, neural networks, support vector machines, and naive Bayes classifiers have different techniques in solving the classification problems. Each algorithm adopts different learning methods to figure out a model which fits best for the correspondence between the attribute set and a class label of the input data. Hence, the main objective of the learning algorithm is to build predictive models that correctly predicts the class labels of previously not known records (Bakos, 2010).

The paper tries to provide tangible evidence to the fact that the global warming is real, ongoing process. The insight since it is provided, using the historical surface land temperature data sets and with the use of machine learning techniques. The land surface temperature data of the eight cities of UK from 1992 January to 2013 August were collected from 'Berkeley Earth'. 'Berkeley Earth' is an organization which is affiliated with Lawrence Berkeley National Laboratory, USA.

The land surface temperature data from 2013 September to 2016 December for the same eight cities were gathered from Weather Underground (The Weather Company, LLC, 2017).

2. METHODOLOGY

2.1.Data classification

Classification (Oracle, 2017), the data mining function assigns objects in a collection to target categories or classes. The main objective of the classification is to correctly predict the target class for each case in the data. For example, within the research, the paper is based the classification model identifies the land temperature for three different classes, i.e. Cold, Warm, and Hot.

(Cold <6 Celsius, 6 Celsius <= Warm <= 11 Celsius, Hot>11 Celsius)



Figure 1. Map indicating the geographical locations of mentioned cities.

As the first step of the classification task, the class assignments are known data sets (the historical land surface temperature data) are collected, from year 1992 to year 2016 of eight UK cities (London, Aberdeen, Basildon, Belfast, Birmingham, Blackburn, Blackpool, and Bolton). The geographical locations are indicated in the figure 1.

According to the research, the classification models are developed, and have predicted the land surface temperature of above stated eight UK cities; from 2017 to 2020.

Classifications are distinct and do not involve an order. Therefore, it is used to gain distinct values as the predicted results. And in other hand to gain results as continuous, floating-point values, which would indicate a numerical, rather than a categorical, target the researchers use the regression algorithms, but not

the classification algorithms. The binary classification is the simplest type of classification problem. As in the word binary implies, in the binary classification, the target attribute has only two possible values: for example, cold or hot temperature. Multiclass targets have more than two values: for example, cold, warm, hot, etc. (Oracle, 2017).

As in the initial process of the classification procedure, building the model upon data set and training it with the training data set, will be carried out. To carry out this process, the classification algorithm looks for relationships between the values of the predictors and the values of the target. To achieve a model building phase successfully, the various classification algorithms, uses various techniques. Then the relationships are condensed in a model, and applied to a different data set in which the class assignments are unknown. The way classification model is tested are quite straight forwarded; it compares the predicted values to known target values in a set of test data. The historical data set used in the classification project is generally divided into two data sets: one for building the model; the other for testing the model. The important aspect of the test data is, it should be accorded with the data used to build the model, also should be prepared in the same way, the build data was prepared. Usually the build data and test data come from the same historical data set. One part of the record is used to build the model; the remaining records are used to test the model. To evaluate the accuracy of the model, the test metrics are used. If the model performs well and meets the business requirements, it will be applied to the new data to predict the future. The accuracy of the classification refers to the amount of correct predictions made by the model when compared with the actual classifications in the test data (Oracle, 2017).

2.2 Decision Trees (DT)

Bakos (2010) describes that, one of the simplest and widely used classification technique is a Decision Tree Classifier. It applies a simple idea to solve the classification problem. Decision Tree Classifier presents a collection of carefully created questions about the attributes of the test record. And every time it receives an answer, a follow-up question is asked. This goes until a conclusion about the class label, of the record is reached.

Sayad (2017) recounts that the decision tree builds the classification models in the form of a tree structure. First and foremost, it breaks down a dataset into much smaller subsets. And at the same time an associated decision tree is incrementally developed. The result is a tree with the decision nodes and leaf nodes. A decision node has two or more branches. Whistle the leaf node represents a classification or decision. The root node, which is the topmost decision node in a tree, corresponds to the best predictor. Also, both the categorical and numerical data can be handled by the decision trees.

2.3 k- Nearest Neighbors (k-NN)

K- Nearest Neighbors is a straightforward algorithm. It stores all available cases and classifies new cases based on a similarity measure (e.g., distance functions). Since 1970 k-NN has been used in statistical estimation and pattern recognition as a non-parametric technique. A case is classified by a majority vote of its neighbors, with the case being assigned to the class most commonly amongst its K nearest neighbors measured by a distance function.

If $k = 1$, then the case is simply assigned to the class of its nearest neighbor (Sayad, 2017)

If $k = 99$, it is a simple model but with many errors

If $k = 1$, it is a complicated model with five or six errors

If $k = 9$, this could be the best solution

2.4 Implementation

The initial step of the implementation is to divide the data set into three batches (1992-2016, 25 years' worth data). I.e.

First batch: 1992-1999 (8 years)

Second batch: 2000-2007 (8 years)

Third batch: 2008-2016 (9 years)

The second task is to build the classification models from the standard DT and k-NN. MATLAB platform is used here.

First batch used DT algorithm and data from 1992 to 1996 to build the model.

Checked the accuracy of the model with the data from 1997 to 1999. Below Figure 2, shows, the results gained by building the first DT model and shows the accuracy of the model.

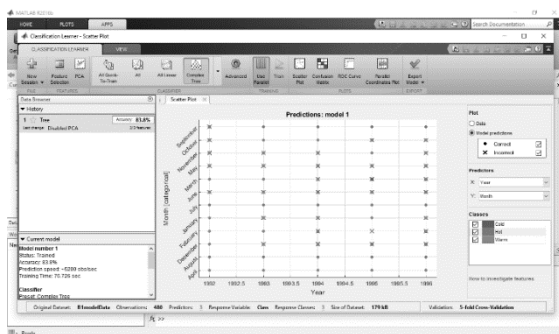


Figure 2. First batch, DT algorithm accuracy 83.8%

Second batch used DT algorithm and data of 2000 to 2004 to build the model

Checked the accuracy of the model with the data from 2005 to 2007. Below Figure 3 shows, the results gained by building the second DT model and shows the accuracy of the model.

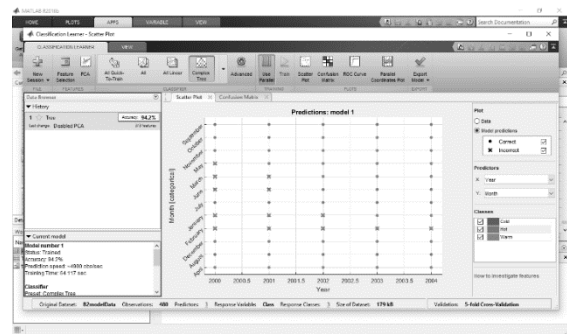


Figure 3. Second batch, DT algorithm accuracy 94.2%

Third batch used DT algorithm and data of 2008 to 2013 to build the model

Checked the accuracy of the model with the data from 2014 to 2016. Below Figure 4 shows, the results gained by building the third DT model and shows the accuracy of the model.

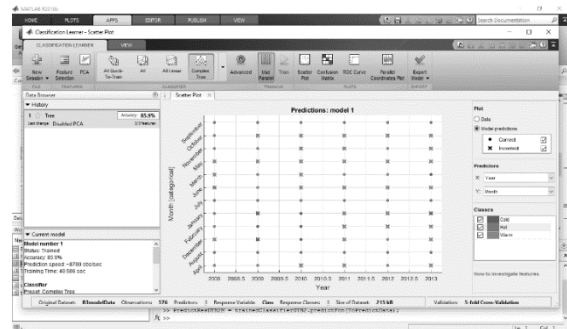


Figure 4. Third batch, DT algorithm accuracy 85.9%

The above process, also carried out using k-NN algorithm. First batch used k-NN algorithm and data from 1992 to 1996 to build the model.

Checked the accuracy of the model with the data from 1997 to 1999. Below Figure 5, shows, the results gained by building the first k-NN model and shows the accuracy of the model.

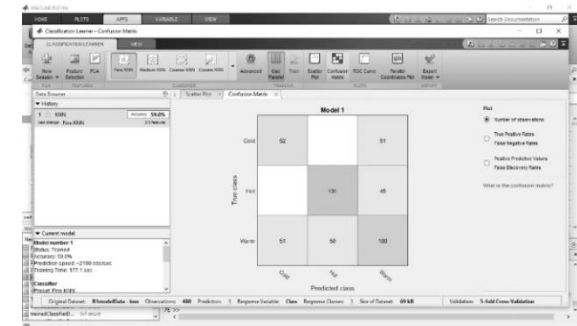


Figure 5. First batch, k-NN algorithm accuracy 59.0%

Second batch used k-NN algorithm and data of 2000 to 2004 to build the model

Checked the accuracy of the model with the data from 2005 to 2007. Below Figure 6 shows, the results gained by building the second k-NN model and shows the accuracy of the model.

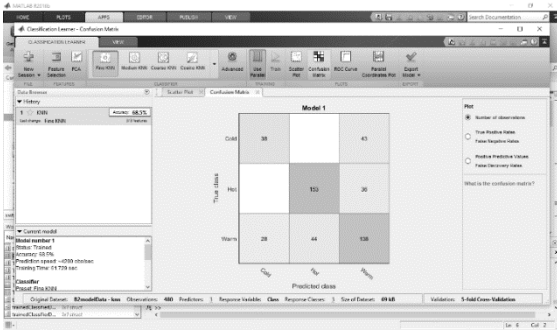


Figure 6. Second batch, k-NN algorithm accuracy 68.5%

Third batch used k-NN algorithm and data of 2008 to 2013 to build the model

Checked the accuracy of the model with the data from 2014 to 2016. Below Figure 7 shows, the results gained by building the third k-NN model and shows the accuracy of the model.

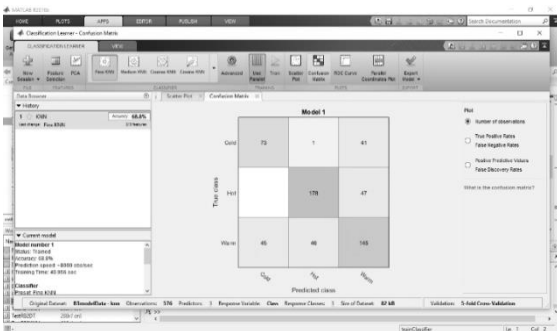


Figure 7. Third batch, k-NN algorithm accuracy 68.8%

According to the above results the accuracies of all the six models were at satisfied level; therefore, applied to predict the surface land temperature, from year 2017 to 2020, of stated eight UK cities. Finally, six different result sets were noted.

2.4.1 Data visualization with Tableau desktop software

Data visualization harnesses people’s natural ability to spot visual patterns quickly (Interaction Design Foundation, 2017) hence it’s crucial in the process of data mining.

Creation of Tableau Graph 1-

The temperature values are compared with the related month and the year; the temperature variations of a year for all 12 months, from 1992-2016 Ex: Year 1992, month January to December.

The temperature variations for 25 years, from 1992-2016, for all the 12 months. Ex: Month January, year 1992-2016

Creation of Tableau Graph 2-

The temperature values are compared with its location and the related year/month. The temperature variant checks, years for all the eight cities, from 1992-2016,

for London, Aberdeen, Basildon, Belfast, Birmingham, Blackburn, Blackpool, and Bolton.

Ex: Year 1992, cities London to Bolton.

The temperature variant of a month in all the eight cities, from January to December, for London, Aberdeen, Basildon, Belfast, Birmingham, Blackburn, Blackpool, and Bolton.

Ex: Month January, cities, London to Bolton.

2.5 Modified Decision Tree algorithm

This hypothesis says, based on the decisions of the decision nodes, leaf node could have classified as ‘Cold’, ‘Warm’ or ‘Hot’.

According to the DT algorithm’s first modification, for the first batch of data, ‘Year’ was taken as the root node.

Underneath the root node, years from 1992 to 1996 act as decision nodes. After isolating one decision node (ex:1992), the months from January to December act as the decision nodes underneath it. The process is same for all the decision nodes (1992-1996). Again, after isolating one decision node (ex: January), the cities from London to Bolton act as the decision nodes underneath it. The process again is similar for all the decision nodes (London-Bolton). Finally, based on the decisions of the decision nodes, leaf nodes are classified as ‘Cold’, ‘Warm’ or ‘Hot’.

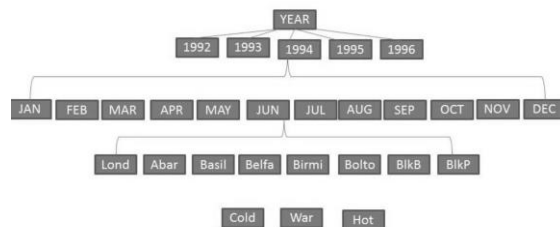


Figure 8. For the first batch, DT algorithm’s first modification

According to the DT algorithm’s second modification, for the second batch of data, ‘Year’ was taken as the root node.

Underneath the root node, years from 2000 to 2004 act as decision nodes. After isolating one decision node (ex:2000), the months from January to December act as the decision nodes underneath it. The process is same for all the decision nodes (2000-2004). Again, after isolating one decision node (ex: January), the cities from London to Bolton act as the decision nodes underneath it. The process again is similar for all the decision nodes (London-Bolton). Finally, based on the decisions of the decision nodes, leaf nodes are classified as ‘Cold’, ‘Warm’ or ‘Hot’.

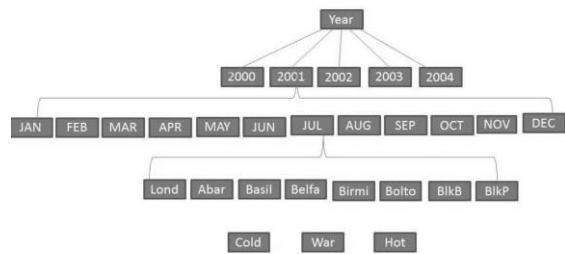


Figure 9. For the second batch, DT algorithm's first modification

According to the DT algorithm's third modification, for the third batch of data, 'Year' was taken as the root node.

Underneath the root node, years from 2008 to 2013 act as decision nodes. After isolating one decision node (ex:2008), the months from January to December act as the decision nodes underneath it. The process is same for all the decision nodes (2008-2013). Again, after isolating one decision node (ex: January), the cities from London to Bolton act as the decision nodes underneath it. The process again is similar for all the decision nodes (London-Bolton). Finally, based on the decisions of the decision nodes, leaf nodes are classified as 'Cold', 'Warm' or 'Hot'.

According to the DT algorithm's second modification, for the first batch of data, 'City' was taken as the root node.

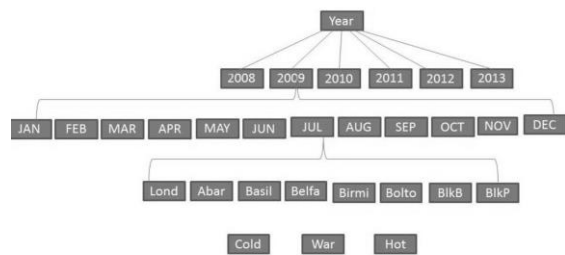


Figure 10. For the third batch, DT algorithm's first modification

Underneath the root node, cities from London to Bolton act as decision nodes. After isolating one decision node (ex: London), the years from 1992 to 1996 act as the decision nodes underneath it. The process is same for all the decision nodes (London-Bolton). Again, after isolating one decision node (ex: 1992), the months from January to December act as the decision nodes underneath it. The process again is similar for all the decision nodes (January-December). Finally, based on the decisions of the decision nodes, leaf nodes are classified as 'Cold', 'Warm' or 'Hot'.

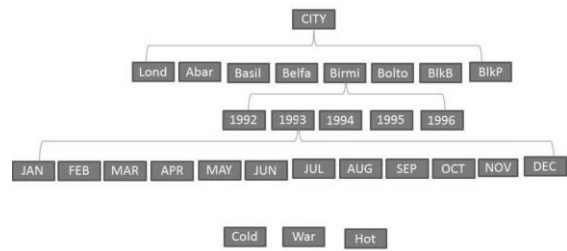


Figure 11. For the first batch, DT algorithm's second modification

According to the DT algorithm's second modification, for the second batch of data, 'City' was taken as the root node.

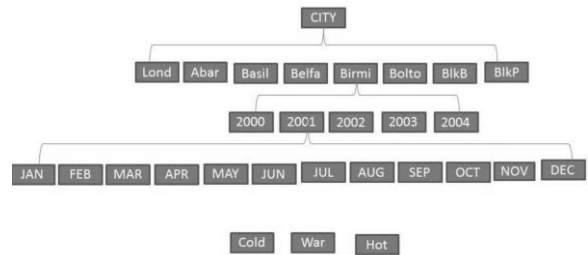


Figure 12. For the second batch, DT algorithm's second modification

Underneath the root node, cities from London to Bolton act as decision nodes. After isolating one decision node (ex: London), the years from 2008 to 2004 act as the decision nodes underneath it. The process is same for all the decision nodes (London-Bolton). Again, after isolating one decision node (ex: 2000), the months from January to December act as the decision nodes underneath it. The process again is similar for all the decision nodes (January-December). Finally, based on the decisions of the decision nodes, leaf nodes are classified as 'Cold', 'Warm' or 'Hot'.

According to the DT algorithm's second modification, for the third batch of data, 'City' was taken as the root node.

Underneath the root node, cities from London to Bolton act as decision nodes. After isolating one decision node (ex: London), the years from 2008 to 2013 act as the decision nodes underneath it. The process is same for all the decision nodes (London-Bolton). Again, after isolating one decision node (ex: 2008), the months from January to December act as the decision nodes underneath it. The process again is similar for all the decision nodes (January-December). Finally, based on the decisions of the decision nodes, leaf nodes are classified as 'Cold', 'Warm' or 'Hot'.

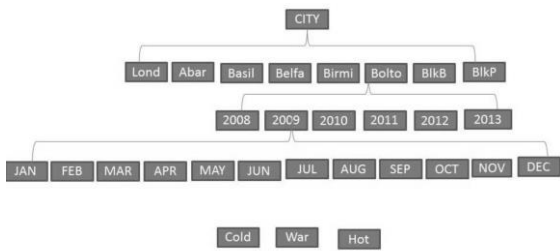


Figure 13. For the third batch, DT algorithm's second modification

2.6 Modified k-Nearest Neighbors algorithm

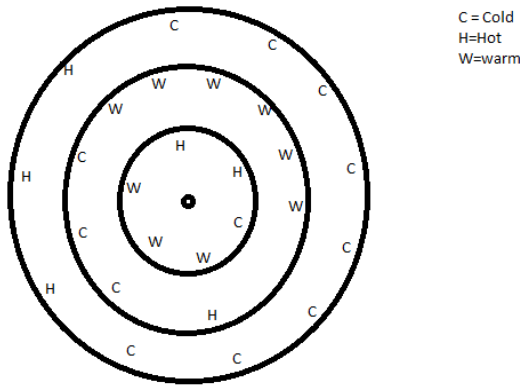


Figure 14. Hypothesis diagram for modified k-NN

The Black dot in the middle, indicates the object which the class is unknown.

According to the diagram,

the first circle has $W=3$, $H=2$ and $C=1$,

the second circle has $W=6$, $H=1$ and $C=3$ and,

the third circle has $W=0$, $H=3$ and $C=8$

As in the modified version we have three k values,

$k = 2$, $k = 5$ and $k = 8$

In the first round, the values which fulfils first k value ($k = 2$) is checked, hence 'Hot' and 'Warm' are the answers

In the second round, the values which fulfils second k value ($k = 5$) is checked, hence 'Warm' is the answer

In the third round, the values which fulfils third k value ($k = 8$) is checked, hence 'Cold' is the answer

Results are,

Class 'Hot' appears once, Class 'Cold' once, and Class 'Warm' twice.

Therefore the answer (the class value for the red object) is Class 'Warm'.

According to this k-NN modification k values always be,

first $k = 2$, second $k = 5$, third $k = 8$, fourth $k = 11$, fifth $k = 14$,

if previous k is odd value then the next k value is even, and always starts with the $k = 2$ value

3. RESULTS AND DISCUSSION

The land surface temperature data from the year 2017 to 2020 is predicted. Six different sets of prediction results are built upon the following six models (MATLAB platform).

First batch -> standard DT algorithm - accuracy 83.8%

Second batch -> standard DT algorithm - accuracy 94.2%

Third batch -> standard DT algorithm - accuracy 85.9%

First batch -> standard k-NN algorithm - accuracy 59.0%

Second batch -> standard k-NN algorithm - accuracy 68.5%

Third batch -> standard k-NN algorithm - accuracy 68.8%

Most of the time the results gained from the six models were similar, but with random anomalies. There are situations, such as, in the same month, in the same year of the same city getting two different class types. But when a situation which gives two class types are predicted for a same month, the different class, is always the very next temperature class of the most occurred class. As an example, in a situation where one model predicts 'Warm', and from other models it predicts 'Hot' or if it's 'Cold' then the different class would be 'Warm'.

Importantly, when the anomaly occurs by the second batch of data, of, standard DT algorithms, it must be considered as a significant occurrence. Since, that model has the highest accuracy of 94.2%, it has more weight/possibility of predicting the correct value than other models.

There are scenarios, regular 'Cold' months have gotten the results of 'Warm'. Or regular 'Warm' months have gotten the results of 'Hot'. Since the models are accurate only possibility is to, put more weights under the 'Global Warming' is an ongoing process, and this provides tangible evidence to prove the main argument, which is 'the land surface temperature' will rapidly increase in the coming future.

The gained accuracy percentages of the models showcased that Decision Tree algorithm is more effective when predicting land surface temperature data for similar scenarios. Therefore, it is highly recommended to, initially use simple algorithms

together with more complex algorithms and compare the accuracy of both the result sets.

3.1 Limitations of the study and future works

One of the main limitations of the research is, since the study is only based upon the eight cities in the UK (London, Aberdeen, Basildon, Belfast, Birmingham, Blackburn, Blackpool, and Bolton), there is less possibility of applying the results gained, to different regions and get an overall conclusion. Even though the research provides results, indicating the increment of the land surface temperature, it only limits to above stated eight UK cities. This act as a main limitation, when it comes to prove the point whether it's the 'Global Warming' which effect on the entire globe or different temperature anomalies which only affect to above stated UK cities. The other main limitation is, since the research is only based upon two classification algorithms, there is little possibility of reaching for an optimum and efficient algorithm to predict the land surface temperature data.

As a solution for one of the main limitations, figuring out an optimum and efficient algorithm, the future works of the research will mainly focus on predicting the land surface temperature data with different machine learning algorithms. Therefore, the land surface temperature data of eight UK cities, London, Aberdeen, Basildon, Belfast, Birmingham, Blackburn, Blackpool, and Bolton from year 1992-2016, will be used with Regression algorithms, specifically with Logistic Regression algorithm etc. Moreover, the use of the Regression algorithm will provide a window to compare its results with, the results gained from the Classification algorithms, for the same scenario. Mostly using different, relevant algorithms to carry out the research further, will lead to finding the holy grail of optimum and effective algorithms.

4. CONCLUSION

There are huge obligations for predicting of accurate land surface temperature information. The known business objective for similar predictions are enormous (Haby, 2016). Such as, Businesses and people could plan for power production and how much power to use in different months and years to come by (ex: power companies, where to set thermostat), very useful for the daily lifestyle, businesses could plan ahead for the transportations and avoid hazards situation that can result from the weather (ex: fog, snow, ice, storms, clouds as it relates to driving and flying), businesses and people can prepare for severe weather and other weather hazards (lightning, hail, tornadoes, hurricanes, ice storms), employers in the agricultural industry can plan for crop irrigation and protection (irrigation scheduling, freeze protection) etc. (Haby, 2016).

It's quite interesting, the way businesses gain advantage of the historical land surface temperature values, and it triggers, the difference importance

aspects of raw data, which when used an accurate and procedural way, could lead to new discoveries.

More similar research should carry out to predict the temperature or weather patterns and to compare and contrast the process with different machine learning algorithms. And it'll ultimately lead to the conclusions of which algorithm suits best for a particular scenario.

5. ACKNOWLEDGMENTS

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Networking Tool to Bridge the Communication Gap between School Teachers and Parents

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ABSTRACT 3-8

Parents face difficulties in managing a closer relationship with schools in relation to the academic performance of children and their daily routine activities at school. Existing in a society where parental involvement is considered essential, parents are required to assist students with better guidance to enhance their academic performances, irrespective of work life. Numerous factors have been identified as the causes behind inefficient parent-teacher communication. Majority of the parents have a very tight daily routine despite being employed. Owing to this, higher chances of missing out urgent notices and upcoming school occasions exist. Gradually, this leads to children's incomplete homework, less activeness in academic and co-curricular activities, damaging impression between teachers and parents and distrust among parents and children. The modern generation, being proficient with technology, introducing a technologically developed networking tool is an effective mode of assistance to bridge the communication gap between parents and teachers. This in return will help to enhance the academic performance of children. Moreover, it will be a more desirable way for parents to build a closer relationship between home and school while maintaining balance between work and home life. Significance of introducing such a tool has been acknowledged through research on peer-reviewed publications and an industry survey, which has contributed towards problem analysis, system design and system implementation. The ultimate impact of this venture, is to support employed parents to manage a balanced work and family life while bridging the communication gap between parents and teachers.

Keywords

SchoolCon, Parental involvement, Parent-teacher communication, International education industry, International schools, Communication gap.

1. INTRODUCTION

The education industry in Sri Lanka is an extremely dynamic industry, well known for its free education to all citizens over the last 50 years. Its literacy rate tops with 92.6% (2016) within the last few decades calculating the literacy rate among all Sri Lankans above 15 years of age, who can read and write. With the advancement of the education industry, the international education industry in Sri Lanka was established in 1985, with the commencement of the first international school to deliver full-time, paid education for students. International school education is provided in English medium while registering all international schools under Companies Act of Sri Lanka. Currently, international education is prominent among the middle-class families earning well in Sri Lanka to offer English medium education for their children, contributing to provide most outstanding education. Furthermore, parents embrace a less hostile than waiting to start a better government school for their children.

Sri Lanka possesses a highly competitive market in the international education industry with all leading international schools. It provides students English medium education with a British national curriculum ending in General Certificate of Education Ordinary level and Advanced level examinations administered by examination bodies in the United Kingdom based on a General Certificate of Secondary Education system of judgment. In such competitive marketplace within the international education industry in Sri Lanka, parents play a major role to affiliate their children to a recognized educational establishment with the considerable amount of international schools spread in Sri Lanka. Moreover, parents contribute to provide children with the most outstanding education while competing with the routine lifestyle. Since a higher percentage of middle-class families of Sri Lanka being educated and engaged in a profession, facing the daily challenges within the international education industry is a struggle with tight daily schedules and lifestyles practiced.

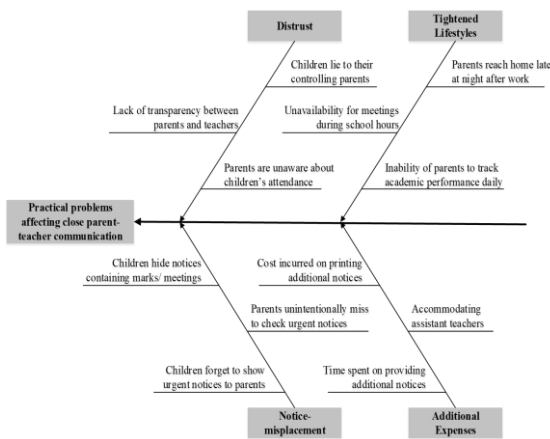


Figure 13

Nevertheless, Sri Lankan parents are dedicated to uplift the standards of their children's academic performances based on the close family relationships maintained as a culturally followed practice. International education industry, being a paid mode of education provider, parents are likely to be more enthusiastic on their children's academic progress to get a value in return for their hard pay. Parents hold a sustainable relationship with schools as a need of assuring advancement of academic performance of their children. Researchers have identified that, a close relationship between home and school plays a leading role as a factor of improving the academic progress. Parent-teacher communication provides students with constant academic assistance in building home-school partnerships.

Currently, parental involvement in the academic activities of students is practiced through parent-teacher meetings and conferences. Face to face meetings are the best practice of traditional parent-teacher communication that requires extra commitment and time to provide their children with the finest assistance. Being in a millennial era, practicing fully occupied lifestyles, it has been tough for employed parents to afford extra time in building a close relationship with school. With the considerable perception on tight lifestyles of current generation, international education industry in Sri Lanka needs to enhance parent-teacher communication in a way which is modernized, creating the lives of involved parties comfortable. Furthermore, Sri Lanka being a technologically developing nation while majority of the parents of international school students being educated, digital technology can be used in overcoming the physical communication adversity between parents and teachers. Hence, introducing a technologically improved networking tool to bridge the gap between parent-teacher communication is an effective way of assistance to enhance academic performance of students. Furthermore, it is a more desirable way of recovering the busy lifestyles and tightened routines

of parents to build a closer relationship between home and school.

2. BACKGROUND AND RELATED WORK

Since the project aims to design, develop and evaluate a networking tool to enhance parent-teacher communication within the international education industry, analysing the complications and practical difficulties in maintaining a close relationship between home and school for parents of primary school students, author has carried out a survey within the international education industry in Sri Lanka recently. It was evident that, majority of the parents of international school students are employed in a full time or a part time career while providing the finest education for their children to improve the academic performance. It was found, that employed parents face crucial difficulties in managing a relationship with schools when considering the academic progress of their children.

Living in a society where parent-teacher communication is considered essential, parents are required to provide students with better guidance enhancing children's academic progress irrespective of their office work. Figure 1 shows the cause effect diagram which illustrates the key difficulties identified as the causes for the inefficiency of proper parent-teacher communication. Furthermore, author describes the attention provided by the schools to maintain a stabilized relationship between home and school.

2.1 Literacy Statistics and International Education Industry of Sri Lanka

The World Factbook states that, literacy is the ability of reading and writing during a specific age where, literacy rate within Sri Lanka is calculated among the population of age varying from 5 to 69 years. Literacy standards are practiced in a country as a validity of international comparisons. Per Socio-Economic Data of Sri Lanka, literacy rate of Sri Lanka has raised up to 91.2% during 2005-2012 holding a highly literate position among other Asian countries because of the free education provided to all citizens below 18 years of age. With the enhancement of technology, IT literacy is taken into consideration where, growth of internet literacy blossomed with mobile internet usage. Internet usage in Colombo district possesses 27.6%. Youth (18-24 years of age) in Sri Lanka tops among other age groups with 57% of computer literacy and internet usage of 27.6% over the past few years. As a technologically developing nation, Sri Lanka broadens its literacy rate daily while initiating a computer literate future generation.

Due to the launch of first Sri Lankan international school in 1985 with the formation of the Wycherley International School, international education has

become prominent within the current generation. Consistently, good-earning, middle-class families are decidedly privileged to deliver international education for their children since international schools charge a high payment for each school term to facilitate students with the British National Curriculum. Therefore, international education industry moderately affords in the upliftment of academic performance of each student ensuring the value of parents' hard-earned money while prospering globalization of education in Sri Lanka.

2.2 Impact of Family Relationships and Parent-Teacher Involvement on Children's Education

“Relationships between parents and children complete the relational triangle at the core of the family” recognizing the significance of family relationships which leads to a child's improvement of well-being. Therefore, the necessitated love, care, involvement and guidance from parents enhance the academic progress of children. It was evident that, when parents are involved in activities related to their child's school, children show their interest in studies. In addition, children perform better in both academic and extra-curricular activities. Besides parents who are maintaining stable family background positively affects the social growth of children. Conclusively, at instances where parents are informed, it is a positive influence on children's education while maintaining a close family relationship.

Behaviour of a child is based on the degree of involvement of parents in children's academic activities. It was identified, children mostly act with enthusiastic attitudes when parents contribute towards academic involvement. Involvement of parents affects the academic performance of children, where their personal attitudes ensure higher educational standards of children. Ultimately, appropriate parent-teacher involvement influences the improvement of academic performance of a child in an acceptable manner highlighting the importance of parental involvement on children's education.

2.3 Parent-Teacher Communication in Sri Lanka

Parent-teacher communication is continual encouragement for children in current generation based on competitiveness in the prevalent education industry of Sri Lanka. Physical meetings between parents and teachers is the most preferable mode of communication among parents to collaborate in enhancing academic performance of their children. Physical meetings create an excellent influence yet, majority of the parents of the current generation being employed, there is a higher prospect in them to encounter the mismatch of their availability that results in insufficient assistance for children to boost

their academic performances. Therefore, within the current education industry, parents and teachers manage their relationships through numerous communication forms such as notice letters, personal phone calls, personal text messages and e-mails where they sustain the parental perception of enhancing the academic progress of children.

2.4 Influence of Parental Involvement

“Parent involvement in a child's education is consistently found to be positively associated with a child's academic performance”; intensified parental involvement influences the academic success of children. For an instance, primary grade children need encouragement from parents to stabilize academic success. Therefore, parental involvement shows an effect on the academic performance of children. Children being interested in avoiding academic work while parents are not involved, it is essential to track academic performance regularly. Besides, family background and social standards of parents effect the academic progress of children whereas, it is evident, effective parental involvement positively influence the academic progression of children while lack of effective parental involvement is a negative impact on their children's academic progress.

2.5 Gaps in Parent-Teacher Communication

“Parental involvement – checking homework, attending school meetings and events, discussing school activities at home – has a more powerful influence on students' academic performance than anything about the school the students attend”. Considering current international education industry, overcoming the practical problems of the generation, parents involve in academic activities of primary children. Yet, a higher percentage of older children achieve their academic performance on their own. Though older children are capable to handle themselves, parental involvement on their academic activities would keep them stick in to education and enhance interests towards achieving higher academic performances. Therefore, a higher communication gap exists among the parents and teachers of the current international education industry due to the complicated daily routines being followed. Consequently, children have become victimized individuals of existing parent-teacher communication gaps.

2.6 Bridging Parent-Teacher Communication Gaps through Technology

Schools of the current generation has mostly proceeded with technology to maintain a parent-teacher relationship in a better way rather than settling in the traditional face-to-face meetings, since technology creates way more accessibility to

communicate while strengthening the relationships between parents and teachers effectively. Based on the gaps of parent-teacher communication in international education industry, technology makes a positive impact to improve the current state of parent-teacher communication. Since parents of the current generation technologically move ahead, it is effortless to manage parent-teacher communication with technology. Parents being possessive with work, technology ensures that they are provided the opportunity to stay connected online, irrespective of time. Hence, parent-teacher communication can be managed while bridging existing communication gaps between parents and teachers effectively by following the current technological trends.

3. PROTOTYPE SYSTEM OVERVIEW

The research is focused at developing a mobile application for parents along with a desktop application for teachers. SchoolCon is to be introduced as “next level parent-teacher communication platform” to lessen the practical problems experienced by parents daily. SchoolCon offers accessibility to essential features and functionalities in order to reduce the communication gap between parents and teachers involved in the international educational industry of Sri Lanka. Following features provided through SchoolCon considers important.

3.1 Urgent notices

Since parents involved in the international education industry of Sri Lanka do not possess the necessitated time and commitment to engage in the academic activities of their children despite of being employed, there are higher chances of missing out notices sent from their child’s school. SchoolCon being a mobile application, it sends real time updates to parents when notices are updated by the school where parents can easily access notices through their mobile phones. At instances where it is needed to provide children with additional equipment for the next school day, parents do not need to rush themselves when updates are being send through SchoolCon. Parents have feasibility to look forward for what their child needs despite of being discouraged to provide children with the needful when they reach home in late hours. It was identified that, real-time notifications of SchoolCon effects the readiness of children to the next school day positively while improving their enthusiasm on academic performances.

3.2 Assignment and Exam Marks

It was identified that, providing parents direct access to assignment marks and exam marks of their children reduces the occurrence of distrust among parents and children. SchoolCon lets parents access assignment marks and exam marks online through

the application. Researchers state that, “adolescents with controlling parents are often defiant and lack trust in their parents which is caused due to children’s inability to see parents as legitimate authority figures.” At instances, children attempt to lie their controlling parents when their academic performance is low. Children lie to save themselves from parents’ strict punishments knowing parents do not maintain close relationship with school. When children do not perform well in the classroom and gets low grades for assignments and exams, they do not prefer their parents checking student’s record book, instead they tend to lie their parents. Moreover, parents distrust the examination marks of their children too when the student’s record book is not sent home on time. It gives children with a possibility to lie their parents mentioning better examination marks. Since parents of international school students being more aware about the progress of academic work, they pay major attention on examination marks to get a value for their pay. Therefore, providing accessibility to assignment marks and exam marks ensure that, distrust between parents and children are reduced while allowing parents to stay alert on their children’s academic performances.

3.3 Annual Calendar

Providing accessibility to annual school calendar provides the feasibility for parents to make plans. It allows parents to ensure their availability at child’s school events despite of office work. It also ensures that, students are ready for their upcoming lessons at school since parents could easily provide children with the needful based on the yearly calendar. It improves students’ readiness to school while increasing the parental involvement with school due to planning. SchoolCon allows parents to skim through days to check on the tasks allocated to each school day.

3.4 Online Payments

It was identified that online payments are popular among the current generation based on its availability, accessibility and feasibility. SchoolCon provides parents with the online payments functionality since it is inconvenient for employed parents to visit bank during working days to ensure payments related to their child’s school is made on time. Parents can make school payments through their personal mobile phones while allowing transactions to be carried online. By providing necessitated transaction information, parents could make payments to their child’s school via SchoolCon irrespective of the time.

3.5 School Occasions

SchoolCon allows teachers to create school events online and send invitations to parents through the application where parents have the ability of

accepting and rejecting event invitations based on their preferences and availability. When schools organize events and notices are sent home through children inviting parents, school could not ensure attendance of parents yet, sending online invitations allow school to ensure the attendance of parents to school events. Besides, parents could view information of school events to discover the importance of their attendance.

3.6 Daily Attendance

In relation to assignment and exam marks, there are chances of children lying to their parents about daily school attendance among the secondary grade students. Children become liars to their parents when their interest of attending school daily reduces. These various influences of children result in creating distrust in the minds of parents and teachers. Even though, children are not being controlled by parents, parents face the issue of distrust about their child's daily school attendance. Parents doubt the daily attendance of children to school despite parents being employed. Majority of the parents are habituated to provide their children with different modes of transportation facilities available to and from school than dropping their children to school with the heavy traffic jams in Sri Lanka. Children get used to private and public transportation modes which makes the parents doubtful about their child's attendance to school. Therefore, real time updates of students' daily attendance allow parents to ensure their child's attendance to school through SchoolCon. SchoolCon offers advantages such as notifications are not missed, instant alerts sent online, absentee notices sent online, easy payment methods, two-way communication, secure and easy access and locate events via Google Maps with the intention of improving the academic performance of students by enhancing parent-teacher communication. The high level architectural design in Figure 2 represents the presentation layer, business layer, service layer and database layer of SchoolCon where an overall design flow is illustrated. Moreover, it illustrates the inter-connectedness of SchoolCon mobile and SchoolCon desktop applications.

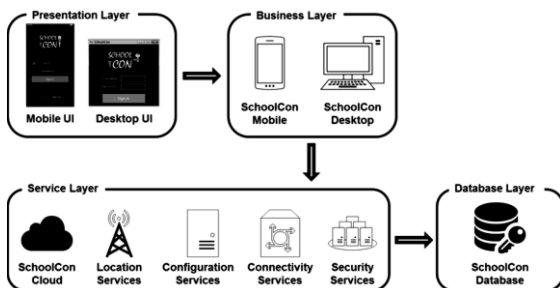


Figure 2

Presentation layer: This layer illustrates the user interfaces of SchoolCon mobile and SchoolCon desktop where the key stakeholders interact with. Author has designed the user interface in a user-friendly manner to ensure that SchoolCon is user-friendly, accessible, understandable and can be easily used without further assistance.

Business Layer: This layer consists the business components of SchoolCon provided for its key stakeholders. According to figure 2, SchoolCon mobile and SchoolCon desktop are depicted as the business entities of this project.

Service Layer: This layer demonstrates the additional services provided by SchoolCon. SchoolCon cloud is used to store application data in a centralized location accessible to authorized individuals while location service tracks event locations through Google maps to improve the convenience of stakeholders. Besides, configuration service is used to authenticate profile logins and sign ups while connectivity service verifies the inter-connectedness and security services of SchoolCon mobile and SchoolCon desktop to ensure the security of application data.

Database Layer: This layer contains SchoolCon database where application data are stored in a cloud-hosted centralized database accessible to authorized individuals. As shown in figure 2, SchoolCon maintains its interconnected among both SchoolCon mobile and SchoolCon desktop where system will be maintaining real-time communication. Therefore, SchoolCon is the best mobile application to bridge the gap between school teachers and parents.

4. DISCUSSION AND EVALUATION

The developed parent-teacher communication platform is currently in the stage of further improvement through evaluation. 3 types of evaluations were carried out to gather the necessitated recommendations. Expert, technical and self-evaluations allow researcher to identify needy improvements.

Expert evaluation was carried out among several teachers of international schools and parents with international school kids. It aids to utilize the knowledge of experts on parent-teacher communication. Selected experts being SchoolCon stakeholders within the targeted audience, they possess the common knowledge on parent-teacher communication since they are being dealt with the situation daily. During the face-to-face interviews with principals/ teachers of international schools and parents with international school children, the practicality of SchoolCon concept and its applicability to the problem domain were evaluated while assessing the available functionalities. By interviewing few experts, unique opinions of those individuals were gathered. Following assumptions

were gathered through a summarization of expert evaluation.

Practicality of the project concept was evaluated through the satisfaction of key SchoolCon stakeholders. Since the project aims to design and develop a networking tool to enhance parent-teacher communication within international education industry, interviewed experts were highly satisfied with the effort of researching the current problem domain, identifying the practical ways of overcoming the problem and designing/ developing a technological solution to overcome the problem effectively. Alongside, when considering the applicability of SchoolCon to its problem domain, it was identifiable that, SchoolCon improves the convenience of both parents and teachers since using a specific professional application for parent-teacher communication leads to protect the dignity of both parties.

Furthermore, based on the expert evaluations, author has understood SchoolCon provides the required accessibility, convenience, user-friendliness, and understandability to both parents and teachers. Understandability through SchoolCon is assured by allowing the experts to use the application where they were enthusiastic to skim in the available functionalities. Experts were satisfied with the overall design of SchoolCon mobile and SchoolCon desktop since it could be easily used by any English literate individual. Moreover, considering the average of level of satisfaction identified from participated expert individuals, SchoolCon provides 100% satisfaction in terms of enhancing quality parent-teacher communication.

Expert evaluation, technical evaluation and self-evaluation were completed to ensure that SchoolCon is a solution with standards for its key stakeholders. Expert evaluation was carried out within Colombo district among some of leading international school teachers and parents with international school children. Author has gathered their feedback to ensure SchoolCon effectively provides accessibility, convenience, user-friendliness and understandability to key stakeholders.

Besides, software engineers participated to the technical evaluation evaluated the problem domain, solution provided, features and functionalities available effectively. Moreover, technical evaluation provided feedback for the back-end functionalities to ensure the quality of the solution. Out of the three types of evaluations carried out by the author, technical evaluation aids to utilize the use of technology during the development of SchoolCon mobile and SchoolCon desktop.

Technical evaluation was done among software engineers by carrying out face-to-face interviews to ensure that data are gathered qualitatively. Since software engineers deal with technical masterpieces

regularly, author identified, executing a technical evaluation among them is advantageous. Based on the technical evaluation feedback from the software engineers who participated to the SchoolCon evaluation, author has understood SchoolCon provides required user-friendliness to parents through SchoolCon mobile and to teachers through SchoolCon desktop. Evaluators were highly satisfied with the overall SchoolCon design and the software and tools used to implement both SchoolCon mobile and SchoolCon desktop. Altogether, understandability of SchoolCon is assured by allowing the technical experts participated in the evaluation to use the application where they were passionate to glance over the available features and functionalities of SchoolCon mobile and SchoolCon desktop. Based on their feedback, author has identified that the participated experts could understand both SchoolCon mobile and SchoolCon desktop solutions effectively. Moreover, corresponding to the expert evaluation, author has identified necessitated accessibility, convenience, user-friendliness and the understandability are available through SchoolCon mobile and desktop for users. Author identified that the participated evaluators were highly satisfied with SchoolCon. Below is a comparison of SchoolCon with existing parent-teacher communication applications which are available to manage parent-teacher communication. Table below is an evaluation of SchoolCon in relation to the existing parent-teacher communication applications identified by the author.

Table 1. Similar System Comparison

	Active School	Talkative Parents	Remind	Buzz Mobile	Class Messenger	SchoolCon
Ability to add posts publicly	Yes	Yes	No	Yes	Yes	Yes
Ability to edit and delete posts	No	Yes	No	No	Yes	Yes
Ability to comment on posts	No	No	No	No	No	Yes
Ability to create online events	Yes	No	No	Yes	No	Yes
Ability to invite to events online	Yes	No	No	Yes	No	Yes
Ability to track location via maps	Yes	No	No	No	No	Yes
Ability to track daily attendance	Yes	No	No	No	No	Yes
Ability to make online payments	Yes	No	No	No	No	Yes
Ability to add complaints	No	No	No	No	No	Yes
Ability to resolve complaints	No	No	No	No	No	Yes
Ability to communicate personally	Yes	Yes	Yes	Yes	Yes	Yes

Besides, self-evaluation was carried out by author which covered the research topic of the project, high level functional requirements identified and software tools used throughout SchoolCon. Research problem was identified by the author based on their personal experience. Problem domain was acknowledged based on problems faced by employed parents with international school children while managing a proper parent-teacher relationship with child's school. Considering the online questionnaire responses gathered from parents and interviews conducted among teachers qualitatively, it was identical through the industry survey that, the current parent-teacher communication methods are not highly efficient. Furthermore, author has identified that addressing the current research problem is practical by positive responses gathered during the solution evaluation. Furthermore, author believes that, completing the expert evaluation, technical evaluation and user evaluation successfully is an immense support to conclude the project.

5. CONCLUSION AND FUTURE WORK

Since SchoolCon aims to design, develop and evaluate a networking tool to enhance parent-teacher communication within the international education industry, analysing the complications and practical difficulties in maintaining a close relationship between home and school for primary school students, author intends to make SchoolCon, the best and most frequently used parent-teacher

communication tool in Sri Lanka. Therefore, to achieve the aim, SchoolCon can be improved by the addition of following enhancements to the project in the future. Furthermore, author has gathered both technical enhancements and feature enhancements as the future work of SchoolCon based on the expert evaluation, technical evaluation and the self-evaluation carried out.

In order to ensure the future success of SchoolCon, feature enhancements are considered highly important to provide teachers, parents and other stakeholders with the best parent-teacher communication experience. It is identified, tracking where urgent notices sent from school are being delivered and read by parents is important. At the current context, parents get notified when teachers post updates yet, introducing a way to track the time stamp where parents read the notices ensure that parent-teacher communication happens in an appropriate way. Since notices are tracked effectively, it is feasible for schools to identify the state of parental involvement which is essential for the improvement of academic performance of students. Moreover, it is a recommendation that, sending reminder notifications to parents at instances where urgent notices are not read is effective. In relation to the tight schedules of parents where they are not involved to manage parent-teacher communication via SchoolCon mobile, it is recommended for schools to directly provide parents with a reminder assuming, there are higher possibilities for parents to reach out to their child's school. It is an improved way of identifying the effort school needs to put in to improve the academic performance of students though sufficient parental involvement is not provided.

Alongside, forwarding notices to parents if payments are not settled on time could be automated through SchoolCon. Since SchoolCon provides a platform for parents to settle all payments related to school online via the application, it is a responsibility for parents to ensure payments are settled at the correct time. Since parents could access due dates of pending payments and settle the payments with few clicks, SchoolCon mobile enhances feasibility of online payments. Therefore, forwarding automatic notices through SchoolCon is a better way of reminding parents about their child's due payments and it allows parents to improve their involvement on child's academic activities. In order to ensure the academic progress of each student, it is identified, allowing parents to generate progress reports is an effective feature enhancement. Though employed parents do not possess the necessitated time and commitment to engage in academic activities of students daily, they could generate progress reports monthly/ annually based on their personal preference. It ensures that, SchoolCon provides a platform for parents track academic performance of their children in a regular manner.

Progress reports need to include both exam marks and the assignment marks of students where parents can easily understand current academic performance of their children. Furthermore, future work of SchoolCon includes adding performance trackers for parents to track the academic progress of children. Though performance trackers are similar to generation of progress reports, performance tracker allows parents to track the academic performance of their child from first school day. Performance tracker allows parents to view through modules, grades and years to ensure parents could have a better understanding on the academic performance of their children up to date. As it is an essential feature enhancement, allowing parents to generate progress reports of children and track performance through SchoolCon will be a great aid for parents to effectively track the academic improvement of their children from the day one to date.

Besides, it is identified that, tracking the time stamps of each update is important for SchoolCon to ensure updates are posted per occurrence. It is effective for parents to identify urgent notices considering time stamps provided. Therefore, as above feature enhancements are recommended based on the expert evaluation, following enhancements cover the technical aspect of SchoolCon while introducing the technical enhancements to be completed as the future SchoolCon work. Since providing parents the opportunity to generate reports including the performance of their children is considered as an important feature enhancement, SchoolCon should allow users to download documents with student performance. It could be a major future work of SchoolCon which results in parents improving their enthusiasm to manage involvement on their child's academic performances. It is also considered essential to ensure both SchoolCon mobile and SchoolCon desktop are inter-connected and updates real-time. Since SchoolCon mobile is used by parents of international school children while SchoolCon desktop is used by international school teachers, it is important to ensure inter-connectedness of both applications as urgent notices updated by teachers using SchoolCon desktop needs to reflect in the mobile as a notification for parents. It shows, to provide parents/ teachers with real-time parent-teacher communication practice inter-connectedness of SchoolCon mobile and desktop is essential.

Moreover, author plans to personalize SchoolCon mobile user interface to improve interest level of parents where parents use SchoolCon mobile frequently when application's user interface is highly familiarized to them. Finally, author intends to directly launch SchoolCon to the international education industry of Sri Lanka partnering with the renowned international schools in Colombo to achieve the objective of making SchoolCon the best and most frequently used parent-teacher

communication tool in Sri Lanka. Therefore, author has ensured that SchoolCon successfully achieved its project aim. Based on the affirmative feedback from experts engaged in international education, it is identical that author completed SchoolCon as a successful masterpiece influencing busy parents to effectively manage parent-teacher communication. Furthermore, author is highly satisfied about accomplishing this project, since SchoolCon serves the success of the overall international education industry while contributing towards the growth of academic performance in Sri Lanka.

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USE OF INFORMATION TECHNOLOGY FOR COMMUNICATION, ACCESSIBILITY, AND SECURITY

Augmented Reality for Education and Teaching Mathematical Concepts

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ABSTRACT 3-1

At present education field, use technology to improve the quality of teaching and learning strategies. Sometimes some theories and problems cannot be clearly identified by the student, and also teaching is very difficult. They may be mathematical concepts, science studies, medical studies, geometrical studies...etc. For example, structure of a molecule, an atom, a planetary system are difficult to describe clearly. So using the Augmented Reality (AR) as a medium of study, teaching and learning will be very interactive for the students. Then they will learn easily and attractively. Because the technology AR brings the real world things as virtual things in front of the users. This review moves in to the technique of augmented reality and how it can be utilized to teach mathematical concepts through more student centered manner. Furthermore, it describes about the limitations, when using this technology in school and university education.

Keywords

Technology, Augmented Reality (AR), Education, Mathematics.

1. INTRODUCTION

As we experience today, Applied Information technology has made revolutionarily impact for our day today life. IT has applied everywhere possible to bring it easy and simple. In that context lots of IT based tools has been developed and being utilized in education field. This research paper moves into the technique of augmented reality and how it can be utilized to teach mathematical concepts through more student centered manner.

To create a successful world, one needs to consider about education as it is the most important area. So when people haven't proper knowledge then they move on to wrong way to develop the world. But anyone knows that the man-made machines or products destroy man at one day. That's why the education become most important field when developing the world. In modern world all the fields are rapidly developing through the technology. And also at a second there are many number of technologies

have been born at present. But such development, modern products, and services do not go in such speed to reach the large number of people in the world. Therefore, education system must be improved to face successfully for that changes and challenges augmented reality means how the 3D virtual objects are integrated to 3D real objects in real world environment. So AR allows to see real world to the user using virtual objects [25].

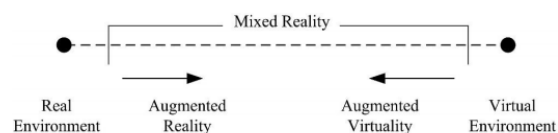


Figure 1. Augmented Reality and Real world

Now a day this technology is used in many areas, such as medical, entertainment, manufacturing, visualization, engineering design, robotics, military and education [1]. Examples for applied Augmented Reality are as follows. Imagine a customer who walks among racks of a super market. He has to touch and/or go close to each and every items of a particular good in order to check price. If a customer can see the prices of goods while standing on corner and see what items has discounts in same way through a mobile device such as a tablet computer or smart phone. It will bring the customer greater easiness and remove unwanted movements in the super market.

2. OVERVIEW OF AUGMENTED REALITY

AR is not a new trend. But it is growing rapidly and become a turning point of modern world [23]. That's why this technology popular among people. AR is invented by Professor Tom Caudell on 1990 by using Knowledge of virtual reality (VR). AR and VR are two different concepts which are overlapped up to some extent. Since many years ago people think AR is the same as VR [1]. They have common ability. But they are different. So it is very important to understand the differences between them.

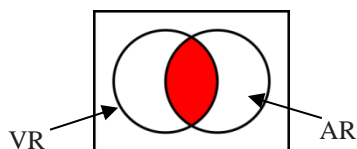


Figure 2. Overlap between Augmented Reality and Virtual Reality

In VR user do not allow to collaborate with the real world objects, But AR collaborate with the real world objects, using the 3D virtual objects [1], [8]. Most of the researchers define AR, using the example Head-Mounted Display (HMD). In past AR grows as a business application. But at present it is using for many fields such as entertainment (Sports, games, movies, music), healthcare, military, architectures as well as Education. Augmented allows to interact with real world using 3D graphic objects in very convenient manner [7], [19], [13].

Due to the easiness brought by augmented reality many apps are created with the concept of Augmented Reality in various subject areas. For an instance “Colorify Augmented Reality” is a mobile application developed for smart phones, by using that a great idea of real world with different colors can percept in real-time.

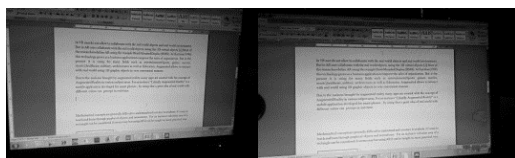


Figure 3. Change of color using AR based smart phone application

3. MAJOR RESEARCHES IN AUGMENTED REALITY FOR EDUCATION

AR related applications are most powerful to teaching and learning science techniques [2]. In this research, researchers had done a practical session in high school students. Students who studied under AR technology, is faced the questioner. Using AR for teach physics solved many problems faced by the students when they try to understand subject matters [3]. Using AR teach the Earth-Sun relationship for the undergraduate geography students, and it helps to solve most of problems [4]. AR is profound technology for the successful education [5], [23]. In this research the students of Macquarie University participate to one day AR camp. After completing the AR camp the researchers shows that the AR using education is more powerful way to teach theories for the students and that theories were became unforgettable things in their minds [24].

Education and training also use marker and maker less AR based applications to develop the student's,

trainers' and teachers' experiences [6]. So astronomy students learn easy through this technology. In chemistry there are many unseen things to learn such as molecule, atom, and practical with elements applying the AR based applications learning and teaching and also training the trainers is much easy than past. AR related mobile devices help for the informal and formal learning [7]. This paper move on to the location aware and vision based location aware through the GPS, object recognition and tracking technologies. AR gives effectiveness and attractiveness to the education [8]. In this research the researcher defines AR, using the head Mounted Display system.

Advantages of AR and application for AR were suggested by many researchers [9]. Education through the AR based applications is more useful, effective, reliable and meaningful than traditional theories. Nowadays most of fields in education such as chemistry [2], physics [3], medical, geography [4], biology, mathematics...etc. using AR for their studies. The researcher prefers that this education improvement [5], no need to chalk and talk like traditional way, no need to read traditional books. It creates seamless interaction in real and virtual world. In science stream learn about theoretical and descriptive concepts is most powerful using AR applications. But inventing these technologies among the student is little bit difficult because some of things. AR has more benefits [10]. It is gigantic development application available on the laptops, tablets and smart phones. it creates easy and accessible multi modal applications to learning, motivate and control the students. Because of the highest interactivity and highest 3D visualization is help to attraction. AR in not a new trend in the education system [14], [20].

There are seven learning types and the learning is the elementary process [11]. Therefore, the teachers and students should follow the new trends in the technology to improve the learning. So it is better to apply the AR to teaching and learning system. There are more subject areas for using augmented reality for the education such as urban, environment and mobile based learnings [12]. They find out that the ‘AR creates the indoors and outdoors to the user learning experiences’. AR has most of advantages and also limitations [13]. But using it for the education field it is most effective as the learning tool. Use of AR in class rooms is helpful for the learning and teaching [15]. Therefore, textbooks are replaced by AR. Augmented Reality is the product of innovation and globalization [16]. It provided that new designing and opportunities for the education field. To teach Science it is better to apply AR based books rather than traditional books [17]. Identifying the problems within the traditional text books and give the solution and effective learning materials for the science students. It creates the interaction between information and the human [18]. This technology use through the software

is effectively occur to the get valuable learning experience to the learners [19].

4. AUGMENTED REALITY FOR TEACHING MATHEMATICAL CONCEPTS

Mathematical concepts are generally difficult to understand and convince to students. It's easy to teach and learn through graphical objects and animations. For an instance calculating the area of a rectangle can be considered. It seems easy but using AR it can be taught in more practical way.

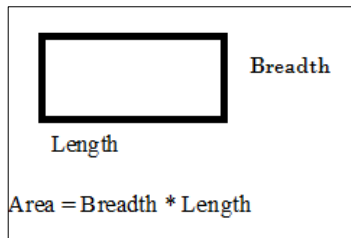


Figure 4. Calculation of area of rectangle

Augmented Reality can be used to teach the entire concept of calculate area of regular shapes in more realistic manner. It convinces the concept of area rather than just let students to know apply equations and without have a real sense of it. This is very vital to teach students when calculate area of complex shapes even though such shapes are not exactly as squares, triangles, rectangles.

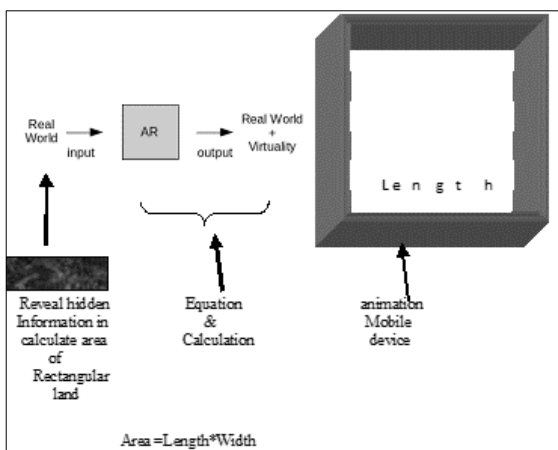


Figure5. Augmented Reality concept for Calculate area

Similarly, Augmented Reality can be utilized to teach the mathematical concepts of addition, subtraction, multiplication, and factor finding problems etc. So objectives of this research are to contrast the areas that Augmented Reality can be used to teach above mathematical concepts and suggest practical ways to how those Augmented Reality concepts implemented.

5. CONCLUSION

As discussed in this study Augmented Reality is one of powerful technique that can be utilized to teaching and learning process. Especially it can use for teach mathematics. It clearly differs from VR. Benefits of utilization of Augmented Reality have broader scope. Obviously it's eye catching technology due to its easiness, portable nature (mobile devices), just simple features etc....

Few areas that could be used to teach mathematics were pointed out in this research. Calculate area of rectangle seems to be very easy at first glance. But, use of Augmented Reality could cause to increase the satisfaction level and convince the concepts easily. Further this leads to develop state of art teaching and suits to modern era.

This research paper identified the technique Augmented Reality and how it related to the education system, basically the mathematical concepts. Then the reader can identify the concept of Augmented Reality, classify how can we change the teaching and learning system using this technique and can understand the basic mathematical concepts through this technology.

There are some difficulties aroused when the augmented reality technology is using for the education, Such as all the time user should keep the mobile device in front of him, Use of augmented reality technology is practically inadequate with constraints of hardware, most mobile devices should use in class at the same time, so it is very costly, and the teachers should have the proper knowledge about the augmented reality technology area, so it is difficult to train the teachers and it takes lot of money and more time. According to these limitations it is so hard to use augmented reality technology for the large class room education systems. But, once those constraints are over come, Augmented Reality could be used in revolutionary manner in education filed.

6. IDENTIFYING FUTURE DIRECTIONS OF AUGMENTED REALITY FOR TEACHING MATHEMATICAL CONCEPTS

In this part identify the areas which are help to improve Augmented Reality based systems and applications and also help to the further researches. Technology is getting changed in every second in modern era. With these advancements of technology, especially in computer technology, it can be predicted that Augmented Reality can be utilized very convenient manner. More advanced apps for mobile devices can be developed so that those can be used with the Augmented Reality concept. Meantime adequate devices should be developed for use Augmented Reality or existing devices should be upgraded accordingly.

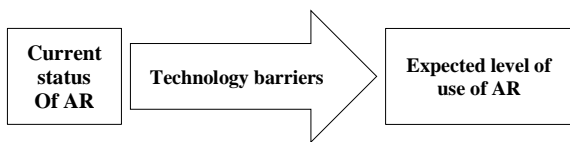


Figure6. Limitations for Augmented Reality

Also, though Augmented Reality is vital and powerful tool, still lack of awareness is one of the main constraints. So it's suggested that Augmented Reality can be made familiar through mobile phone apps and games.

In education field AR can be used very effective manner as it can be used to convince some concepts more practical way to students. Use of AR will make revolutionary changes in traditional teacher centered teaching process in future. It is emphasized that more research should be carried out to find ways how AR can be used to teach various subject filed. Also, constraints generated by hardware and software such as lack of suitable mobile devices, software and "Apps" should be addressed.

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Usage of Augmented-Reality (AR) for Safe-Driving

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ABSTRACT 3-2

Today, vehicle manufacturers have been moving to Augmented Reality as a next generation technology for the automobile industry. It helps to increase the safety of driving and minimize the driver workload to provide necessary information. But in representation of such a way should be more easily understood and bring lower cognitive capacity onto the user. When driving a vehicle, driver should continuously pay attention to different situations which he befalls to face outside and inside details of the vehicle. For a safer driving, the driver should always keep eyes forward while driving. Augmented Reality Head Up Display (AR-HUD) can help to provide traffic information and other necessary details to the drivers and keep user view on forward.

Keywords

Safe driving, augmented reality, Augmented Reality Head Up Display (AR HUD)

1. INTRODUCTION

Augmented reality (AR) is a hot topic with the new generation. AR is a computer graphics technology that integration of real environment with virtual objects or information based on computer technology. AR helps to the user to see the real environment with the augmentation of the virtual environment [1]. AR is currently being used in many aspects of the real world.

The technology which is rapidly growth has been applied modern ways for enhancing the senses of drivers. Even though all the advancements in vehicle safety facilities, the amount of people killed in accidents to rise. Research have found that most of the accidents are caused by inexperienced drivers and human errors. So there might be an opportunity to use new technologies like AR to help drivers.

This paper discusses about the AR and driving safety and how the augmented reality relates with the safe driving. The technologies that can be applied for this process also discussed.

2. AUGMENTED REALITY

2.1 Background

AR most compelling advanced have been after all the mid of 1990s. CAD program has been used around the

many years for aircraft architecture and assembly, navigation, simulation, medical and military purpose. Maintenance and assembly like complex tasks can be simplified to accommodate in produce prototypes can be built without manufacturing.

AR has been proven very useful on a daily basis when exclusive with location-based technology. With the smartphone population is rising, the degree of processing power is increased. More and more customers are carrying phones facility of displaying AR. So long as the resulting augmented content remains innovative and engaging, customers will certainly adopt AR as a fresh and fun twist to conventional services and marketing.

2.2 Definition

Augmented reality is the combination of digital information with the user's world in real time. AR uses the existing environment and overlays new information on top of it [2]. It improves the user involvement for any application area which are using the AR technology. AR is allows mixing virtual with real world in different proportions to achieve a level of immersion that no virtual equipment can provide [3].

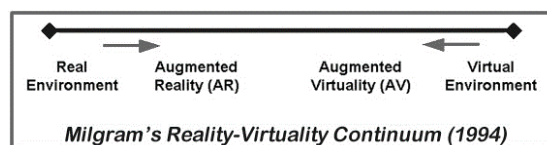


Figure 1. Virtual environment and real environment

2.3 Applications of AR Technology

For the Archaeology can be used Augmented Reality technology. It helps to create feasibility for archaeologists to landscape as they previously existed or rebuild ruin buildings. Before the real building is constructed easily can construct a local view of the building and upgrade the visualization of a constructed property.

AR is used in E-Commerce. The customer can be advance the shopping experience. Even allows a user to view what's inside the manufacturers without opening it.

This technology helps to improve the learning ability of the children by superimposing text, video, audio, and graphics into a real-time environment.

AR allows game lovers to novel experience of play game in a real world environment.

For the Manufacturing Industry is used AR. Before completion product, designers can be gotten the experience of operation and design products.

AR is using military purpose also. With the help of this technology helps to make combat strategy better and show a 3D vision of the battlefield.

3. DRIVING SAFETY

3.1 Existing Technologies for Driving Safety

Vehicle manufacturers have been introducing new features and technologies for the safety of drivers and pedestrians.

3.1.1 Rearview camera

This feature not only save your vehicle but also safe animals and pedestrians from the accidental back of the vehicle.

3.1.2 Tire pressure monitoring

This feature already has been contained in the newest automobile. Sensors are holding in wheels and it able to alert if the air pressure too low by light on the instrument panel, an audible warning or both.

3.1.3 Collision warning

This is a short-range detection system. This technology is planned to alert the driver to objects or vehicles in your blind area during parking or driving. Usually, a warning will react when the driver put on the turn signal and if it identifies barriers in the way then vibration of steering wheel, sound an alarm or flash a light in your mirror will be generated.

3.1.4 Collision mitigation

Using radar and sensors, cruise control can change the brakes and throttle to keep a safe gap of the vehicle in front off you if a slowpoke cuts in or if there are changes in traffic speed [4].

3.1.5 Lane-departure warning

This is like blind spot technology but with a large range. It judges an arrive vehicle's distance and speed to alert potential of danger if driver change lanes. This can also alert if it determines the vehicle is going away of the road. This could warn to the driver form of an alarm, vibration through the steering wheel or seat.

3.1.6 Dual stage airbags

This can sense the abnormal seating position, vehicle speed, and seatbelt usage as well as distinct weights and sizes of users. While the driver, travelers and side airbags are not new things, but sensing airbags are popping up in all over.

3.1.7 Emergency brake assist

This brake system is different from electronic brake force distribution or an antilock braking system. It can recognize when the driver makes a fuss shift brake pedal and will add an additional brake power to help minimize the stopping distance. If it detects a possibility of collision, it may work as stability control system in lot of vehicles.

3.1.8 Night vision assist feature

This can be practiced in various ways, such as thermal imaging cameras or infrared headlamps. An image is built through a cockpit display, and brightening the items that are difficult to see with the eye. Adaptive headlights observe the way of the vehicle.

4. AR FOR SAFE DRIVING

4.1 Augmented Reality based Head Up Displays

This is a combination of AR and HUD technology delivers a proper solution for overcome existing bottlenecks and increasing information wants in modern vehicle. AR HUD are arising as a future-generation in automobile display technology, it can reduce drivers' psychical workload and divided advertency across dashboard information and roads. AR HUD technology has the ability to increased concern to elements without contrary affecting attention and reducing the capacity to react with the environmental details outside the concentrate of attention.

In roadside or vehicle AR HUD system have the ability to improve safety by accommodating drivers with advance alerting of modifications in the route geometry. This system is assisted to drivers by easily providing safety details and allowing them to safely evade forward barriers. AR-HUD can be easily arranged to the preferences and needs of drivers. It is also able to adjust the brightness and the contrast. According to the driver discretions, this allows to change the positioning of the virtual object on the windshield.

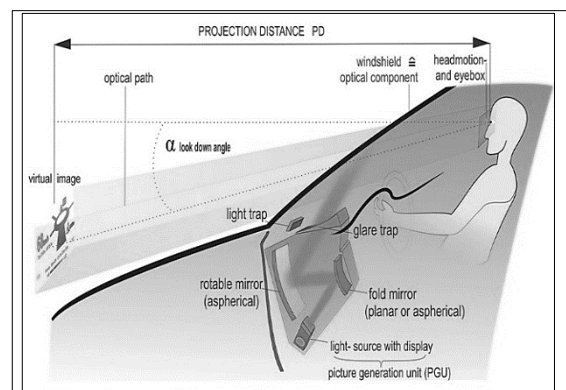


Figure 2. Key components of a head-up display

This System can integrate AR HUD based vehicles tracking and lane, traffic signs for driver assistance, this new approach adds safety functionality and give a contextually pertinent of the on road details for the driver.

4.2 Traffic Sign Detection

Road signs or traffic signs are providing a virtual message for all road users. Some vehicle manufacturers provide a video based augmented reality auxiliary display to help drivers to identify obstacles while backing up. This system able to detection and identification of speed limits, road signs and other additional details that might helpful for drivers [16].

A significant amount of things has traffic sign identification and four important factors have been recognized in traffic signal recognition.

- Image segmenting and extract a Region of Interest. (ROI)
- Verification of the road signs in the ROI using binary classification.
- Identify multiclass road sign obtain from detection.
- Track the road sign in video sequences, adding AR details to the object properly.

At first system detection of the road signs helping of scanning window with the Haar cascade detector for every picture of the input stream, which remove most of the “not objects”. The second stage builds the system more powerfully by verifying the identified road signs using Speeded Up Robust Features (SURF) identifier and by adding augmented reality details to the objects properly. This method is composed online stage and offline stage. During the detecting stage finally, few number of sub windows accepted by all phases of the identifier are regarded as objects. In the detection process gets an image input and gives the regions that consist the ROI at the output. The recognition model complies finer validations and produces the final detecting results [5].



Figure 3. Frames representing the insertion of virtual 3D object sign [16]

Using this AR-TRS system, drivers can easily recognize traffic in the complex environment such as weather condition, illuminations, and geometric distortions.

4.3 Recognition of Dynamic Object at Nighttime

Vehicle driving at night is very dangerous things. Vehicle death rates at night are very high. Vision is one problem for that. Nearly 90% of a driver's response vary on it. To abstain an accident during the night time, vision-based vehicle recognition systems have been implemented [6] and in vehicle HUD was used to implement AR, which is presently being applied in different aspects of the real world [7]. Using this technology able to providing conflict warning details on the windshield overlying actual world in a vehicle while the driving at night.

This system consists of representation and decision parts, sensors. In sensor section, radar-vision fusion is helped to recognize a vehicle and a pedestrian from dataset taken from radar sensors and night vision at nighttime. The risk level is determined by the time to collision (TTC) and forward collision warning (FCW) in decision part and AR information is represented on the windshield using HUD.



Figure 4. Vehicle for Vehicle Ahead using Results of Augmented Reality [8]

The sensor part of the proposed system acquires situation, such as scene, velocity and position, using night vision, radar, CAN and GPS and detects a pedestrian and vehicle in front of the host vehicle. For night vision, we use FLIR PathFindIR camera, which is a thermal imaging system and displays cold objects as black and hot objects as white. A radar utilizes the Delphi 76 GHz ESR to long range coverage.

The radar vision fusion is used to detect and recognize a pedestrian and a vehicle at nighttime. The distance and angle of an object extracted from the radar are overlapped to an object detected from night vision image, and then final result are defined as shown in Figure. 5. Fig. 5 (a) is an image as a driver vision and (b) is an image of night vision of the proposed system. A selected range by radar shows in (c) and there is the detected pedestrian by radar vision fusion in (d).

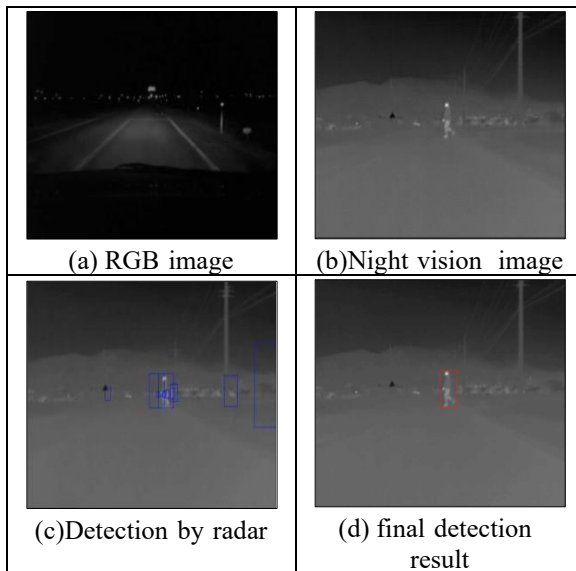


Figure 5. Dynamic Object Recognition of at Nighttime

This system used the AR technology in a vehicle as a proper representation mechanism based on driver's characteristics under invisible environments such as unfavorable climate conditions and darkness. It can develop intuitive cognition and reduce the distraction of a driver [8].

4.4 Forward Collision Warning System(FCWS)

Modern vehicles have used HUD to present Details without requiring drivers to look away from their normal view. Because this can take down workload by 0.2 seconds than normal Head-Down Display and increase situation awareness [9]. In present, interesting research has aimed on object detection and AR based HUD [10] to convenience and increase the safety. While controlling vehicle directions and speed drivers should care of vehicles, lanes, pedestrians, road hazard and traffic signs. All these physical and mental workloads which is dangerous for slow recognition and response people and elder drivers.

Therefore, alerts the driver of a risk in the road can help to avoid the vehicle accidents and reduce driver workload. It should help driver's hazard object detection. Necessary information such as nearest vehicles, crossing pedestrians are detected from front side stereo cameras.

This captured images are used to identify the objects. When once the detection is done, the ultimatum is appraised by using Time-To-Collision (TTC) calculation. According to the TTC decide the visual properties for augmented warnings. A speedometer is helped to calculate the TTC by representing the speed of the vehicle. The feasibility study used to make relations of visual properties like color, shape. Projective transformation is used to take the increase warnings in the track of the driver's view position obtained by an eye tracker. Projective transformation is carrying out geometrical modeling between a HUD

and camera. Lastly, the augmented warning alerts are rendered onto the HUD [11].



Figure 6. Augmented warning results

The system identifies the frontal pedestrians and vehicles, find the imminent danger things by the detected results, and gives the augmented warnings to help safe driving.

4.5 Lane Level Guidance

While driving a driver faces various situations inside or outside the vehicle and the driver must consider all of that details for driving safety. The driver should always keep the safe gap between other vehicles and be careful of the pedestrians and vehicle cutting in to avoid road accidents. Thus, driver's vision range is limited but he should check the details on the dashboard and pay attention front and rear of vehicle while driving time [12].

This lane level guidance system procures the lane level details which is determined by a decision layer. To get this information system is used the road properties from the navigation map, camera and the position information through the vehicle augmented reality system route information.(the decision layer determines the forward car situation, the risk level of collision, the lane departure, the lane changing conditions and the results of decision are provided in accordance with the expression strategy through HUD in a display layer). The representative services are a lane change service which guides to change the current lane if the car unable to drive as guides on current lane and a lane departure service. This service also provides suitable services for a variety of road types and shapes, such as underpass, overpass, crossing road.

This system is used Information optimization technique that processed by a decision layer for a method of deciding whether to accommodate the service details, time and giving a driver with the details effectively based on the data acquired from the

sub system. This technique of the lane level guidance service decides whether the vehicle deviates from its route and whether the driver has to change the route for the lane departure service. Besides, it determines whether to provide the details in any form at any point in time. And then, the results of decision are decided by the information optimization are shifted to the upper HUD display layer and are shown as an expression that can provide most effective details to the driver.

a) Lane Change Guidance Service

If the driver wants to vehicle turn left at an intersection ahead, this system recognizes that this vehicle need to move from the current lane to the left lane possible to turn left and provides the augmented reality details as shown in Figure 7 [13].

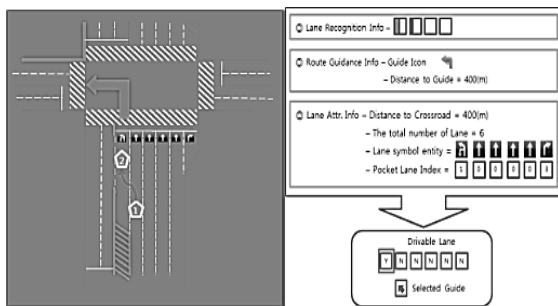


Figure 7. Lane Change Decision

First, the decision layer checks the lane guidance details which the vehicle wants to turn left at the forward intersection and the remaining distance to the opposite intersection received from the map and the display layer displays the remaining distance to the intersection with the intersection icon on the HUD. The decision layer makes sure that current driving route is not possible for the vehicle to turn left and makes the display layer, display an arrow indication pointing to the first lane possible to turn left.

Figure 8 shows the guidance details displayed as the augmented reality about the driving situation that the vehicle drives on the highway and then exit to the route by using the current driving information and lane related information.



Figure 8. Lane Change Guidance on the Intersection



Figure 9. Lane Change Guidance on the Highway

b) Lane Departure Warning Service

The lane departure warning service identify whether the vehicle is departing from the current route and notifies the driver of it. The optimization technique of this service determines whether or not the lane departure of the vehicle using a distance between the driving lane and the vehicle. As shown in Figure 6, if the vehicle arrives close to the lane, this system shows a yellow and saw tooth shaped line matched with the lane for giving the first warning. If it crossed the lane, it shows a red and saw tooth shaped line matched with the crossed lane. Thus, this service may reduce the risk of accidents caused when the driver gets out of the lane [15].

And also, if the slope of the recognized lane is over a certain size in a curve section, this system recognizes it as a sharp curve section and displays the forward road in red in order to induce keeping the lane. Figure 10 shows the result of this service.



Figure 10. Lane Departure Warning [14]



Figure 11. Curved Lane Guidance [15]

5. DRAWBACK OF USING AR FOR VEHICLE

AR-windcreens can present too much details and distract drivers, other passengers. Lawmakers will have to decide on the use of these technologies, as the obstructive and distracting nature of windshield Augmented Reality displays, especially full windshield Heads up Displays (HUD), may make them hazardous.



Figure 12. Too much information [17]

Another disadvantage of Augmented Reality technology is internet dependency. For years now, vehicles have had online connectivity, typically achieved by synchronizing a smartphone to the vehicle and using the phone's data plan. However, connectivity is dependent on coverage and if the phone loses signal AR features may no longer work.

6. CONCLUSION

Using Augmented Reality technology can facilitate a way of communication between the driver and the vehicle. It is like intelligent transportation systems by superimposing nearby traffic information on the driver's view and keep users view on roads. In this paper, we have discussed augmented reality relates to the safe driving and way to provide driving safety details that superimpose augmented virtual entities onto a real view under all categories of driving conditions, unfavorable climate conditions and nighttime. This will enhance the safety on the roads and new driving facilities such as automated driving.

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Use of Privacy Preservation Techniques in Big Data

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ABSTRACT 3-3

Data becomes a valuable asset in the present. Day by day enormous digital data is generated at large volume, high variety and high velocity called Big Data, that cannot be handle and manage via traditional database techniques. And there are lots of challenges when dealing with Big Data. "Privacy of data" is one of the major challenges to be considered. Having a better privacy preservation technique that provides maximum data utility while protecting sensitive data is a necessity. Because of the research area is still infancy. Starting with brief review about Big Data, Big Data analytic and privacy in Big Data, this paper provides some available privacy preservation techniques and their performances and issues.

Keywords

Big Data Analytic, Privacy and Security, Privacy preservation, Data mining.

1. INTRODUCTION

With the rapid growth of technology people tend to interact with internet more and more in their day to day activities. In every online transaction, wide range of data is generated [5] called Big Data, having large volume, high variety, at high velocity [1]. Those data are used to create important information by using specific tools and technologies called Big data analytic. That information is distributed among various parties [5] like government, data collection companies, data service companies for their different objectives. But this information is sometimes including personal information like medical and financial. When they are distributing, it is very important to ensure that private information are secured. But the problem is available privacy preservation tools are performed well or do they can ensure the protection of the private data?

There are various areas to be covered when dealing with privacy preservation not only technical matters but also human rules and legislation matters for better privacy preservation [4].

There are different types of privacy preservation techniques available in present. But no one performs better in all areas. The important matter is data should be protected while getting maximum utility from it.

In this paper we present overview of Big Data, Big Data analytic and some challenges when dealing with Big Data environment and discuss existing privacy preservation techniques and highlighted some important contributions of researchers in context of Big Data and privacy.

This is the flow of rest of the paper. In section 2 I am giving overview of what is Big Data, Big Data analytic and how privacy related with Big Data and also review existing techniques to preserve privacy with their performances. In section 3 it presents related works have done by other researchers regarding privacy preservation concept in Big Data. Finally, section 4 is about discussion the paper and section 5 is identifying future directions.

2. OVERVIEW OF BIG DATA AND PRIVACY PRESERVATION

Handling Big data is an important technical matter in the present. As Big Data becomes a revolution, the challenges are also available. Privacy and security of data is very important topic to be discussed under Big Data context.

2.1 Big Data – where and why

Big Data can identify as data that cannot be processed by using traditional database techniques due to its large volume, high velocity and high variety. It consists different types of digital content [6].

- Structured data- easy to model, query, process, visualize. Specific type and size, presented in relational DB or spreadsheet, easy to extract useful information.
- Semi- structured data – contain meta model (tags and markers). E.g.- JSON, XML
- Unstructured data – stored without pre-defined format. To process there should be new mechanism like NOSQL.

Big Data should be identified by is 3vs (volume, variety, velocity).

- Volume – large amount of data. Data is distributed in many locations.

- Variety – data is coming as internal or external sources. Creates varied information.
- Velocity- speed that data is generating and changing.

Big data enable large opportunities in business growth, job creation, government planning, and health care services [5].

2.2 Big Data Analytic

As described earlier, Big Data cannot handle using traditional methods, there should be advanced methodology to handle process and manage Big Data. These tools are called Big Data analytic tools. That enables to get lot of benefits and insight about the area [6].

2.3 Privacy and Security of Big Data

There are various sources that Big Data is generated. Like online transactions, mobile phones, search queries, e-mails, videos [1, 5]. Since it is large, they are stored in distributed databases. It implies that data are store and sources are spread all around the internet. Since it deals with web model, “security” issues are generating.

Here are some set of security and privacy challenges when dealing with Big Data [6].

- Random distribution- large data are stored and processed at different locations in distributed systems. In this case sometimes we cannot recognize the exact location of the data resulted in many security problems.
- Computations – using computations data analysts get powerful knowledge from data. It is important to secure the computations [6].
- Integrity – to get quality of the result it is important to ensure the validity of the data.
- Communication – because of the distributed data, clusters are communicated via network. Therefore, it is important to secure the network protocols.
- Access control / authentication– to access to the data, there should be considerable administrative rights.
- Rules and legality – since Big data are distributed in multiple locations sometimes different countries and since it contains personal information of human such as medical and financial there should be developed set of rules and regulations which are not consider yet [6].

And also as discussed in previous sub heading when data set linkage via user identity it creates a problem to the privacy [4]. Following are some privacy challenges when dealing with individuals.

2.3.1 Interaction with individuals

- Providing transparency – involvement of individuals. It covers personal data and also details of algorithms and processes involved in big data analytic. Most challenging part.
- Getting consent – individual have rights to ask about prior to processing of their data. Sometimes it contains informed consent, that is individual have right to ask what sort of processing is happened and about result.
- Revocation of consent and deletion of personal data – according to European privacy law it is granted that individual has right to revoke their consent even at the later stage. Furthermore, all related personal data should be deleted. Challenge is arising if data are spread at that moment.

2.3.2 Probable vs. provable result

Depending on the query different types of result sets are produced. The validity of the result sometimes creates a threat. If the type of the linkage is not reliable, the situation is more challengeable.

2.3.3 Economic effects

When big data analytic techniques require huge data sets it may cause to exchange those data sets among business partners. When data providers sell their data to customers, threats arise from economic considerations.

2.4 Available Techniques for Privacy Preservation

Due to 3V s (volume, variety, velocity) traditional methods are fail to handle Big Data. There should be techniques to ensure individuals privacy [1]. Let’s review some existing privacy preservation techniques and their performances.

2.4.1 Cryptography (traditional method)

In cryptography, it stores and manipulate the data in particular form where only authorized people can access those data. There are 4 basic cryptography methods to protect private data.

2.4.1.1 Encryption

Transform data/ information into ciphertext by using cryptographic key. So data can be protecting by irrelevant accesses. In a good encryption mechanism, it cannot get the original data by ciphertext (reverse conversation) without knowing the key. Figure 1 shows the encryption process.

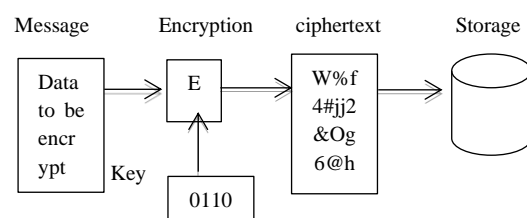


Figure 1. Encryption process

2.4.1.2 Data authentication-

By adding a tag, it modifies the data that creates data unfeasible. It uses cryptographic key to process this. The tag will invalid if modification done to original data. Introduce new tag requires the cryptographic key. Using verification algorithm, it can be checked the validity of the tag.

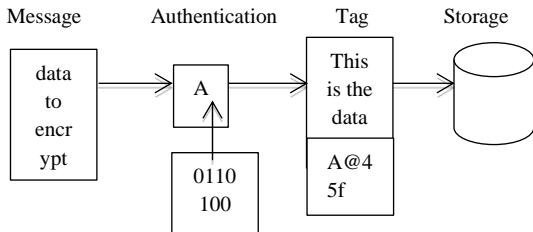


Figure 2. Data authentication process

2.4.1.3 Hashing

This present a small piece of data in a unique way that doesn't have revers approach. No cryptographic key as input and no authentication mechanism.

2.4.1.4 Digital signing-

This is a process that develop a short string depend on the information. It includes data and entity authentication.

In Big Data context it is difficult to retrieve all data for analytic due to its large volume. Therefore, cryptography methods cannot apply Big Data privacy concerns.

2.4.2 Anonymization methods

In big data analytic, operations can be done on encrypted data but it is complex and time consuming. Since big data has large volume, it is inefficient doing operations over big Data because it needs to get new knowledge within time limit. Therefore, data de-identification is much more flexible than previous case. It is a traditional method for preserving privacy in data mining. Before data mining happened data should first have generalized that is replace quasi identifiers then suppression that means not releasing all values. But in many real world examples, after de-identification, data will not actually anonymous. If an attacker has more external information there will be a threat to data re-identify. Therefore, for protecting data privacy, de-identification is not enough [9]. To reduce the risk of re-identification, anonymization techniques are introduced.

There are 4 types of attributes in a table. Identifiers, quasi identifiers, sensitive attributes and non-sensitive attributes. Identifiers will be removed and quasi identifiers will be generalized before publish the data. Such data set called as "anonymized data".

Information disclosure happens in 2 ways. First is identity disclosure. When person links to a specific record in final table then identity disclosure happens. Second is attribute disclosure. It occurs when person's new attribute/ information released. To overcome identity disclosure, k-anonymity method introduced [8].

2.4.2.1 K-anonymity

In k-anonymity, attributes of the data set are divided into 3 types.

- Key identifier- Use to identify something uniquely. Ex- ID no.
- Quasi identifier- with linking external data it can be used to identify record uniquely.
- Sensitive attributes- those values are to be protected.

Suppose if you want to identify an individual and there have only gender and zip code attributes available in data set. So there are at least k many people satisfy that requirement [10]. So there is at least k-1 records which indistinguishable from other records.

Attacks on k-anonymity [10, 12]-

- Unsorted matching attack

This happened because of the released table's order of the tuples.

Solution- sort tuples randomly.

- Temporal attack

Data set is dynamic. Data can add, remove or change.

Solution- in initial table, all attributes are defined as quasi identifiers to following releases.

- Homogeneity attack

Due to homogeneity of data that means discovering same patterns we can identify useful information. Because of low diversity in the data set.

- Background knowledge attack-

That means based on some social factors, environmental factors, religious issues, attacker can identify some information that are hidden.

In k-anonymity, by linking data, individuals cannot identify.

Disadvantages-

- Since it has low diversity, tend to leak information
- Vulnerable to background knowledge attack.
- Unable in attribute disclosure preventing [8].

L-diversity is more applicable, easy to understand than k-anonymity. Since k-anonymity open to attackers due to low density of sensitive attributes. Therefore, introduced l-diversity model.

2.4.2.2 L-diversity

This reduces some disadvantages in k-anonymity. This is also like k-anonymity further developed by increasing diversity of sensitive attributes.

L-diversity problem become difficult, when there are more sensitive field.

Though this ensure the diversity problem, it may leak information due to semantically close values.

L-diversity attacks-

- Similarity attack

Even sensitive attributes are distinct, if they semantically similar, attacker can get the information.

To preserve privacy, k-anonymity and l-diversity are based on generalization. For an example “age” is replaced with “age range”.

Data quality and protect privacy are conflicting goals in here.

2.4.2.3 T-closeness

L-diversity further develops by maintaining sensitive fields called as t-closeness. This expands the l-diversity model by treating attribute value distinctly where considering the distribution to the values for that attribute.

This method calculates probabilistic distribution by using EMD (Earth Mover Distance). But EMD distance metric unable to work properly due to scaling property of probability.

This prevents the reveal of attributes.

2.4.3 Notice and consent

This is mostly used in web services. When user access to a service/ application in web, it displays a notice about privacy concerns. User needs to consent it before using the app. This ensures the privacy protection by empower the person.

But in Big Data context, it is unknown the time Big Data is used. So, every time when Big Data is used, notice need to change [1]. By using a third party, this model can be modified.

2.4.4 Differential privacy

This method is using in databases. This presents strong protection of privacy while extract useful information [20]. This reduce the risk of identifying person when the querying. There is no anonymized (modified) data here. There is a middleware which identify result and inaccuracies. If it preserves privacy, inaccuracy become large.

The advantages of Differential Privacy method.

- No data modifying.
- Distortion is added to result that is useful to analyst.

Major disadvantage is since this is using in databases, analyst need to know the query.

2.4.5 Privacy preservation in data mining

Data mining can be known as identifying patterns and knowledge from big data. Privacy protection of those data is an important aspect. Privacy-preserving data mining (PPDM) is performs well to preserve privacy while getting utility of the data since it avoids use of sensitive data directly and avoid using sensitive patterns in data mining [7, 25].

Privacy preservation techniques can be classified into

- Heuristic based techniques – not modify all values.
- Cryptography based techniques- includes SMC model. Means computation is secure at the completion.
- Reconstruction based technique- from the randomized data, original data distribution build.

Considering above dimensions, PPDM techniques divided into:

2.4.5.1 Anonymization based PPDM

Identity/ sensitive attributes are hidden. It is a risk when quasi identifiers (such as race, zip code, sex) are linked to external data (linking attacks). This may have information losses widely.

2.4.5.2 Perturbation based PPDM

Here, originals data are changed with some values that don't harm statistical values. No linkage attacks. This can be done by adding noise, synthetic data introduce and data swapping. Treat attributes independently. Can be loss of information.

2.4.5.3 Randomized respond based PPDM

This is simple method. This doesn't consider distribution of other data. This can be done in data collection time. No need of server. This treats equally for all records. This can make attack to outlier records.

2.4.5.4 Condensation approach based PPDM

Generates clusters in data set. Then build pseudo data from them. Rather modifying data. Mining result may damage due to large records include in a cluster.

2.4.5.5 Cryptography based PPDM

Avoid reveal of information by collaborating multi parties. Data may distribute vertically/ horizontally. Because of that it is difficult to scale.

By considering above mentioned privacy preservation techniques, it can be seen they can protect privacy to certain extent. But lots of problems are there. Most of the time, information may loss. Due to that, it unable to get maximum utility from the data. Sometimes data can be distorted when we trying to modify hem. So there is always some issue with each technique at the performance.

3. MAJOR RESEARCHES IN BIG DATA AND PRIVACY PRESERVATION

Privacy protection is become necessary thing when dealing with Big Data analytic. Since this is very hot topic, scientific researches and approaches are still infancy. Here I review some important and interesting contributions what other researchers have done so far regarding this area of study.

When considering about privacy preservation techniques, Gosain, Chugh [1] showed differential privacy technique is performing better than data anonymization, re-identification, notice and consent by showing disadvantages of them.

Data mining is important Big Data analytic tool. When dealing with privacy preservation in data mining, authors [3] present different PPDM (Privacy preservation in data mining) techniques. And show each technique performs better than another in specific criteria like performance, data utility, uncertainty level etc.

In [7] authors developed a framework for preserve privacy in each stage of KDD (Knowledge Discovery in Databases) process. Called as "Rampart framework". There are 7 categories which represent each stage of the KDD process.

According to authors [9] implemented client side page for communicate with the server. To enhance the security, it has unique authentication mechanism for each user. To replace existing DES (Data Encryption Standard) they developed triple DES which has 3 individual keys.

To avoid data loss rate and privacy leakage, authors Yonghon, Qing [13] combine k-anonymity algorithm with distributed randomization. And proved there is no obvious harm to the data with compared to the unprotected status when used to clinical data which is diabetic nephropathy (DN).

4. DISCUSSION

With the development of technology, Big Data become more powerful asset to deal with lot of areas. Such as government, organizations, scientific matters etc. It provides hidden knowledge by using appropriate tools called Big Data analytics which cannot do by using traditional methods. As expanded the area, more challenges are open to Big Data environment. Privacy is a major challenge where scientists should pay attention. To protect privacy of data while getting maximum utility is a must. In this paper I review what is Big Data, Big Data analytic. And showed how privacy and security relate with Big Data. There are lot of privacy and security challenges in Big Data environment. They can categorize as technical issues, social and legitimate issues as well aseconomic issues. And review about some existing privacy preservation techniques such as traditional cryptography method, some anonymization methods and data mining

methods in privacy preservation. There I showed performance of each technique to protect privacy and their advantages and issues also. There is no technique available to protect privacy while getting maximum utility of the data. That means most of the techniques will loss information. And also some are vulnerable to attacks from external parties. There is no such technique available as this is the best technique to preserve privacy. So as an individual, be aware with your online behaviors and identify the risk is a need though there are tools to protect privacy.

5. IDENTIFYING FUTURE DIRECTIONS OF PRIVACY PRESERVATION TECHNIQUES

Digital data is generating day by day in everywhere at enormous speed. Protecting the privacy of those data is very important. But there are still issues with privacy preservation techniques as we discussed throughout this research paper. For example, lots of methods are losing important information when they try to modify private information. And sometimes it unable to generate the original data. Therefore, scientists should pay their attention to develop algorithms/ tools to protect privacy without losing the original data since the research area is infancy.

Apart from that, I presented some set of privacy and security challenges when dealing with Big Data. They are technical wise, social wise and economic wise. So it is important consider those challenges when developing privacy preservation tools.

Since data is generating very faster manner there should be efficient and secured methods to collect data and distribute private data to only authorized parties.

Though there will be better privacy preservation methods, individuals need to know their private information are still open to someone in somewhere when they are doing online things. Therefore, there should be an efficient mechanism to inform individuals that their particular action may cause for a threat if any mistake happens.

6. CONCLUSION

This paper presents the use of some available privacy preservation techniques in Big Data context by mentioning the way they work. According to the results the following conclusion can be done when suggesting an appropriate privacy preservation technique for a particular problem.

- Cryptography is a traditional method for privacy preserving which manipulates data where unauthorized accesses are denied. Encryption is one of the best cryptography mechanisms that ensure the data is secure from unauthorized parties. But the problem here is this cannot use for the Big Data context, because it is impractical to use all data for analytics, since it has a large volume of data.

- k-anonymity is failed since it has low diversity of information and it opens for background attack. As a solution for problems in k-anonymity we can increase the diversity of sensitive fields and come up with a new model, l-diversity. But still it also vulnerable to attacks if it has semantically similar attributes or when there are more sensitive fields.
- Notice and consent method is for to empower the online users about their privacy concerns. Since Big Data has large volume, it cannot consider the each and every time when Big Data is used. So this method is not that much applicable for Big Data.
- Differential privacy method is good approach when for when dealing with databases. There is no modifying of data and the drawback is when joining databases.
- Data mining techniques used to extract hidden patterns or knowledge for future predictions which requires high security. The big challenge here is correctly transform data into mining pattern and recover them.

By considering above factors it can be concluding that each privacy preserving technique has advantages as well as some drawbacks. Therefore, according to the problem context we can choose a technique. Since the research area is still infancy there is a need of powerful privacy preservation technique for protecting sensitivity of data without information loss and having maximum utility over them.

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Braille Messenger: Adaptive Learning Based Non-Visual Touch Screen Text Input for the Blind Community Using Braille

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ABSTRACT 3-4

'Braille Messenger' is an Android application (app) that is designed to facilitate the communication between users via the Braille alphabet through the medium of Short Messaging Services (SMS). This application is mainly envisaged to be used by the visually handicapped community. The proposed method is comprised of three gesture types for braille communication. The gestures can be generated with either two fingers, three fingers or six fingers. The app can be used by the blind and blind-deaf users with tactile feedback in the form of vibrations. Simple drawing patterns were selected as commands instead of long-tap and double tap operations. The app automatically suggests a word with the highest auto completion probability when a user types five characters, using vibration methods. A standard 6-bit encoding scheme was used to convert braille characters to text. A novel static algorithm was introduced in this research to detect drawn patterns by users. A feed-forward algorithm was formulated using the K-NN algorithm to detect the input fingers when a braille character is typed, and the K-Means algorithm was used to track the user's input fingers with time. 'Braille Messenger' was tested at different typing speeds. Average typing speed and accuracy were analysed on a sample of five blind users. The maximum typing speeds for the designs with two fingers, three fingers and six fingers were 5.4WPM, 9.6WPM and 18.9WPM respectively. The average typing speeds were recorded as 3.74WPM, 7.28WPM and 13.29WPM for the designs with two fingers, three fingers and six fingers respectively. An accuracy of 97.4% was recorded for braille character detection when using Bayesian Touch Distance with Nearest Neighbour and K-Mean algorithms. An accuracy of 94.86% was recorded for the drawn pattern commands with the proposed static mathematical algorithm. The proposed method currently only supports English language communication. The basic standard for Grade-II Braille alphabet commonly used by the blind community in Sri Lanka was used in this research. Future work would include implementing

the app as a system wide keyboard, introducing error correction and support for other languages.

Categories and Subject Descriptors

H.5.2 [Information interfaces and presentation]: Graphical user interfaces (GUI) – *Input devices and strategies, screen design and user centered design.*

I.2.2 [Applications and Expert Systems]: Natural Language Interfaces

Keywords

Blind, Braille, Smart Mobile Devices, Text Entry Method, Universal Design.

1. INTRODUCTION

In present day, mobile phone has become an essential tool of communication in life. Among the plethora of different techniques for communication, SMS is the most pervasive. However, this method is challenging for the blind and visually impaired (VI) users. Looking at the history of the smartphone, the Ericsson GS88 (McCarty, 2017) was the first which was manufactured with a physical keyboard in 1997. Therefore, blind users could manage to use the phone if they could physically feel the keys. The difficulties faced by the blind users increased with the advent of the Touch Sensitive Displays as they lost their sensitivity of keys that were there on a physical keyboard. A special accessibility feature for the blind community became an essential part of the mobile phone when they were introduced to the market.

There were solutions introduced by the companies that developed operating systems alongside 3rd party developers (Bonner, Brudvik, Abowd, & Edwards) (Mascetti, Bernareggi, & Belotti, 2011) (Hatzigiannakoglou & Kampouraki, 2016). All the solutions were however restricted to the technical capabilities of the smartphone. The main restriction was the number of multi-touch inputs that could be detected by the phone.

Voiceover in iOS by Apple (iPhone - Accessibility, 2017), Narrator in Windows by Microsoft (Windows

phone accessibility, 2017) and Talkback in Android by Google (Android accessibility , 2017) are some of examples that were introduced by the leading software companies who developed the Operating Systems for the leading brands in the world. When the accessibility function is activated, a user should double tap on any button to execute a task instead of a single tap, as the single tap just reads screen view.

The initial stages of the proposed App before the initial testing was published in (Udapola & Liyanage, 2016). In this study, a novel method for the Blind and VI users to communicate using the Braille Alphabet is proposed. The app features the ability to customize the UI according to the preferences of the user and the technical specifications of the device. As most of the previously developed Apps were specifically aimed for the devices with 6 multi touch inputs, 'Braille Messenger' initially checks the number of multi touch inputs supported by the device using a calibration procedure.

Even though there are several mobile apps developed for blind and VI users such as, (Bonner, Brudvik, Abowd, & Edwards) (Mascetti, Bernareggi, & Belotti, 2011) (Hatzigiannakoglou & Kampouraki, 2016) blind-deaf users were unable to use them since those apps were designed with the screen reading/Text-To-Speech (TTS) Manager. 'Braille Messenger' includes a method to facilitate blind-deaf users to read and write messages using braille with tactile feedback in the form of vibrations. Moreover 'Braille Messenger' facilitates any type of Multi-touch mobile device holders to type in Braille by introducing three different non-visual touch screen text entry methods by considering the number of touch points available in their mobiles.

1.1 Objectives

Major objectives of the proposed system is to provide a more accurate, more user friendly, high speed, user customizable typing mechanisms for the blind and blind community with different disabilities, depending on the multi-touch capability of a mobile device.

An integrated app with three different gestures was developed to achieve these objectives by introducing three different methods of typing (using one-hand design with two or three fingers and using two-hand design with six fingers). Some simple pattern drawing commands were introduced to execute basic tasks in lieu of tapping on a button.

1.2 Current Study

In the current study, a self-updating blind dictionary (B-Dictionary) was developed. When a user adds a word that has more than five letters, the most matching and most frequent word is suggested. If the word is not available in the dictionary's data file, the typed word is added to the dictionary.

2. RELATED WORK

The related work for this research considered looking into the literature on current implementations for blind and VI users, UI and UX, text entry methods, input finger detection and K-NN classifications.

2.1 Universal Design

Blindness can be divided into two types, (Vision 2020 Sri Lanka, n.d.) which are full and partial blindness. Full Blindness means, inability to see anything at all, and partial blindness refers to having limited vision. The fully blind identifies the environment by touching because they do not possess any sense of dimensions or objects located around them. The mobile technology in the modern society has become such an essential part of human day to day life. Most of the mobile apps are designed for sighted people. Nevertheless, 'Design for Usability' clears that difference without considering the user's visibility (Sierra & Togores, 2012). Under the concept of 'Low Vision Mobile App Portal', some authors have provided a way to access mobile applications for visually impaired users. This research mainly focusses on the concept of "Universal Design" which is widely used in several areas/fields. Universal Design concept is closely related to the meaning of accessibility or usability. This does not imply only about the accessibility to a computer or a mobile device, but with the fast-developing technology, accessibility of the blind can be extended to include computers and mobile devices.

In 1999, the Web Accessibility Initiative [WAI] published the Web Content Accessibility Guidelines [WCAG] to improve the accessibility of disabled people. But with the development of mobile phones with touch displays, accessibility of mobile for visually impaired & blind users was fell due to the loss of physically feedback. So, some (Sierra & Togores, 2012) researchers have designed special apps for visually impaired or blind users to access the touch screen mobile devices. Low Vision Mobile Portal is one of the mobile apps that provide the facility to access important apps such as phone calls, messages, contacts, and calculator etc.

2.2 Human-Computer Interaction Design

In line with the concept of 'Mobile Accessibility', designing the user interface (UI) was given high priority. Application of Human/User -Computer Interaction Design concepts assist in designing effective User Interfaces especially for blind users (Arrigo & Cipri, 2010). Apple with iOS operating system, have considered the concepts of user experience and accessibility in mobile apps, when designing apps for the blind or VI users. (Sierra & Togores, 2012).

User experience refers to observing and analyzing the users' experiences to evaluate the effectiveness of a product design. Which is considered the most

valuable aspect of Human-Computer Interaction (Marcus, 2013)

Accessibility in mobile apps generally implies that the app should be accessible by as many users as possible. For instance, narrator, voice over, voice control, speak recognition, auto text and tactile buttons are some of features that have been introduced to users with special needs to access the mobile (Craddock).

D. McGookin et al. have suggested a set of guidelines for mobiles with touch displays (McGookin, Brewster, & Jiang, 2008) that can be applied to maximize accessibility.

2.3 Text Entry Methods

All the apps that have been described above relate to the blind or VI people. But these apps were rarely used by blind users and regarding to an online survey (Leporini, Buzzi, & Buzzi, 2012), blind users mostly use mobiles (iPad/iOS) to take mobile calls (92.7%), read SMS (90.9%), write SMS (87.3%) and to listen to music (80%). But most of them (52.7%) are not satisfied about the usability of the keypad and 72.7% of blind users preferred an editing mode with a single tap.

According to Leporini et al. blind users prefer to the QWERTY keyboard rather than using multi tap keyboards (Leporini, Buzzi, & Buzzi, 2012). However, there are many text entry methods such as, Multi Tap, Nav Touch, Braille Type (Oliveira, Guerreiro, Nicolau, Jorge, & Goncalves, 2011) and Robust Entry Technique which were used in Eyes-Free Text Entry type in No-Look Notes (Bonner, Brudvik, Abowd, & Edwards).

2.3.1 QWERTY

In the basic QWERTY method, a user has to move his/her finger on the touch keypad, and then the system reads the letter that the user has touched, and the double tap types the letter.

There is another approach using the digital QWERTY keyboard that is used in iPhones known as 'Voiceover' (Oliveira, Guerreiro, Nicolau, Jorge, & Goncalves, 2011). In this approach the user should set his/her finger on the desired key and then tap anywhere on the screen with a second finger. Afterwards, lift the first finger and then double tap anywhere on the screen. These are the steps that must be followed to enter a letter using voice over (iPhone - Accessibility, 2017).

2.3.2 Multi-Tap

In multi-tap method also, a mechanism similar to QWERTY is employed. But here the targeted number of keys on screen are less than QWERTY. The user must select the group of keys by double tap and multi-tap to select a letter.

2.3.3 Navigational Touch

In the method of navigational touch, the user needs to move the finger up and down (vertically) to select a group of letters and move the finger left and right (horizontally) to select a letter. Here letters are grouped into five and each group starts with a vowel 'a, e, i, o, u'.

2.3.4 Eyes-Free Text Entry

In the eyes-free text entry method, a user must tap on a group to enter a letter. As an example, if user needs to input 'B' then user need to select 'ABC' group by touching on that particular group of letters. To select a specific letter through the group or to open a group the user should tap a second finger anywhere on the screen. The next screen shows all the letters in a given group category vertically. Then user can move his/her finger up or down to select the individual letter. The user must tap his/her second finger anywhere on the screen to confirm the selection.

2.3.5 Braille Type

The Braille type method is the most familiar method for the blind and variants of Braille type input method can be found. This is known as the first approach with having less number of screen targets and here each cell known as braille cell and user should long touch on cell to mark the cell and the double tap anywhere on the screen to tell that single braille character has finished the typing. When user marked a cell then it denotes a single bit otherwise 0.

Braille type has been applied in (Alnfai & Sampalli, 2016) with an extension known as 'SingleTapBraille'. In the Braille type design, a user should mark on the virtual cell area. But, in SingleTapBraille design, user does not need to find a specific location or area to mark the cell (Oliveira, Guerreiro, Nicolau, Jorge, & Goncalves, 2011). Here they developed their algorithm by using the factors of Number of dots in each character, the x, y coordinates of the touch points and distances between two points. As an example, if user need to input 'b' then user need to mark two points vertically anywhere on the screen. The relationship per the number of dots activated by input are as follows:

- Character with 1 tap anywhere on the screen - always known as letter 'a' or number 1.
- Character with 2 taps - $|X1-X2|$; D is a specific value for this status.
- Character with 3 taps - $|X1-X2|$; $|Y1Y3|$; D is a specific value for this status.
- Character with 4 taps - $|X1-X2|$; $|X3-X4|$; $X2 < X3$; $|Y1-Y3|$; $|Y2-Y4|$; $Y3 < Y2$, D is a specific value for this status.

- Character with 5 taps - |X1-X2|<error; |X3-X2|<error; |X4-X5|< error; |Y1-Y4|<error; |Y2-Y5|< error; D is a specific value for this status.

So, using the above results the typed character can be classified and output. A ‘Sliding Rule’ is also used in this method to run special characters such as, New Line [Enter], White Space, Backspace, Switch keyboards among Uppercase keyboard, Numerical keyboard, lowercase keyboard and symbols (punctuation marks) key board.

Furthermore, there are more approaches to type braille letters on screen. One of them is ‘PerkInput Text Entry Method’ (Azenkot, Wobbrock, Prasain, & Ladner, 2012). This is similar to Perkin Braille Device input method. A user must put 6 fingers on the screen and long touch on screen to add the point. The screen is shown in Figure 1.

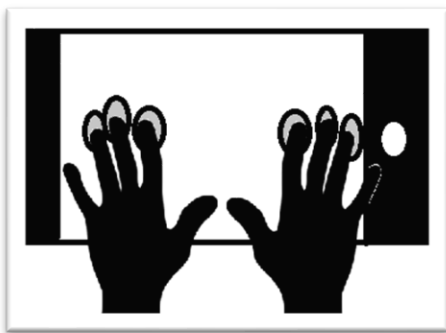


Figure 14. PerkInput method in touch screen

In PerkInput, Azenkot et al. have introduced the theoretical concept of IFD ‘Input Finger Detection’ which is based on a multi-touch signal detection technique. In this method, a single finger input is denoted as one bit ‘1’ or ‘0’. These methods can be used with either both hands or with a single hand. If the user needs to use both hands, then the user has to touch on screen only once to enter a single braille character, otherwise a user has to touch twice to enter a single braille character.

There is another new technique to type in braille in touch screen which known as ‘TypeInBraille’. In this technique (Mascetti, Bernareggi, & Belotti, 2011) a user needs to input pairs of dots at a time as shown in figure 2.

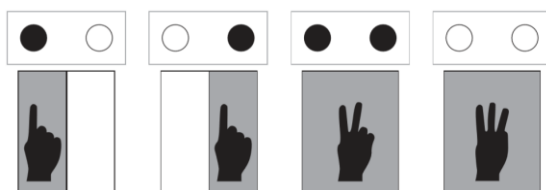


Figure 15. Technique of TypeInBraille

In ‘TypeInBraille’ method a user has to touch three times to enter a single letter. Usually a single braille letter is denoted with a 3 x 2 matrix. A user must fill a single row in this method. When considering a

single row, a single dot is denoted using a single touch in left/right side. If a row has both dots, then two fingers touch and no dots for a row are denoted by three fingers. A flick/slide rule is used to denote ‘End Character’ and ‘Blank space’.

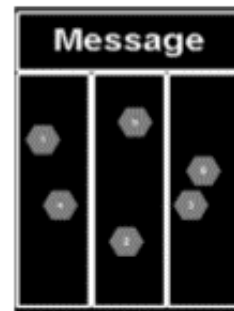


Figure 16. Technique of BrailleOne text entry method

As well as ‘BrailleOne’ (Hatzigiannakoglou & Kampouraki, 2016) the research team of Paul, also an extension of this techniques. In this method, a user needs to touch twice to enter a single letter. In blue it represented one, two and three inputs. And in red it represented four, five and six. This method also has done in a previous research (Azenkot, Wobbrock, Prasain, & Ladner, 2012) however using in different way of Input detecting. In BrailleOne they input was detected by view wise. Assume a user names a Linear Layout A, B & C from left to right, then if a user taps on Linear Layout A then it detects it as 1 or 4 inputs due to group of categories (1,2,3 & 4,5,6). Similarly, if user taps on Linear Layout B then it detects it as 2 & 5. But in ‘PerkInput Braille’ (Azenkot, Wobbrock, Prasain, & Ladner, 2012) method use IFD technique. Here once user touch on screen with his/her 3 fingers then it detects its (x, y) coordinates of reference point and then using Maximum Likely Hood function they corrected the next time touch points with the previously touched reference point.

‘Braille Key’ (Subash, Nambiar, & Kumar , 2012 4th International) is another approach of typing braille. In this approach, they have divided the screen into four parts as 2 x 2. The first line is reserved for text entry and the left area, one touch selects the point one, two touches, the point two, and long touch, the point three. The same applies to the right, for points four, five and six. The ENTER and DELETE buttons are on second line.

In Google Play Store, there is an alternative keyboard known as “Swift Braille” by the Swift Team. In this method, the user need to draw the patterns from one dot to another.

Figure 17 shows how user type braille character ‘e’ using Swift Braille. Here user starting at dot 1 position and then move his/her finger to the dot 5.

First two methods of QWERTY and Multi Tap that are described above are much difficult for blinds that is why researchers introduced new techniques just like

third and fourth methods that are mentioned and they have analysed each method on factors of fast/speedy and easy/user friendliness.

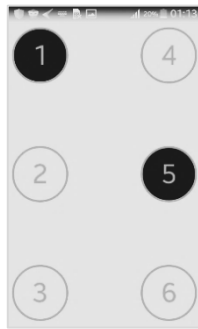


Figure 17. Typing letter 'e' using Swift Braille

Nav Touch & No-Look Notes are much different when compared with normal text entry methods of QWERTY & Multi Tap. Per their analysed data No-Look Notes (Bonner, Brudvik, Abowd, & Edwards) has proved their method is faster than 'Voice Over method' (Text entry speeds are 0.66 WPM for Voiceover and 1.32 WPM for No-Look Notes) and QWERTY (Oliveira, Guerreiro, Nicolau, Jorge, & Goncalves, 2011) is the fastest method (2.1 WPM with 0.7 of SD) of typing. Slowest method (1.49 WPM with 0.43 of SD) is typing braille (a user need to touch 6 times at maximum to enter a single braille character). But typing braille was the most accurate way of typing letters. However, they have come up with some difficulties for each method and 'Timeouts & Lose track of text' were identified difficulties for typing braille.

In (Siqueira & Silva, 2016) has analysed the most of braille methods which exists on today. Per their research 'Braille Touch' the method of typing braille using 6 fingers simultaneously and the 'TypeInBraille' are the fastest way of braille typing. But 'Braille Touch' has the maximum of error rate and 'PerkInput' method is most accurate way.

2.4 Input Finger Detection (IFD)

Input through the touch screen can be modelled for transmission of information through the noisy channel (Azenkot, Wobbrock, Prasain, & Ladner, 2012). In IFD mechanism at the first user should set his/her n reference points on the screen. As an example, when user insert long press by inserting n fingers Then, the user transmits a message into the device by encoding the message into multi-point touches, each representing a binary sequence with n bits. If user's i th finger touch the screen for pre-given target point, then bit of that point will be one (1) otherwise will be zero (0). As mentioned earlier touch input given to the device with some inconsistency, since the user will not hit exact reference point with every subsequent touch. The device receives the noisy, encoded message which analogous from inconsistency through

noisy channel and the input method decodes it using their detection algorithms.

There are three sources of noise in their model:

1. Hand repositioning. When the user repositions the hand on the screen, the current touch points are no longer near the reference points. This was addressed by simply set new reference points that reflect the new position of her hand.
2. Touch-point inconsistency. As with mouse clicks around a target, there is natural error that occurs when a user attempts to touch a consistent point on the screen. The Maximum Likelihood (ML) to detect which finger corresponds to which point while accounting for the distribution of points around the target reference points.
3. Hand drift. When user touches the screen repeatedly usually our fingers moving little bit (drifting) from the target point. This was addressed by tracking the reference points after each touch to minimize the error of decoding.

2.5 Character Classification

Usually a Braille character is denoted as a 3 x 2 matrix and it is numbered 1 to 6 from top to bottom, left to right as shown in Figure 18. In PerkInput typing method fingers are numbered as in Figure 19.



Figure 18. Braille Cell

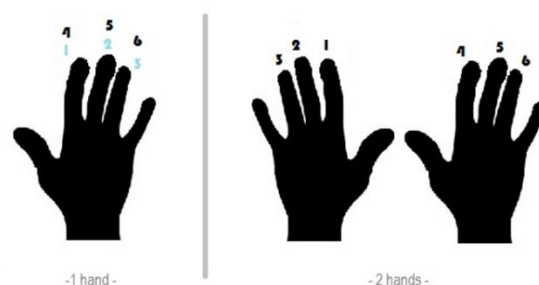


Figure 19. Mapping Fingers in one hand and both hands

2.6 Tracking Reference Points

When the Hand Drift was addressed in the previous Section 2.4, ML functions were used for target selection criteria. They have assumed that users keep their hands next to the reference points. But this is not true in reality. Therefore, in this solution 'First-Order Phased-Locked Loop' has been used to track references points.

After the input finger is detected, where each touch reference points were moved by a fraction of distance between touch point and the corresponding reference

point. Here they assumed that each individual finger touch is correlated with the other fingers. Therefore, the concept has been formalized into the following equation:

$$R_{n+1} = k \cdot C \cdot E_n + R_n$$

Equation 1

where R_n is the vector of references points at time n , E_n is the vector of differences between references point and touch point at time n , k is a scalar constant which known as 'adaption coefficient' (Smaller values of k are reducing the effect of tracking) & C is the 'correlation coefficient matrix'.

k and C values, are they derived through the experiments and they as follow;

$$k = 0.1 \quad C = \begin{bmatrix} 1 & 0.4 & 0.4 \\ 0.4 & 1 & 0.4 \\ 0.4 & 0.4 & 1 \end{bmatrix}$$

Equation 2

2.7 Sensor Vibration

Blind-deaf communication is more important when a message is received through a smart touch phone as most apps are built only to read the message through system voice feedback.

Blind-Shell (Svobodnik, Novak, & Cerman, 2013) is a launcher app that is created especially for the visually impaired. Through this facility is provided for the blind to perform basic operations such as SMS, Contacts and setting an alarm.

V-Braille (Jayant, Acuario, Johnson, Hollier, & Ladner, 2010) is a technique that is capable of reading Braille letters through a fully touch screen using vibrations. Jayant et al. have used different signals for Braille cells. The Figure 20 shows how vibration signals work when reading Braille letters. The dotted line has low vibration than a straight-line vibration.

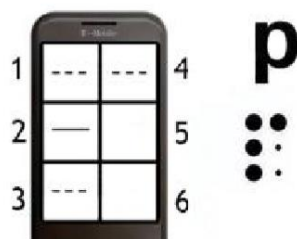


Figure 20. Reading the lowercase letter 'p' (V-Braille) (Jayant, Acuario, Johnson, Hollier, & Ladner, 2010)

'Braille Scan', 'Braille Rhythm' and 'Braille Sweep' (Rantala, et al., 2009) also embody different methods to read Braille characters. Braille Scan is similar to V-Braille above mentioned, where when a user moves his finger from top to bottom the vibration happens only once per dot and again go back to the top and the last 3 dots of braille character in 2nd column are read. 'Braille Sweep' method is almost like the Braille Scan

method but here the braille dots' positioning is different from the Braille Scan method. Here dots are positioned as three, two and one dots horizontally as well as four, five and six placed horizontally. Here the reading direction is different from the Braille Scan as this method uses vertical finger movement to read the text. Figure 21– (a) represents the numerical order of braille dots for Braille Rhythm method. In the Braille Rhythm method, the characters are read using temporal tactile patterns. This produces tactile pulses in numerical order from one to six (1-6/left to right).



(a)



(b)

Figure 21. (a) Braille Sweep numerical order & (b) Braille Rhythm (Braille Sweep) (Rantala, et al., 2009)

Figure 21 – (b) denotes the pattern/ Rhythm for braille character 'c'. Character 'c' consists of dots one (1) and four (4). However, one and four has a higher pulse than other dots. Due to their data analysing part mean recognition accuracies and the mean reading time (Character Per Seconds) are as follows. 'Braille Scan' is more accurate, but 'Braille Rhythm' is a much faster method.

Table 2.1. Analysis of Data after 3 sessions (Rantala, et al., 2009)

Method of Braille Reading	Recognition Accuracy (%)	Reading Time (cps)
Braille Scan	97	0.18
Braille Sweep	91	0.20
Braille Rhythm	92	0.27

3. METHODOLOGY

3.1 Typing Braille Characters

Under the literature from the previous chapter, several types of text entry methods were developed for touch screens to blinds or VI people by researchers. Among them 'Perk-In-Brailler' (Azenkot, Wobbrock, Prasain, & Ladner, 2012) is the fastest way of to insert

characters. Nevertheless, due to the proposed system, three types of different gestures were developed to use with two, three or six fingers.

Design A: Type a single braille character using two fingers & needs to tap thrice to insert a single braille character. Target the devices which have only basic multi-touch capability of points of two.

Design B: Type a single braille character using three fingers & needs to tap twice to insert a single Braille character. Target the devices which have multi-touch capability with less than six points but greater than two points.

Design C: Type a single braille character using 6 fingers & by a single tap can insert a single Braille character. Target the devices which have best multi-touch capability of points of ten or more than 6 points.

With the customizable UIs, the restriction of hand positioning on the screen in Design B & C is avoided. Therefore, user has the freedom to register the reference points (Dots of a Braille character) as they were preferred. Following Figure 22 shows sample UI with references points (Design B & C) for each design.

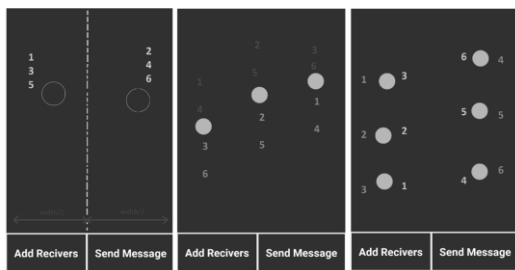


Figure 22. Text Entry methods (Design A, B, C)

3.2 Input Finger Detection

In each design, tapped finger need to be identified and two different ways were used in design A and design B&C. In design A, simply screen is divided into two spaces and if left side is tapped, then it counted as left column and if right side is tapped then it counted as right column. And if a row has no marked cell then draw pattern command to denote empty cell row. Thrice a time, inserted braille code is converted into the alphanumeric text characters. Following Figure 23 demonstrates an example of inserting a braille character 'm'.

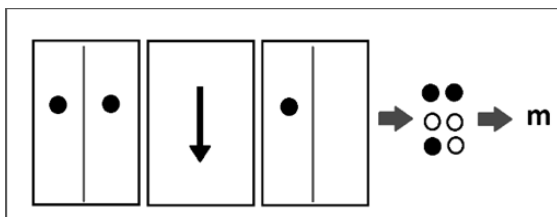


Figure 23. insert braille character 'm'

With the increases of number of fingers which were used to insert a braille character in design B & C,

above mentioned simple method cannot be used further. Therefore, more user friendly and accurate method is introduced. For that, K-NN classification algorithm is used to detect finger which is inserted by the user.

3.2.1 K-NN Classifier

K-NN classifier is a non-parametric method that is used to classify the objects. In design B, three different classes have been defined and user's registered references points have taken as centroid of each class.

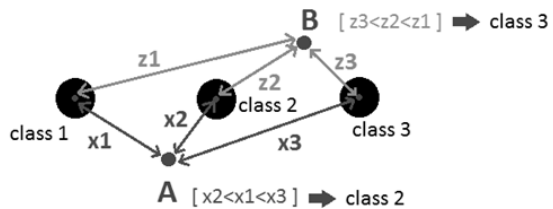


Figure 24. Classify Point A & B using Nearest Neighborhood algorithm

Different types of distances have been used with K-NN classification algorithm to calculate distance between user touch points and reference points, namely Euclidean distance, city block distance and Bayesian touch distance.

Euclidian Distance

Let A (x, y) be the user touch point and registered reference point $P_i(x_i, y_i)$ for class i (where $i=1,2,3$). Then calculate Euclidean distance using following equation.

$$d(A, P_i) = \sqrt{(x_i - x)^2 + (y_i - y)^2}$$

Equation 3

City Block Distance

Let B (x, y) be the user touch point and registered reference point $P_i(x_i, y_i)$ for class i (where $i=1,2,3$). Then calculate city block distance using following equation.

$$d(B, P_i) = |x_i - x| + |y_i - y|$$

Equation 4

Bayesian Touch Distance

s- coordinates of the finger touch, t- target, W- Width of the t, c- center of the t

α & σ_a^2 are constants which they find out through separate experiments.

$$BTD(s, t) = \frac{(s - c)^2}{2(\alpha W^2 + \sigma_a^2)} + \frac{1}{2} \ln(\alpha W^2 + \sigma_a^2)$$

Equation 5 (Zhai & Bi, 2013)

With some simplifications, they have generalized above equation up to 2-dimensional circular targets. Also, here they have used the proved results which ‘distribution of 2-dimensional target selections approximately follow a bivariate ‘Gaussian Distribution’. Then above equation has become to $BTD_2(s, t)$ as follows.

$$BTD_2 = \frac{1}{2} \left[\frac{(s_x - \mu_x)^2}{\sigma_x^2} + \frac{(s_y - \mu_y)^2}{\sigma_y^2} \right] + \ln \sigma_x + \ln \sigma_y$$

Equation 6 (Zhai & Bi, 2013)

Then they have replaced μ_x , μ_y , σ_x & σ_y with some estimations as follows.

$$BTD_2 = \frac{1}{2} \left[\frac{(s_x - c_x)^2}{\alpha_x d^2 + \sigma_{a_x}^2} + \frac{(s_y - c_y)^2}{\alpha_y d^2 + \sigma_{a_y}^2} \right] + \frac{1}{2} \ln(\alpha_x d^2 + \sigma_{a_x}^2) + \frac{1}{2} \ln(\alpha_y d^2 + \sigma_{a_y}^2)$$

Equation 7 (Zhai & Bi, 2013)

Where α_x , σ_{a_x} , α_y & σ_{a_y} are constants that they have obtained by separated experiments. Those values are as follows.

Table 3.1. (Zhai & Bi, 2013)

α_x	$\sigma_{a_x}^2$	α_y	$\sigma_{a_y}^2$
0.0075	1.68	0.0108	1.33

Zhai & Bi (Zhai & Bi, 2013) has introduced this distance for target selection. When converted that model into my problem model, targets are known as registered reference points. That distance can be calculated using Equation 7. d (width of target) in Equation 7 is taken as 1 for each reference points.

Among the distances which are mentioned above, BTD is selected to classify the class using Nearest Neighbour Classifier due to the higher accuracy that have been recorded.

3.3 Tracking Finger Points

Cause of finger drifting there would be a greater error between previously registered references points and the currently touched point d . Therefore, two different algorithms were used to update reference points. They were K-Mean and First-Order Phased-Locked loop algorithms.

K-Means algorithm

K-means algorithm is generally used to cluster noisy data, to constraint data to lie on the surface of a high

dimensional unit sphere and for directional noisy data. General k-mean algorithm is an iteratively running process to partition ‘ n ’ number of observed data into number of given groups. (Ramler, 2008) Moreover, among different types of clustering algorithms K-Mean is the most simplest algorithm (Complexity - $O(n)$) and, K Means is found to work well when the shape of the clusters is hyper spherical (Kaushik, n.d.). Even though KNN classifier known as a *lazy learner* By combined with K-Mean centroid of the clusters updated and classes

Let’s assume that observed references points (centroid of each clusters) at time n are $\hat{r}_{1,n}$, $\hat{r}_{2,n}$, $\hat{r}_{3,n}$, $\hat{r}_{4,n}$, $\hat{r}_{5,n}$, $\hat{r}_{6,n}$. In General form, this can be denoted as $\hat{r}_{i,n}$ for $i = 1, 2, 3, 4, 5, 6$ and let’s take d_n as the newly taped point and assume it belongs to the class j then by k-mean algorithm updated the reference point (centroid of the class j) $\bar{r}_{j,n+1}$ as follows;

$$\bar{r}_{j,n+1} = \left(\frac{m\bar{r}_{j,n} + d_n}{m + 1} \right)$$

Equation 8

Where $\bar{r}_{j,n}$ is; $\bar{r}_{j,n} = \frac{\sum_{k=1}^m r_{j,k}}{m}$; $m \leq n$;

m – number of members belongs to class j at time n .

First-Order Phased-Locked Loop

First-order phased-locked loop was used by Azenkot (Azenkot, Wobbrock, Prasain, & Ladner, 2012) and Equation 1 & Equation 2 were used to updated references points. In this case, they have considered each finger are correlated with other fingers.

Both algorithms’ accuracies have been equal and therefore K-mean algorithm was selected as reference points tracking algorithm cause of its simplicity.

3.4 Sense of vibration to read text

When ‘Blind-Deaf’ mode is activated, vibration patterns were used to read text and to give the feedback of typed text. The ‘Braille Rhythm’, a vibration technique (Rantala, et al., 2009) was used to input character and to read character. Following time periods and breakpoints patterns were implemented to build vibration patterns for each braille character.

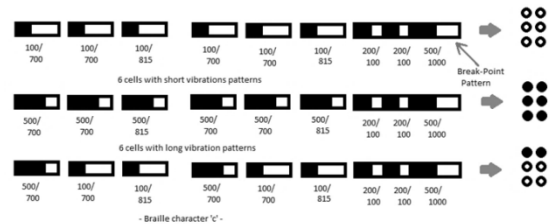


Figure 25. Vibration Patterns with Break-Points

In this approach, basically 7.13 - 9.53 (seconds) time was taken to read a character. In Chapter 7, I have

described the correctly identifying rate with participation of pseudo blind-deaf.

3.5 Braille Character Classification

In braille conversion, 6-bit (Figure 18) encoding scheme has been used to convert braille to text and sixty-three (63) braille characters which categorized under 7 lines in braille system has been used in ‘Braille Messenger’ including nineteen (19) punctuation marks & ten (10) digits. (Appendix)

The numerals 0-9 and the English characters “a, b, c, d, e, f, g, h, i, j” has the same braille characters. Numerals are distinguished from the above English characters with the presence of the “.” braille character. If “.” character appears prior to a braille character, it must be considered as a number (activate number mode) and after every WHITE SPACE or NEW LINE number mode will turn off.

3.6 Detecting Drawn Patterns

3.6.1 Using Gesture Detector

In Android Developing Environment there is an inbuilt function to detect draw patterns which known as ‘Gesture Detector’. In this approach, there was an app called ‘Gesture Builder’ which developed by Google to save patterns as .txt file and then load that .txt file into Gesture Library in Android Studio. Then calculate the prediction score for drawn pattern compared to saved gestures.

When returning predicted pattern, it delayed around 1.5 seconds. Also, accuracy of the predicted pattern from Android-inbuild feature was less than the accuracy of predicted pattern from mathematical algorithm that was introduced in this research. Cause of prediction delay most of the times, braille inserting task not performed correctly.

3.6.2 Using Static Mathematical Algorithm

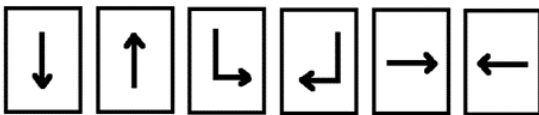


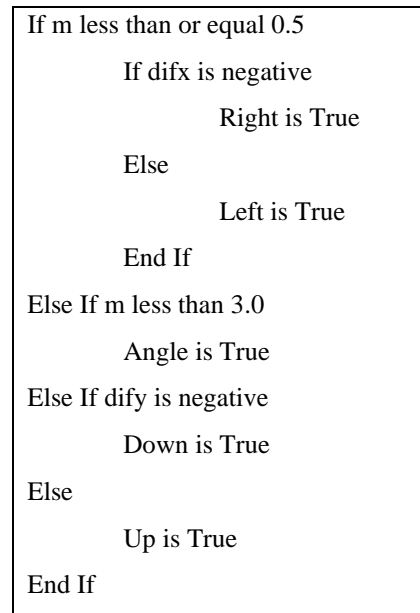
Figure 26. Drawing Commands, A, B, C, D, E, F

The proposed mathematical algorithm consists of the following steps to detect drawing pattern commands.

1. Store the all the points of drawing commands
2. By considering first and the last point of drawing command, check whether drawing lines moving side. Here considered slope between first and last points as well as difference between 2 points.

Take *difx* as the difference between the x coordinates of the first and last points, and *dify* as the difference between the y coordinates of the first and last points. Let *m* be the magnitude value of the gradient of the line drawn between first and last points of drawn

command. The right, left, up, down and angle variable can be set using the following criteria as shown in Figure 27 – a;



3. If ANGLE is true, then check for command C & D, if left is true then check for command F, if right is true then check for command E, if down is true then check for command A, if up is true then check for command B.
4. As examples, ‘Checking for command C’ (Figure 27. concept of detecting drawing command patterns - b) & ‘Checking for command B’ have been considered.
 - a) Checking for command C – Here find out the breaking point as shown in (Figure 27. concept of detecting drawing command patterns-b). x-coordinates of pattern before the breaking point should lie between the $[x_1-e, x_1+e]$ limit and y-coordinates of pattern after the breaking point should lie between the $[y_n-e, y_n+e]$ limit. Otherwise variable OUTFOSHAPE set to be true. Moreover, here have been checked for reverse drawn lines and if it was, REVERSE set to be true.
 - b) Checking for command B – Here x-coordinates of all points in drawn line should lie between the $[x_1-e, x_1+e]$ limit otherwise OUTFOSHAPE set to be true. And here also have been checked for reverse drawn lines and if it was, REVERSE set to be true.
5. Then by using the Boolean values of variables UP, DOWN, LEFT, RIGHT, ANGLE, REVERSE & OUTFOSHAPE detect the command or not and if it was a command then returned the command name.

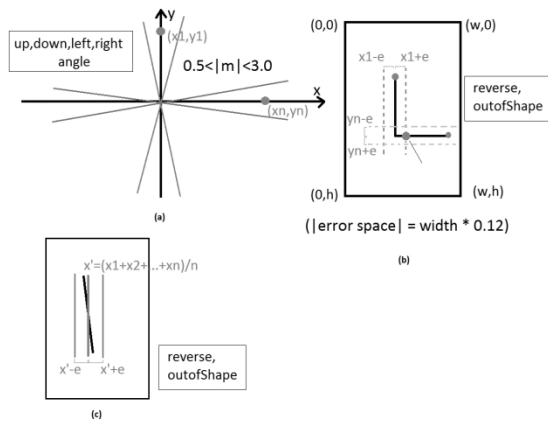


Figure 27. concept of detecting drawing command patterns

4. RESULTS AND DISCUSSION

In this section, the proposed design with three customized gestures are discussed. Figure 22. Text Entry methods (Design A, B, C). In this scenario, different algorithms were tested to detect the input finger for design B and design C. K-NN classifier with K=1 (Nearest Neighbor Classifier) using different distance measurements were attempted.

BTD, Euclidean and City Block three different distance measures that were used to calculate the distances in the Nearest Neighbor classifier. The app was implemented and tested for speed of typing, average typing speed and for accuracy with a sample of 5 blind users. Highest accuracy was recorded for the BTD at 97.54%. For other distances, Euclidean & City-Block distances observed accuracy at 95.38% & 92.3% respectively. Moreover, we can conclude that the accuracy level of the BTD is in between 93.63% and 97.14% at 95% level of confidence.

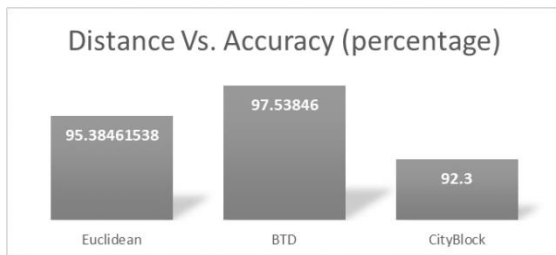


Figure 28. Distances Vs text entry accuracy rate

After the evaluation of accuracy, Bayesian Touch Distance has been selecting as the distance for nearest neighbour classifier. Then accuracies were tested against the method which is used Maximum Likelihood function and 96.89% of accuracy was recorded for ML. Since accuracy of Nearest Neighbour Classifier with BTD was higher than the method that used ML function, the Nearest Neighbour Classifier with Bayesian Touch distance was chosen to implement in the algorithm to detect input finger when inserting braille characters for design B and C.

4.1 Text Entry Speed

After 5 sessions of testing with participation of 5 users, the maximum speed of each text entry was recorded at 5.4WPM, 9.6WPM and 18.9WPM for designs with finger 2 (Design A), 3 (Design B) and 6 (Design C) respectively. Results of the experiment were concluded that the typing speed of Design-A (one-hand 2 finger) lies between 3.37WPM and 4.11WPM, Design-B (one-hand 3 finger) lies between 6.58WPM and 7.98WPM and Design-C (two-hand 6 finger) lies between 11.69WPM and 14.89WPM at 95% level of confidence.

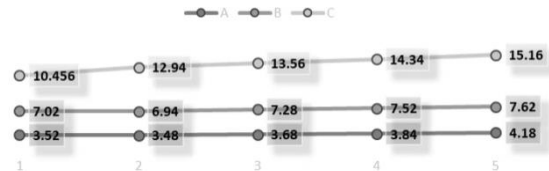


Figure 29. Entry rate over sessions

As is observed from the graph, text entry speeds of each design have gradually increased over the number of sessions. Each design is observed highest speed at the session 5 and at that session speed has been increased by 19%, 9% and 45% when compared to the session 1 for design A, B, and C respectively. Which is concluded a higher learnability of my proposed app.

4.2 Accuracy of Text Entry

In this section, uncorrected error rates for each design is analysed over the time (number of sessions). Below Figure 30 demonstrates the error rates over the time. For the design A, 99.99% of accuracy (error rate = 0.01%) was recorded. Likewise, for average uncorrected testing, 2.46% of uncorrected error rate for design C and 1.15% of uncorrected error rate for design B were recorded. And, as is observed from the graph, there is a decline in Design-C and B. This showed that, this approach improves the learnability of the proposed app.

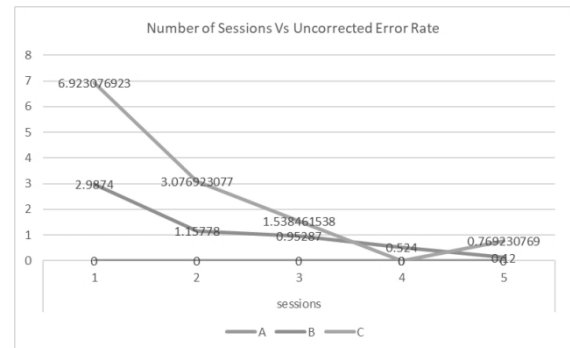


Figure 30. Uncorrected Error rate over time

4.3 Drawn Pattern Detection

In proposed solution, some of drawing pattern commands were introduced to execute commands. As Android was chosen for the development, there was an in-built functionality to detect drawing patterns.

So, in this study, the accuracy for the novel mathematical algorithm was measured and checked against its accuracy against the Android in-built functionality of 'Gesture-Detector'. Figure 31 represents the accuracy level for the 'Drawn Pattern Commands' for the mathematical algorithm that was introduced in this research while Figure 32 represents the accuracy level for the 'Drawn Pattern Commands' for the Android in-built functionality of 'Gesture-Detector'.

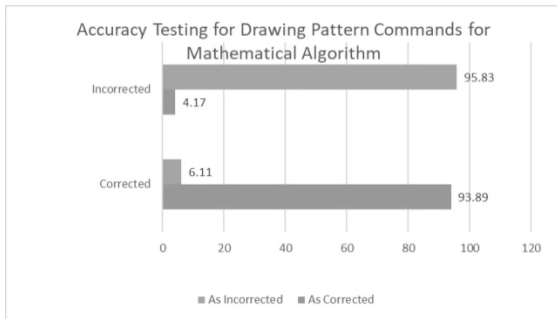


Figure 31. Accuracy rate of drawing command patterns for mathematical algorithm

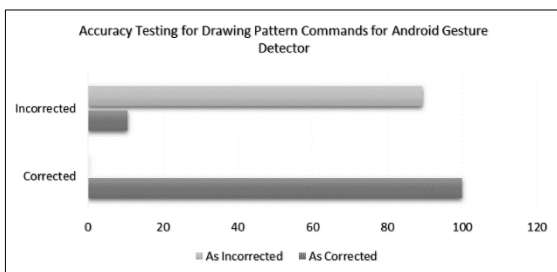


Figure 32. Accuracy rate of drawing command patterns for Android Gesture Detector

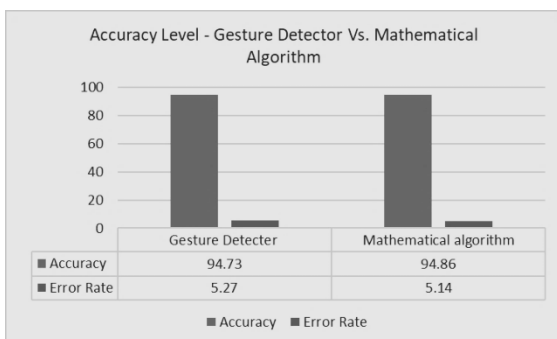


Figure 33. Accuracy Level of Gesture Detector over Mathematical Algorithm

When comparing the accuracy level of mathematical algorithm over the Android's inbuilt feature 'Gesture Detector' there is no significant difference between them. Also, 94.86% accurately detect the drawn patterns from the proposed novel mathematical algorithm. But when considering the time taken to detect, Gesture Detector took more time to detect

drawn pattern commands than the proposed method. Moreover, using gesture detector leads to increased error rates in typing when tested on blind users. Therefore, novel mathematical algorithm is used to detect drawn pattern commands.

5. CONCLUSION

'Braille Messenger' is an integrated mobile application which is designed to send and receive text messages using Braille via short message service. The app can support both blind and the blind-deaf communities.

The app is designed with the user in mind, giving the user a chance to select any gesture what they preferred and through this entry method could to reach higher typing speed than other ordinary typing methods that blinds using.

K-NN and K-Means algorithms were employed with Bayesian Touch Distance to classify the inserted braille character on gesture. A novel static algorithm was also implemented to execute drawn pattern commands. The app demonstrated a higher accuracy for character and pattern detection and recognition. Furthermore, the app is able to predict words when a user types more than 5 letters.

The Braille Messenger recognized and converted the Braille to text with an accuracy of 97.54% while the drawn pattern commands were detected and recognized at an accuracy of 94.86%. When considered about the learnability, a higher rate of learnability was observed within a limited number of sessions.

In this research, 'Braille Messenger' was implemented as an integrated application to send and receive text messages using SMS Manager. But this customizable typing views can also be developed as a customizable keyboard. Thus, enabling a blind user to type with Braille when using any application on the phone.

Currently the app supports only English language, which can be extended to more languages like Sinhala and Tamil.

Error correction functionality is another important task that can be useful for the blind community when typing Braille. In future, the app can be implemented with an error correction functionality in an effective way.

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An Aspect Based Online Reviews Evaluation System for Higher Education Institution

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ABSTRACT 3-5

The higher education opportunities have increased significantly over the past decade in Sri Lanka. Today's younger generation is keen to study and most of them opt for higher education. Choosing the right course at the right private institute is most challenging choice since there are so many options available. In order to find the right institute, students have to surf internet for the reviews and find user comments of particular institution from social network sites like Facebook, Twitter, Google plus and etc. This takes lot of time for reading the comments to understand whether that ratings are good or not on the particular institution. The key information a student wants to get from the review is: whether that institute is good, and what aspects received positive or negative opinions. This task is quite challenging because it is difficult for a human being to extract statistical aspect sentiment information from a massive set of online reviews. As a solution for this problem higher institution aspect based evaluation system which evaluates the institution by considering the reviews given by reviewers is suggested by this project. This system implementation is based on natural language processing. The outcome of this research project, is a system which retrieves review data from the social media networks and gives a rating to an institution by analyzing the sentiment value of the reviews and the features evaluated in them. Data gathering and analysis process of this project is made automated as possible and this can be accessed from anywhere, as the client application is developed as a web application.

Categories and Subject Descriptors

I.2.1 Applications and Expert systems, I.2.7 Natural Language Processing

Keywords

Natural Language Processing (NLP), Data Mining, Aspect based Sentiment analysis, Online Reviews

1. INTRODUCTION

With the arrival of social media networks, it has become a very popular communication tool among internet users in past few years. Mostly the younger generation has a huge interaction on these social networks. According to the "Global Trends Report survey 2014" results, social media for universities has been among the most popular medium through which students share experiences and inspiration and also seek for information [1]. It is reasonable to assume that engagement of social media applications as part of university marketing could contribute to increased enrolment numbers and help prospective students to make better-informed decisions regarding their study choice and university selection [2].

Online opinionated texts (e.g. Reviews, Tweets) are important for customer decision making and constitute a source of valuable customer feedback that can help companies to measure satisfaction and improve their services [3]. An article on Business 2 Community (2015) shows that "Approximately 90 percent of consumers surveyed said that they read online reviews and 88 percent of them said that they trust the online reviews as much as personal recommendations". In other words, making a decision about a particular service whether to select them or not according to online reviews and ratings are recommended by users and business expert.

Today's younger generation is keener to study and most of them enter for higher education. However, Government universities have limited resources and only those who get the highest marks are able to attend to them. According to the research 70 percent of high school graduates in America entered some kind of a higher educational institution in 2009, the number of Sri Lankans entering public universities was as low as 4 percent [4]. Therefore, most of them choose private institutes than government universities.

According to a report by centrist thinktank, the social market foundation (2016), nearly 6 percent of university students drop out after their first year because of bad university selection. No institution is good at everything. Choosing the right course at the

right private institute is most challenging choice when there are so many options available.

In the internet, there are some online resources and university ranking websites which can assist in choosing the right course and institution. All these ranking methods do have serious shortcomings. Even the most popular ranking schemes cover only less than 5 percent of all the universities in the world [5]. University rankings are also mired in controversies due to the fact that many a times, rankings could be influenced by made-up, dicey and false data. However, there is no proper higher education evaluation system particularly in Sri Lanka.

GradReports and Unigo are institute consumer review sites which offer processing review text and sentiment when evaluating institute mainly focusing only on the 5-point rating scale scores [6]. In this way, if a reviewer gave 5-point star rating to an institute, one may not know whether it was for the studies or whether it was facilities [6].

As mentioned in the introduction, there were some problems because of not receiving the best recommendations while selecting higher education institution. Some of the problems were:

- **Lack of resources** –There are no any specific tool or web application in Sri Lanka which gives a summarized analysis of higher education institution based on online reviews of social network and automatically suggests the best institution among the offered institutions.
- **Too much information and too little time**–Due to huge amounts of reviews and comments about the institution and not enough time to read them all and understand whether that reviews are good or bad on the particular institution.
- **Fake reviews and hard to make judgments**–Fake reviews and comments also available on social media network. Reviews could be influenced by false data and it's hard to select at a decision.

Those some major problems which motivated the author to undertake this project and research and develop a system.

2. BACKGROUND AND RELATED WORK

Sentiment Analysis (SA) or Opinion Mining (OM) has become a very demanding and fascinating field. It represents a large problem space. Sentiment analysis refers to identify and understand the feelings and attitudes of consumer towards services through the use of natural language processing (NLP). The target of SA is to find options, identify the sentiments they express, and then classify their polarity as shown in Figure 1.

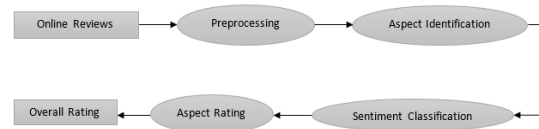


Figure 1. Sentiment analysis process on online reviews

Sentiment analysis can be considered a classification process as illustrated in Figure 1. There are three different sentiment classification levels [7] in which SA can be performed, including Document Level, Sentence Level and Aspect Level [7]. In recent years, the latest has gained pre dominance and is the widely accepted.

2.1 Sentiment Analysis Task

There are three main sentiment analysis tasks such as aspect identification, sentiment classification and summary generation. The aim of aspect identification is to identify and extract relevant topics from the text which can be used for summarization. This can be done by syntax tree parsing and part-of-speech (POS) tagging used to detect nouns and noun phrases. The most frequent nouns and noun phrases are identified using set mining and using distinct linguistic rules, those are filtered.

Next task is sentiment classification which determines the semantic orientation of each aspect [8]. The last task is summary generation is to represent processed results in a way that could be understood by users. Aspect based sentiment analysis summary can be represented in bar charts showing positive and negative opinions of each and every aspect of a single entity.

2.2 Aspect Level Sentiment Classification

Lu et al. (2011) mentioned that though extensive research has been done on the areas of sentiment analysis, most have them have contributed to Document level sentiment analysis. However, in recent year aspect based sentiment analysis has spiked up interest. Aspect based sentiment analysis, which has been also called “feature based” [9], goes even deeper as it attempts to identify aspects of the target entity within a sentence [10].

Proposed system intends to take up Aspect level SA analysis, as opposed to other two methods, due to the fact that reviews and opinions about institution touch upon many intrinsic aspects and qualities and analyzing each of these aspects is much valuable than analyzing the overall polarity of sentences or document.

To support the above justifications, sample review from Google plus, clearly showing how human reasoning appears to trust one review more than the other is demonstrated in Figure 2. The reviews are

annotated to explain the reviewer and review characteristics.

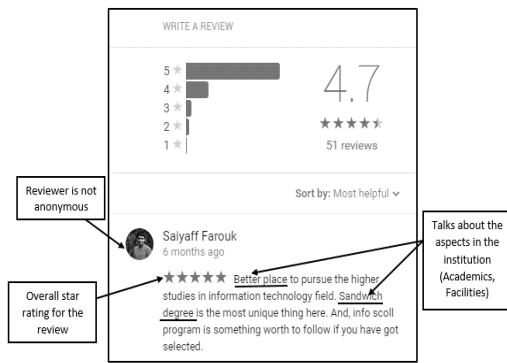


Figure 2. Example of a Trustworthy review

2.2.1 Techniques Used in Aspect Identification

Kim et al. (2011) provides a comprehensive survey on the different types of techniques used in aspect based feature extraction and sentiment classification. Table 1 shows the different types of feature identification techniques.

Table 2. Techniques used in aspect identification (Kim et al., 2011)

	Aspect/Feature Identification	Sentiment Prediction
(Hu and Liu 2004a; 2004b; 2006)	NLP-based Technique. Perform POS tagging and Generate n-grams.	Use association rule mining to find all rules.
(Ku et al, 2006)	Mining, Use the frequency of terms in and across paragraphs.	Lexicon- based. Use sentiment words to assign option scores to sentences.
(Liu et al, 2005)	Same technique used in (Hu and Liu 2004a: 2004b)	Orientation assigned to phrases based on whether it comes from 'pros' or 'cons' reviews.
(Liu et al, 2009)	NLP-based Technique. Identify head terms and cluster head terms into k interesting aspects.	Learning- based technique. Use overall ratings and a Naïve Bayes classifier.
(Popescu and Etzioni, 2005)	NLP-based Technique. Use KnowItAll system to extract features.	Statistical: Use relaxation labeling to predict sentiment orientation of opinion phrases.

It is evident that the majority of researches make use of NLP in order to extract features/ keywords of the text. A Machine Learning (ML) classifier has been

used mainly to classify the features into their respective sentiments.

2.2.2 Techniques used in sentiment classification

Main sentiment classification techniques are discussed in Table 2.

Table 3. Comparison of different sentiment classification techniques

Technique	Common approaches	Advantages	Disadvantages
Machine Learning based	Naïve-Bayes Maximum Entropy Support Vector	Can reach higher level of accuracy	Experts example data or past experience is available (Khan et al., 2009) Rely on domain and temporal datasets (Read,2005)
Unsupervised	Decision Trees Neural Networks Latent Dirichlet Allocation (LDA) Probability Latent Semantic Analysis	Domain specific results can be obtained fairly easily.	Takes longer to train unlike supervised
Dictionary Based	Mostly finding co-occurrences of words in text.	Opinion seed words can start off small which will be grown using synonyms and antonyms using statistical approaches	Restricted in understanding contextual and domain specific orientations (Medhat et al., 2014)
Corpus Based Approach	Semantic orientation Conditional Random Fields (CRF)	More accurate than dictionary based sentiment classification	Corpus requires to be large enough

2.2.3 Summary of Aspect Identification and Sentiment Classification Techniques

As indicated in Table 1, it can be concluded that it would be better to use NLP techniques to identify aspects from text. Table 2 states that ML classifiers will be useful in order to further classify each aspect into their respective categories (Academics, Culture, Extra-curricular activities, Facilities).

In order to classify the sentiment based on linguistic factors, supervised, statistical and unsupervised methods will yield better results.

2.3 Review on Existing Solutions

Nowadays several web based as well as mobile based applications can be found where they recommend different kind of higher education institute for students based on their course and location. Also there are several ranking applications for universities which show a number of higher institutions along with rating.

As per the detailed study, it is evident that there are no existing higher education institution evaluation systems which has the feature for analyzing the quality of the institutions based on aspect level sentiment analysis. It is obvious from the researches that analyzing an institution's quality from the online reviews posted in the social media sites is more efficient. It is stated that students prefer selecting an institution according to their desires.

3. SYSTEM DESIGN

3.1 High Level Design

High level design provides the overall system design in terms of functional architecture and database design which helps to understand the flow of the system for implementation.

Following figure shows the high level system architecture which describes the general functionalities and the system component which are playing major roles in the system.

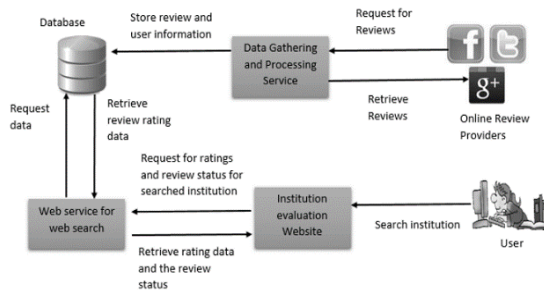


Figure 3. High level design for proposed solution

4. METHODOLOGY

The section below discusses the most important modules of this system shown in the figure above.

4.1 Data Gathering and Processing Service

Data gathering and processing service is the main module in the proposed system. This service will gather the data from the external online data streaming APIs provided by various review sites and social media networks. As identified from the requirement analysis this service should

contributing to the following functional requirement.

- Gather data from the external APIs provided by various social media networks and review sites.
- Identify and extract institution aspects from reviews.
- Analyze and calculate the sentiment of reviews and comments.

Following is the visual representation of the data gathering and processing component architecture with the workflow.

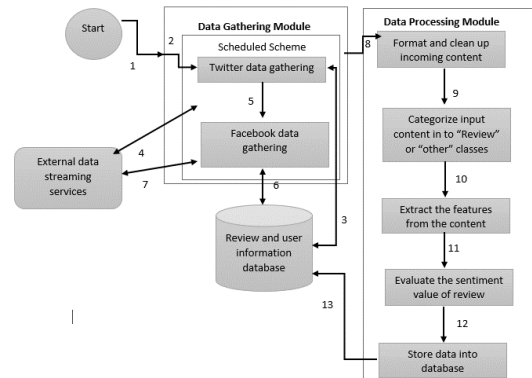


Figure 4. Data gathering and processing module workflow

4.2 Web Application

Web interface and the web service is the interface of this system. In this section website and the web service for the website will be discussed in details. Following are the requirements those have high priorities.

- Search institution by institution name.
- Allow user to enter the date length to filter the data (Comments, Reviews) which input in to system by data streaming provider.
- Show the institution rating as the percentage of positive, negative and neutral in graphical chart.

Following is the work flow and architecture of the web application.

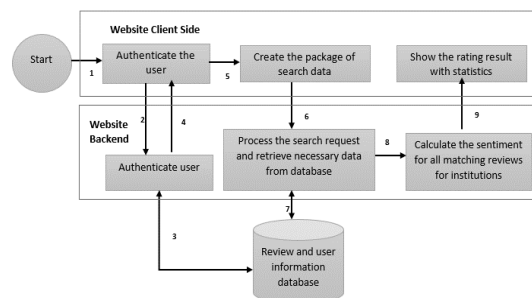


Figure 5. Work flow of the web application

5. DATA COLLECTION TECHNOLOGIES

5.1 Twitter API

Twitter API is an interface supplied by Twitter organization to collect the data from twitter social network. Twitter is a social network where every day more than 150 million posts are posted by the users. This API supply many more way to access data but with restriction because of the security. There are many API provided by Twitter to access data. One is rest API and other one is streaming API [11]. This API is available in many programming languages. Java is one of them.

5.2 Facebook API

Facebook API is an interface supplied by Facebook organization to write applications that uses Facebook data. Facebook is a social network where people share their thoughts and feeling with other. But unfortunately Graph API given by the Facebook is more restrict than the twitter API. Accessing data using API is hard because of the security reasons [12]. This API is written as a service and allows retrieve data by sending http request or JavaScript request.

5.3 Justification of Data Collection Technologies

For the problem discuss in this system to resolve it need many more data that able to collect to accurately output the result. Both of above APIs are supported by Java and supply large amount of clean data. So using both APIs to collect the data will be better than using only one.

6. SYSTEM IMPLEMENTATION

6.1 Core Functionality

- **Searching feature:** Include a simple searching facility. Therefore, user can able to view the rating of particular institution by searching the name of it or searching by the keyword.
- **Categorized reviews based on positive, negative and neutral:** Categorize online social media reviews based on positivity and negativity.
- **Generate analyzed reviews summary to the user:** Include a percentage indicating system which shows the user about the total percentage of negative, positive and neutral ratings and reviews given to an institution. Percentage will be represented in graphical chart.
- **An aspect based evaluation:** Identify and extract institution aspects from reviews. (Institution aspects include academics, culture, facilities and extra-curricular activities)

7. DEVELOPMENT PROCESS

7.1 Data Gathering and Processing Module

In this module there are three main processes. Those are classifying reviews, feature extraction and sentiment analysis.

7.1.1 Classifying Reviews

To implement this, help of the Apache OpenNLP is used. Because of the custom developed ANN was not accurate enough to classify large number of data.

7.1.2 Feature Extraction

In this module algorithm will get the POS (part of speech) tags and using them identify the nouns and adverbs and comparative adverbs in the review. Then using them identifies features mentioned and the literal values that reviewer given to them.

7.1.3 Sentiment Analysis

Sentiment analysis is done using the Stanford NLP library. This contains the algorithm part to process the sentiment analysis in order to calculate the positivity and negativity percentage of the reviews. Here, value for positivity is given as 4 and 5, for negativity 1 and 2, and 3 is for neutral. For example, if a word is considered as positive it will get a value of 4 and it is considered that it has a negativity of 1.

7.2 Web Application

Web application is developed using the PHP. Pattern used to develop the web application is MVC (Model View Controller). Website built on a framework which implement MVC pattern, "Codeigniter" framework. This help developing the MVC application very easily by helping to handle connection between controller to model and controller to view.

8. CONCLUSION

Developing an aspect based recommendation system for higher education institution evaluation is a concept of very challenging research area.

The test plan for testing of Aspect based sentiment analyzer consists of test cases to test the functional requirements. Initially the testing of the prototype was conducted by carrying out unit testing. Unit testing was carried out for all components of the prototype in order to seek and fix errors or any bugs in the prototype. Thereafter, all these components were integrated in order to carry out performance testing since the project plays a major role in responsiveness and stability. This has been done to the web application using apache benchmark tool which will help in load testing and also website is tested for various web browsers to check which browsers support the website layout styles and fasten the loading process. Performance tests has been performed on the Data gathering and

processing unit as well by calculating the processing time each of main functionalities of a module.

Accuracy of the system is determined by the accuracy of the StanfordCoreNLP java language analysis library used for sentiment analysis. Since StanfordCoreNLP uses Twitter words to create corpus and it's more generic and due to limited time constraint this has been used for the implementation of sentiment analysis. Generally, accuracy of sentiment analysis researches do not exceed 80% since humans have different judgments and vulnerable to make mistakes and errors. The developed system has the accuracy of 72.56% which is fairly a good percentage for an initial research.

In conclusion, this research will set foundation for incorporating opinion mining and sentiment analysis in higher education institution evaluation and further improvements in the context area can be made to fine-tune as a commercial product.

9. FUTURE WORK

Due to the limited duration, it had to be designed considering only a limited number of main features. During the evaluation process, some enhancements were identified.

- Add more data gathering sources like Foursquare and Google plus.
- Implement the recommendation system.
- Implementing the results sharing and saving functions.
- Increase the accuracy of the review classification module.

10. ACKNOWLEDGEMENT

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Movie Success Prediction Using Sentiment Analysis of Movie Related Tweets

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ABSTRACT 3-6

Social Media Networks play a major role in fostering communication across geographical boundaries and have been able to capture the general public in an emotional level by providing the facility of openly sharing user opinions. Businesses have taken this concept as an advantage to grab the consumer insights and turned it into an opportunity to improve themselves. So has the movie industry of Hollywood and Bollywood. While Digital Marketing has become the easiest and the most cost-effective way of positioning the product in the targeted segment, businesses are now using Social Media Networks like Twitter as a valuable source to collect real insights from the aggregated sentiment of the movie watching community. This brings up a requirement to validate these insights that are analyzed from the twitter platform. In addition, a platform like twitter provides geographical as well as time information that can be utilized by Directors/Producers and even Actors to understand how their popularity is spread over time and region. This research will target the improvement of current sentiment analysis practices by going in depth to capture the real insight of social media posts through novel preprocessing approaches and sentiment classifications. The information collected can thereby be used by the directors/producers to perform and plan better in their future movies.

Keywords

Movie Tweets, Preprocessing, Sentiment Analysis, Classifiers

1. INTRODUCTION

The advancements of internet have resulted in major improvements in the movie industry; one of which is grabbing viewers' insights, which is not a dream

anymore. However, it is not practical and at the same time a daunting task to grab each viewer's insight, specially, if the movie is showcased in more than one country. One might argue that Social Media Networks like Twitter help out by providing viewer insight in the form of text, but that it is still impossible to get a quantitative measurement of the extent the movie succeeds. But tweet texts include opinions that direct into multiple dimensions, which makes it more complex to analyze. The notable fact here is that such viewer opinions, if effectively extracted, could be used by the directors and producers in making future decisions.

Such decisions made might bring positive or even negative impacts to a movie, which would result in deviations of the profits made by the producer. It is believed, that the application that is proposed will not only output a measurement that gives an overall rate of the movie, but will also reflect the effectiveness of its components like actors/actresses, director etc.

Considering a viewer's opinion, they not only rate the overall quality of the movie but go to the extent of rating the actors/actresses, locations etc. The producers who are actually planning to invest in upcoming movies will have a high concern on the directors, the actors/actresses since the success factor depends on these individuals. In addition, this research benefits movie production companies, who make use of traditional techniques like market research to capture the viewers' insights; which consumes time and money. Other than that, movie production companies will ask for the comments from the viewers near cinemas. These comments are not real always, since they are afraid of expressing negative comments in public. In contrast, the final outcome of this research being an application, captures the real insights that are published by the viewers.

Therefore, this research study aimed to provide an analysis on twitter data based on movie reviews. The aim of the research study was to develop classifiers that provide information regarding the hype a movie creates globally across time using Twitter user opinions. The aim was achieved through two main objectives i.e.; 1) retrieve tweets relevant to a specific movie and extract features of interest and 2) develop a method to classify polarity of a given movie at the aspect/feature level.

2. LITERATURE REVIEW

2.1 Twitter Extraction, Preprocessing and Named Entity Recognition

In pre-processing, there are multiple steps that can be taken in producing the final output. According to the research done by I.Hemalatha *et al.* [1], in preprocessing of tweets for sentiment analysis; all incomplete, noisy and inconsistent data should be processed. The initial task as mentioned is the removal of URL's. No URL should make any contribution to the Sentiment of the text. For example, the URL <http://www.happycoding.com/> might generate a positive sentiment even if it is used in a negative context. Further, the research mentions a filtering process that replaces a sequence of repeated characters found within a word to ensure that the word would be identified by Sentiment calculation phase. For example, the word "cooooooooool" might have been used to show intensity but may not be identified as a correct word. Another processing done was the removal of question words like "what" "why" "where" which do not contribute to the polarity of a tweet. The final form of preprocessing stated, is the removal of retweets. Retweets is in essence an exact copy of another tweet. In using a machine learning algorithm for sentiment calculation, feeding in retweets would result in a phenomenon called "over fitting" which would render the model inaccurate. K. Vithiya *et al.* [1] also discusses the importance of removing duplicate tweets or the "retweets" so as to avoid confusion and also to improve efficiency. Hence the accurate removal of such duplicate retweets is focused on in the implementation phase.

According to the research done by Apoorv Agarwal *et al.* [2] two new resources for twitter preprocessing were highlighted. An emoticon dictionary and an acronym dictionary. The main concept behind the emoticon dictionary is to map the most popular emoticons to its polarity. *Table 1: Emoticon and Acronym mapping dictionary*, shows the mapping that was used. During the preprocessing phase, the emoticons are replaced by the corresponding polarity. The Acronym Dictionary is also a similar approach that maps acronyms into their expanded words. This is quite essential since tweets do not guarantee complete words due to the limit of a tweetable text.

Table 1. Emoticon and Acronym mapping dictionary

Emoticon	Polarity
:-) :) :o) :] :3 :c)	Positive
:D C:	Extremely-Positive
:- (: (:c :[Negative
D8 D; D= DX v.v	Extremely-Negative
:	Neutral

Acronym	English expansion
gr8, gr8t	great
lol	laughing out loud
rotf	rolling on the floor
bff	best friend forever

According to the research done by Hao Wang *et al.* [4] the advantage of tokenizing the tweets to separate the word elements is clearly mentioned. Accordingly, it makes it easier and more efficient to identify emoticons, emojis, retweets, URL's, @ symbols used for user mentions, hashtags and repetitions. K. Vithiya *et al.* [1] also mentions the concept of lemmatization. This concept along with the concept of stemming are important word form normalization techniques used in Natural Language Processing. Lemmatization is the process of reducing an inflected word to its base form.

A new area of research in the domain of twitter preprocessing is included in the research done by Petra Kralj Novak *et al.* [5]. This research concerns with the sentiment that is given to emoji's. In this they provide the first emoji sentiment lexicon in which they provide sentiments for 751 most frequently used emojis. These sentiments were based on the sentiment of the tweets in which they are found.

Another area of study for the analysis of movie tweets and reviews is the concept of "Named Entity Recognition" (NER). Considering a movie tweet, the requirement is to understand what this tweet is referring to in the movies so that it would be possible to attribute the sentiment of a tweet to a relevant attribute of the movie. M. A. Shah *et al.* [6] provides an in depth introduction to the statistical component of NER within the context of NLP. According to the paper, NER is used to examine text; in our context - the tweets, and to identify whether they are named entities like persons, locations or organizations. Statistical models such as Maximum Entropy Model (MEM) and Hidden Markov Model (HMM) are stated as two of the most commonly used models. Current implementations of NER are provided by NLTK and Stanford which are able to identify "person", "location" and "organization" entities.

2.2 Feature Identification and Sentiment Analysis

The research area of this feature extraction and sentiment analysis module resided on identifying the feature set that delivers the best results in different sentiment analysis algorithms. The idea in a nutshell was to measure the information gain that can be

obtained through possible statistical and morphological features. The effective feature set was then to be fed into different algorithms and the respective accuracy levels compared.

Different statistical approaches that can be used to extract features of a given text were examined. Prior to executing the machine learning algorithms, it was necessary to extract features/clues that gives a better classification. Once the desired properties were captured of a given text, they were represented numerically which was the basement of performing sentiment analysis. The human intuition and the knowledge is the typical way of capturing the best feature set and will be represented in the form of; $\vec{F} = (f_1, f_2 \dots f_n)$ where f represents a feature. [7]

One such way of identifying features statistically is the ‘bag-of-words’ model. It is the approach that consider each word of the text as a feature and assumes that the occurrence of a word doesn’t depend on the occurrence of the previous word; which is the unigram model. The labeled dataset will be trained in such a way that it considers that each word of the positive and negative corpus as a feature. The feature vector will be derived including the presence and the absence of each word.

The bag-of-words model further describes another way of extracting the features of a given text which is computing the frequency of a word appearing.

The bag-of-words model further describes another way of extracting the features of a given text which is computing the frequency of a word appearing. [7] However, previous papers suggest that it is not an effective method to extract features, if the content is in the form of sentences. The reason is that it is unlikely that the same word will appear in multiple sentences, given that the training dataset is considered of a descriptive text and the sentiment is calculated sentence-wise. It further explains that the unigram model and the term frequency model both deliver more or less the same results due to the aforementioned reason.

A research conducted for sentiment classifications for movie reviews by Kavi Goel and Anthony Hui [8] suggest that the bag-of-words model concept delivers the highest accuracy among other feature extraction techniques. However, it explains that the bag-of-words model will not be effective when the dataset is comprised of unbiased opinions (not necessarily neutral opinions). For example, suppose that there’s a user comment appears like; “Acting of Shahrukh Khan is good but of Alia Bhatt’s is bad”. The bag-of-words model will extract the words of the dataset as features which is linguistically and intuitively not the correct way of identifying the features. Therefore, the paper emphasizes the importance of paying attention to morphological features coupled with Part-of-speech (POS) tagger. Such that, they have used 3 techniques as follows.

Appearing movie title in a given review. It is stated that a review which contains the title of the movie is highly likely contributing to the overall sentiment of itself than a review which doesn’t contain the movie title. However, in analysis of movie review tweets, this doesn’t affect at all since the tweets are extracted by the hashtag of the movie title. The use of suggestive adjectives. It is stated that the adjectives matter heavily in computing the sentiment of the review. Even though the feature is captured morphologically, this feature will be represented in a statistical form. That is the machine learning algorithm will be trained in such a way that it uses the frequency of a given adjective is appearing in both positive and negative corpus.

The use of contrasting words such as but, nevertheless, despite etc. The paper suggests that the presence of these words is a good indicator for the final sentiment of the word. That is because if the contrasting word combines opinions in 2 different subjects, the final sentiment of the overall review will not be affected as such. For instance, “Acting of Shahrukh Khan is good but of Alia Bhatt’s is bad” talks about the performance of 2 different people. Suppose a review saying, “Acting of Shahrukh Khan is good but his costumes are bad”. This itself talks about the same person therefore, the contrasting word “but” contributing heavily to the final sentiment.

A research by Anastasia Giachanou and Fabio Crestani [9] elaborates the concept of dependency trees which is another way of feature extraction. It tells that the words and linguistic units are interconnected in such a way that the verb of a sentence is the term that builds these connections with other linguistics of the sentence.

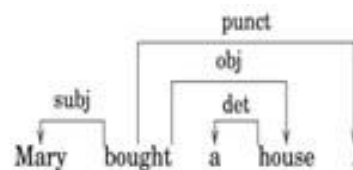


Figure 1. Sentence Classification

Figure 1: Sentence Classification shows how the sentence being classified according to the linguistics. For instance, the verb can build a Tree Relationship as above with the subject, object, and punctuation mark of the sentence. Sentiment Analysis on the other hand will be performed using different kinds of machine learning algorithms such as Naïve Bayes Classifier, Maximum Entropy and Support Vector Machine etc of which Naive Bayes Classifier is the benchmark. Several related work suggest that the Naive Bayes Classifier is capable of delivering accurate results with compared to other learning algorithms [10]. This classifier is coupled with the previously mentioned bag-of words model, such that it requires the term frequency as the feature. The advantage of this classifier is that it doesn’t require a large corpus to

generate dimensions that are required for classification.

Maximum Entropy (or MaxEnt) is unlike Naïve Bayes and it doesn't make no assumptions about the interrelationships between features [11]. It allows adding features such as bigram model so that it outperforms Naïve Bayes when there's no conditional independence assumptions. MaxEnt can be written in the following probabilistic form.

In addition to Naïve Bayes and MaxEnt, Support Vector Machine (SVM) is another method that can be used to train the model [11]. This can be used to derive the hyper-plane in such a way that it decides the training dataset into 2 classes as positive and negative. The only challenge of SVM is that it cannot be used to classify multiple classes. However, applying SVM again and again will solve this problem. The hyper-plane is represented by vector \vec{w} and it is the straight line that gives the highest margin for the support vectors of the 2 classes.

This technique is called 'classification' since it uses the features of labeled data to predict the sentiment of the unlabeled data. Other than classification, another widely used technique is 'clustering' which uses unlabeled data. Clustering techniques like Self Organizing Maps (SOM) will organize the data by itself based on the statistical properties of the dataset. Accordingly, dataset will be grouped/clustered based on the similarities. This is unsupervised learning technique since it doesn't require labeled data.

For a project like movie sentiment analysis, classification techniques will deliver accurate results because the process of determining statistical properties is difficult when it comes to non-numerical data. Also, movie reviews must be analyzed accurately as much as possible, since it will be useful for the directors, producers and actors to make their final decision. A research conducted by Hanzhe Li [12] suggests that by incorporating Python Pickle it will increase the efficiency of the code by saving the time taken for deployment of the module. Pickle will convert the object into a character stream that will contain all useful information in order to rebuild the project in another Python script.

3. SYSTEM ANALYSIS & DESIGN

3.1 Data Extraction, Preprocessing & Named Entity Recognition

Within this module, there are 3 main sub modules; Twitter data extraction, basic preprocessing and named entity recognition which generates the output data. The modules are graphically represented in the following figure.

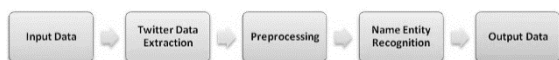


Figure 2. Data Processing Diagram

The input to the data extraction part is from the twitter streaming API. The related tweets come in at a high velocity and are persisted in mongodb as entries. Such tweets are collected for a specific period of time for each movie that was select. For example, the tweets for the movie "Dear Zindagi" were collected 3 weeks prior to the release of the movie and the collection was continued 2 weeks after the movie was released. This was so that an idea can be taken of the hype of the movie started and propagated before and after the release of the movie. The tweets collected were based on the hashtags that were used. From a simple research done for each movie which could identify the key hashtag that is internationally used for tweets related to that movie.

In the preprocessing stage, each tweet is taken and the related fields are extracted. The text itself is preprocessed so as to convert it into a form that would result in an accurate sentiment prediction. Firstly, the duplicate tweets are removed and then the sentences are tokenized. Tokenization is done to make it easier to preprocess the tweet. URLs, mentions and the other usual tasks are done during this phase. Additionally, an emoji and emoticon map will be used to map the symbols to meaningful words. Stop words and punctuation which also have no effect to the sentiment are removed during this stage as well. Lemmatization is done on each word to convert them into its base form. This would ensure that different form of the same word have the same impact on the final sentiment that is calculated for each tweet. From here, two forms of data sets are generated.

One dataset would include the date, tweet, preprocessed text, favorite count, retweet count and location tag. The other dataset would be simply a list of tweets having been preprocessed. No filtering will be done to select the tweets that have an attached location object. The goal of this dataset is to be used to train and test sentiment predicting models. The output of this stage are csv files including the relevant data.

3.2 Feature Identification and Sentiment Analysis

Despite of the feature extraction mechanism and machine learning algorithms that will be used, each classifier should be developed based on the following figure for twitter feeds. The analysis will be conducted for 2 classes (positive/negative) and 5 classes (very positive/positive/neutral/negative/very negative). The 2 class classifiers were implemented to filter out the most efficient machine learning algorithm. Filtered algorithms were then used in implementing 5 class classifiers using different feature extraction methods.

The input for the feature extraction sub module will be the preprocessed tweets. Prior discussing the architecture of this module, it should be first understood that the term 'feature' does not indicate an attribute of a movie like actor/actress, director, location. "Feature" is a term that indicates a dimension

which counts when it classifies our training dataset into either positive class or to negative class. If training dataset was represented in an m-dimensional space, each dimension will represent a feature. In the lexicon of neural network, when a dataset is plotted in the Euclidean space, as the number of features increase, the dataset will become sparse and thereby it will less perform. Therefore, the dimensions (features) should be selected in such a way that it gives the best classification results.

As mentioned in the Literature Review, the approaches which can be followed to extract features can be broadly divide into 2 methods; non-numerical and numerical feature extraction. Non- numerical feature extraction methods include KEA (Key phrase Extraction Algorithm). Numerical feature extraction methods include unigram model (frequency distribution), bigram model, tf-idf and first occurrence. This categorization was conducted in order to explain the approaches and the experiments that were followed. It is important to experiment the possible combination of feature extraction methods and machine learning algorithms as much as possible; since it can be then recommended the classifier which delivers the most accurate results.

KEA requires each tweet/review to be in the form of a “.txt” file. Other than that, at least minimum of 3 keywords/key phrases have to be manually defined for each tweet/review as a “. key” file. The generation of “. Key” files can be conducted by running a simple python script, given that each tweet/review is in the JSON format. The aforementioned keywords/key phrases should also be included in the JSON. A classifier is usually trained with a larger set of data, and it was found that reading each tweet/review and defining keywords/key phrases for them will be daunting task. One way of overcoming this problem is to use same set of keywords for many tweets/reviews, however it will not deliver accurate results.

In numerical feature extraction methods, Unigram model suggests that each word occurrence is independent of all other words occurrences [13]. This model will be used in such a way that it assumes a fixed probability of occurrence is associated with each word and has no history. On the other hand, Bigram model assumes that the occurrence of a word will only depend on the occurrence of the previous word, which is also known as Markov assumption. The model incorporates the conditional probability of the preceding word. The following assumption is made when predicting the conditional probability of the next word.

TF-IDF compares the frequency of appearing a phrase in a given text with the frequency of appearing that phrase in a given corpus. Given that the input for this module are stemmed, it is quite obvious that the popularity of a given phrase is likely to increase. However, this technique suggests that rarer the phrase, it is highly likely to be captured as a key phrase

because, that particular key phrase itself is contributing to overall sentiment than of the other common phrases.

The next step of this module is to calculate the sentiment analysis by identified features. For that it should first develop the feature matrix for training dataset and train the model using different machine learning algorithms. As the benchmarking algorithm, it is decided to use Naive Bayes Classifier to calculate the sentiment and eventually other algorithms; MaxEnt and SVM.

4. SYSTEM IMPLEMENTATION

4.1 Tweet Extraction with Tweepy and Pymongo

Twitter exposes two types of API's. Namely the Streaming API and the REST API. The Streaming API was used since it gives low latency to twitter's public twitter stream whereas the REST API only provides access to singular searches or user profiles. Tweepy is the widely used python library used to access the Twitter API. To access tweets via the Twitter API, the main requirement is to create and register a “Twitter Application” at [14]. Once the twitter app was registered, the consumer key, consumer secret, access token, access token secret was generated and used to authenticate the API calls.

Having obtained the authentication for read and write operations using the API, the next step included streaming the data and persisting them in a mongoDB instance. Since the twitter data being collected coincides with the 3 principles of Bigdata – Velocity, Variety and Volume, an appropriate database – MongoDB was used. The persisting of data was implemented using the widely-used python library called pymongo. Pymongo library would establish a connection to the mongoDB server and support real time data persisting. Since the Streaming API requires a standing HTTP connection to the Streaming endpoint the requirement of using a dedicated server arose. For this an Amazon Web Services (AWS) instance was used. Having set up the environment in the remote server in AWS, tweets were collected for a predefined time frame and predefined keywords. Having collected a certain number of tweets, the mongoDB document was exported into a JSON file to make it easy to be transferred to our local systems. JSON file format makes it easy to be pre-processed using python as well.

4.2 Preprocessing of Tweets

In pre-processing, there are several tasks that have been implemented. The first of which is reading the JSON file and extracting the relevant information by parsing the twitter object. Attributes of a tweet shows the structure of the object that is exported to JSON format from the mongoDB server. The interested elements of this object are the “text”, “date”, “coordinates”, “favorite_count” and “retweet_count”.

In natural language processing, the easiest way to preprocess text is by tokenizing them. The NLTK library was used in tokenizing the tweet. Instead of using the normal Tokenizer class to achieve this, the modified “TweetTokenizer” class was used which takes care of shrinking repeating characters and stripping the tweet of user handles. After the tokenizing process, the following were done on the text: Removal of URL’s, removal of retweets, removal of stop words, replacing of symbols with words, shrink repeating characters, POS tagging, Lemmatization, Map emoticons to words and Map emoji to words

A TweetTokenizer can be implemented so as to reduce the repeating characters as well as to remove the user handles. In addition, NLTK’s “pos_tag” method was used to tag the tweets according to its usage. i.e. if it’s a verb, noun etc. This step was necessary so as to fulfil a requirement for the lemmatization process. Here the adjectives, verbs, nouns and adverbs are identified from the POS tagger and lemmatized accordingly. Stop words and punctuations are removed together in a single process by looking up words from a ‘stopword bag’ and a ‘punctuation bag’ provided by nltk.corpus and by the python string library.

The main contribution done during this phase was the creation of an emoji dictionary to map the emoji’s present in tweets to their corresponding words. This would ensure that the feature extraction part would effectively consider the contribution of emoji. In creating the emoji map, Unicode website [15] was used to map the emoji with the corresponding word. A sample program was then executed with the most frequent emoji’s as the input. Their corresponding python representation of the Unicode was then recorded against the emoji. Once this map was built, the python implementation would take in the Unicode as an input, and output the corresponding mapped words. A similar implementation was created for the emoticon dictionary and an abbreviation dictionary as well. Once the preprocessing of a tweet was completed. The tweets will be written into a csv file making us of the “unicodectsv” library in the appropriate format required.

4.3 Named Entity Recognition

The next major implementation in this module is the Named Entity Recognition (NER). As found from the literature review, Stanford and NLTK both provide library’s for NER. In addition, a library called “Spacy” was used. In using the NLTK Stanford library, the existing model was not used to recognize the entities since “Actor”, “Director” and “Song” entities had to be recognized. Stanford NER was only able to recognize “People”, “Organization” and “Location”. Therefore, attempts were made to train a custom model to use for entity recognition. For this, a corpus with 500 tokens extracted from the tweets of 6 movies were used to train the model with the required entities. This proved unsuccessful due to the small size of the corpus. The spacy NER tagger was also used to create

a custom model. The advantage of this over the Stanford NER is that the custom model could be built on top of the current model by adding new entities to the existing list. This mechanism also proved unsuccessful. The next approach was to create a bag of words implementation that would pick and match the relevant entities.

4.4 Feature Extraction and Sentiment Analysis

Different combinations of feature extraction and machine learning algorithms which were implemented are included in the following table 2.

In order to extract the features from a given text, it is first need to select a dataset that falls into our domain. The selected dataset was published by the Stanford University, which is the largest and the latest movie review dataset which is available on the internet. These reviews are labeled as positive and negative reviews and is available as two separate corpuses.

Table 2. Combinations of feature extraction and machine learning algorithm used

Classifier	Feature Extraction Method	Machine Learning Algorithm Used	2 Class Classifier	5 Class Classifier
1	Freq Distribution	Naïve Bayes		√
2	Freq Distribution	Maximum Entropy	√	
3	Freq Distribution	Naïve Bayes	√	
4	Bigram Model	Naïve Bayes	√	
5	Bigram Model	Naïve Bayes		√
6	TF-IDF Data	Naïve Bayes	√	
7	TF-IDF Data	Naïve Bayes		√
8	TF-IDF Data	SVM		√
9	TF-IDF Data	SVM	√	

In classifier (1), the dataset was first fed into the preprocessing algorithm because prior running through the feature extraction module, basic preprocessing is essential since it increases the accuracy of the final sentiment. The preprocessed dataset was computed in the .csv format and splitting of the dataset as training and testing was accomplished through the source code, by randomly shuffling the dataset. 70% from each corpus is considered as the training dataset while remaining 30% was used to predict the accuracy of the classifier.

The FreqDist() method; which is an inbuilt method of NLTK library has been used to calculate the frequency distribution of the words of these reviews. This method outputs the words that has a high frequency distribution value, which are ultimately treated as the features of the training dataset. The same code is manipulated to classify the Stanford dataset into 5 classes. The objective of decomposing the dataset into

5 classes is that to compare the level of accuracy when classifying to 2 classes and 5 classes. Theoretically, 5 classes classification is useful for analytical purposes. However, the level of accuracy might vary, when changing the number of classes.

To train the classifier using Stanford dataset, it was first decided to choose Naïve Bayes Classifier as the benchmark, since most of the literatures suggested that it delivers a greater accuracy over other machine learning algorithms. A classifier object has been created by extracting the features of the training dataset and then again passing these extracted features to Naïve Bayes Classifier. The model calculates the frequency distribution of words, based on the original label.

Python pickle was used to save the feature set and the results set in the hard disk so that it will reduce the time of deployment. The Stanford dataset was entirely used to train and test the classifiers. And the extracted tweets were stored in a separate csv file, in order to predict the sentiment based on the pickled feature set. The twitter datasets were loaded by a python script which incorporated python pickle.

In order to calculate the accuracy of the classifier and for validation, the confusion matrix was generated by calculating 5 values; count of true very positives, true positives, true very negatives, true negatives and true neutrals. The accuracy of the classifier will be calculated by dividing the summation of these values from the size of the test split. When splitting the dataset as training and testing, entire tokenized positive and negative dataset were shuffled to avoid the training set becoming biased. Therefore, the features that are generated in each running instance will differ from one instance to another. Similarly, in order to compare the accuracy levels, classifier (2) was implemented using the same feature extraction method but with a different machine learning algorithm; Maximum Entropy.

In classifier (4) and (5) were implemented using the same feature extraction mechanism for both 2 classes and 5 classes to compare the level of accuracy. The remaining classifiers; (6), (7), and (8) were implemented using the same feature extraction mechanism but with different machine learning algorithms; Naïve Bayes Bernoulli, Naïve Bayes and Support Vector Machine. Term frequency and inverse document frequency will be combined together to produce a composite weight for each term in each tweet/review. Naïve Bayes algorithm can be used in 2 different ways. The first one is multinomial model and the second way is multivariate model. The second method will be generating an indicator; either 1 in the presence of a term in a given text or 0 in the absence of the word in the given text. For instance, if it's a 2 classes classifier, the string "positive" will be represented as [1,0] and "negative" as [0,1]. If it is a 5 classes classifier, "very positive", "positive", "neutral", "negative", "very negative" will be represented

as [1,0,0,0,0], [0,1,0,0,0], [0,0,1,0,0], [0,0,0,1,0] and [0,0,0,0,1]. SVM usually deals with numerical dataset. Since tf-idf mechanism deals with numerical values to compute the sentiment, the features were extracted using tf-idf and was then fed into the classifier. With that, the above issue of SVM dealing with non-numerical data was solved.

6. DATA ANALYSIS & RESULTS

5.1 Preprocessing of Tweets

This module provides the input for feature extraction and sentiment analysis module. The result of the classifiers may vary with respect to the changes take place in preprocessing. Therefore, couple of experiments were conducted in preprocessing to observe the variation of accuracy of the sentiment. Preprocessing module mainly includes lemmatization of words, emoji mapping and eliminating duplicates. However, since retweets, duplicates of tweets and reviews are out of the scope of the analysis, evaluating the variation of the accuracy with retweets and without retweets has no point. Therefore, the variation of accuracy was evaluated with and without the entire preprocessing module and with and without emoji mapping.

For the first experiment, the classifier chosen was Naïve Bayes since it provides the highest accuracy as suggested in literatures and features were extracted from Tf-idf data. The Stanford dataset was chosen to train and test the classifier. The size of the dataset is 30000 reviews; 15000 positive reviews and 15000 negative reviews. 70% of the data was used to train the classifier and remaining 30% reviews were used to test the classifier. Here, tweets extracted were not used since the level of lemmatization is not effective since a tweet is only comprised of maximum 140 characters which would result in inaccurate impact on accuracy. Here 87% of accuracy obtained with preprocessing and 63% accuracy obtained without preprocessing.

For the next experiment, same Naïve Bayes algorithm was chosen since it is kept as the benchmark. Features were extracted using unigram model. In general, a large set of data is used to train a classifier. However, since annotating a dataset manually is a daunting task, Stanford dataset was used to train the model. 100 tweets extracted from Assassins Creed movie were used to train the model.

The model was trained with lemmatization for 30000 reviews; equally comprised of 15000 positive reviews and negative reviews. The accuracy was predicted for 100 Assassins Creed tweets, which were manually annotated. These tweets were preprocessed with and without emoji mapping to check the accuracy. Here 36% of accuracy obtained with emoji mapping and 31% accuracy obtained without emoji mapping. For instance, a laughing emoji will be converted to a text as 'laugh' and an angry emoji will be converted into a text as 'angry'. The semantic meaning of these texts

will ultimately result in the final sentiment of the test data.

5.2 Feature Extraction and Sentiment Analysis

2 classes classifiers were initially implemented in order to filter out the most efficient machine learning algorithms. Accordingly, when it comes to 5 classes classifiers, MaxEnt algorithm is eliminated since the efficiency of the classifiers is very low in case of 2 classes classifiers. The reason is that MaxEnt requires to calculate entropy; first, for each class and secondly for each feature. Therefore, Naïve Bayes and SVM were filtered out to come up with the most effective 5 classes classifier.

Classifier (1): FreqDist – Naïve Bayes – 5 Classes

This classifier was implemented for 5 classes. The Stanford dataset is originally classified into 2 classes; positive and negative. 625 reviews from positive corpus and negative corpus were extracted. Those 625 positive reviews were further annotated manually as positive, very positive and neutral. Same operation was followed for the negative 625 reviews and classified them into negative, very negative and neutral. Ultimately, the total dataset was generated in such a way that it contained 250 reviews for each class. Stanford dataset is originally comprised of 50,000 reviews in total. Since classifying 50,000 reviews into 5 classes is a daunting task, the dataset was limited to 1250 reviews. By extracting 70% of the data from each class, the classifier was trained. By testing the classifier from remaining data, the accuracy obtained was 26.75%.

Classifier (2): FreqDist – MaxEnt – 2 Classes

In this classifier, it is observed that the time taken to complete the code is higher when compared to other classifiers. The training dataset is comprised of 30,000 reviews; equally comprised of positive and negative reviews. The level of accuracy obtained is 59.7%. The code should be typically checked for at least more iterations until the accuracy doesn't change, but the Windows operating system doesn't foster the deployment. However, this problem can be overcome by trying a light operating system like Ubuntu.

Classifier (3): FreqDist – Naïve Bayes – 2 Classes

This classifier was trained using 70% of 50,000 reviews; equally comprised of positive and negative reviews. Here the item count can be changed and it is observed that when the number of word items is increased, the accuracy will also increase. Accordingly, when number of items is set for 1500, the accuracy level reached 55%. For 2000 word items, the accuracy level reached up to 61.22%. The time taken to run the code is proportional to the number of word items that are considered.

Classifier (4): Bigram – Naïve Bayes – 2 Classes

In most literatures, it suggests that by increasing the size of the dataset, up to the memorization point, the accuracy of the neural network can be harnessed. Therefore, the dataset as in Classifier (2) is entirely used for training. This data was included in form of a .txt file and 70% of both positive and negative data were used to train the classifier. This classifier was coded in such a way that it iterates the process by changing number of features used for classification. It was observed that the accuracy is gradually decreasing when the number of features used is reduced. The following figure 3 accuracy levels were obtained.

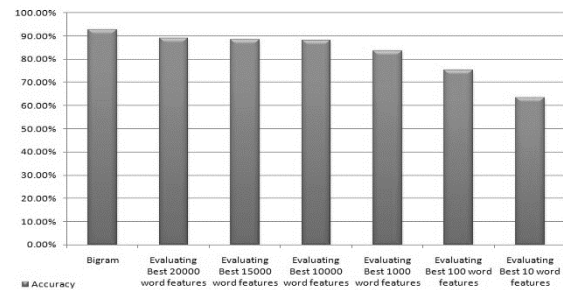


Figure 3. Accuracy levels obtained for sentiment analysis

Even though the classification was conducted for 2 classes, the accuracy has improved with compared to classifier (1). The reason could be due to the large set of data is trained for low (2) number of classes.

Classifier (5): Bigram – Naïve Bayes – 5 Classes

The classifier was trained using the dataset as in classifier (1). The Bigram Measurements are calculated using the Chi-square test method. By changing the total set of words that is considered, the accuracy will change. By changing the total words that is considered as 400, will deliver the highest accuracy: 31.57%.

Classifier (6): TF-DF – Naïve Bayes

This classifier used tf-idf data and the whole dataset is used to train the model and was input as a comma delimited file. The accuracy obtained was 88%. In this classifier "TfidfTransformer()" is used to calculate the tf-idf data. This method has a binary attribute "use_idf". If this attribute was given "True", both term frequency and the inverse document frequency will be used. If the attribute value was given "False", only the term frequency will be used and the results obtained will be similar to the unigram model with 2 classes. However, by introducing a percentile of data, again the dataset can be limited and the accuracy will become high. Having said that, when taking a percentile of 30, an accuracy of 57.46% was obtained. This experiment was conducted using collected tweets which were manually annotated by us.

Classifier (7): TF-IDF – Naïve Bayes – 5 Classes

The same dataset as in the classifier 1 was used to this classifier. In order to reduce the biasness of the training set, 5 comma separated files were generated for 5

classes. And the code was implemented in such a way that it extracts 70% of data from each comma separated file and then compose the training set. The level of accuracy obtained was 11.89%. In this classifier, “TfidfVectorizer()” was used instead of “TfidfTransformer()” and “CountVectorizer()”. “TfidfVectorizer()” has 2 major attributes; “use_idf” and “max_features”. “use_idf” is a Boolean attribute which by setting as “False” will only consider term frequencies, while if it is set as “True” will consider both term frequencies and inverse document frequencies. On the other hand, “max_features” allows changing the features considered to calculate the sentiment.

The above accuracy was obtained setting use_idf = False and max_features = 500. It was observed that by setting use_idf = True and gradually increasing the maximum features incorporated, the accuracy is also increasing. The highest accuracy obtained is 13.57% for the values use_idf = True and max_features = 1000.

Introducing the same percentile technique as in classifier (6), by considering 1/30 of the dataset the highest accuracy is obtained; 44.02%. That is 20.45% than in the method which doesn’t consider percentiles. Therefore, with compared to all 5 classes classifiers, the highest accuracy was resulted in this classifier, with the percentile technique.

Classifier (8): TF-IDF – SVM – 5 Classes

The dataset used for this classifier is as in classifier (1). Similar to classifier (7), the attributes use_idf and max_features were changed and the maximum accuracy obtained was 11.68% while use_idf = True and max_features = 1700.

Classifier (9): TF- IDF – SVM – 2 Classes

The dataset used for this classifier is as in classifier (2). Similar to classifier (7), again attributes use_idf and max_features were changed and the maximum accuracy obtained was 86.76% while use_idf = True and max_features = 2000.

The results obtained from all 8 classifiers can be tabulated as follows. Classifiers developed for 2 and 5 classes can be plotted in the following figure.

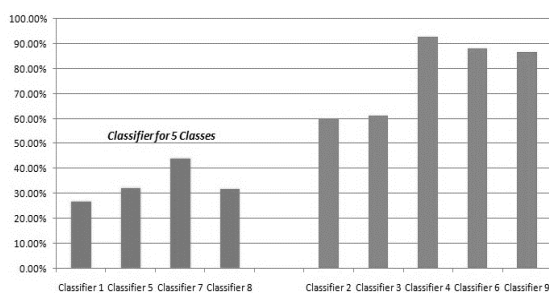


Figure 4. Results obtained for different classifiers

6. CONCLUSIONS

This research study was aiming of developing a system to predict the success of a movie using the tweets and analyzing them using sentiment analysis. Here the research has conducted in two main modules first is considering the feature extraction and sentiment analysis module, from the results obtained, it was able to observe that the accuracy levels drastically drop when the number of classes increases. In addition, the classifiers which were trained using large number of data have delivered higher accuracies. In order to overcome this problem, couple of options can be suggested. If the users of this application require analytical data in detail, it is always better to train these modules into more classes as much as possible. However, in that case, users must ensure that the module is trained using large number of data. If the users need an analysis in detail and are lacking from a large set of data to train the module, it is better to limit the analysis for 3 classes; positive, negative and neutral.

By conducting a pilot test; for example, we can annotate the entire dataset into 3 classes; positive, negative and neutral and train the module in 2 instances. In the 1st instance, the whole dataset will be fed into the module and checked for the level of accuracy. In the 2nd instance, half of the dataset is input to the module and then the accuracy can be recorded. From the result of each instance, users will be able to decide the most appropriate method for their analysis. Considering the analysis of the movie sentiments, there might be several internal and external factors that affect this overall sentiment. Within our scope we have only identified the entities that the tweet is related to thereby attributing the sentiment to a specific feature. But further research could lead to more advanced analysis of the text to identify why in fact the sentiment of a movie is high or low. For example, identifying that the sentiment is very positive for the actor could be enhanced to a level to identify why the sentiment is very positive to the actor.

In addition, the key behind Natural Language Processing is the quality of the data that is being used to train the multiple models in use. i.e. for sentiment prediction as well as named entity recognition. There is always room for improvement in extracting and preprocessing to increase the quality of the data being used. Having done this comprehensive project based on twitter does not by any means convey the message that these are two main platforms for users to express their opinion. There are several other forms in which user opinions about movies that can be obtained. Looking into such forms and analyzing the accuracy and veracity of the data is another way in which this research could be extended.

As future work, tweets can be collected for well-known movies like Assassins Creed, The Pirates of the Caribbean, X-men etc. along with the geographical location of which the tweet has originated, preprocess them, and feed them into the most accurate sentiment

analysis module. Then it can be visualized in a Spatio-temporal visualization, so that the directors/producers will not only be able to know how good or bad the movie was, but also the parts of the world map where a hype has created. In order to have a scattered visualization, it will be effective to collect either Bollywood or Hollywood movies. If local movie tweets are collected, most of the tweets will not be coupled with its location, and as well as the tweet propagation will only be limited within Sri Lanka.

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Offline Recognition of Handwritten English Characters Using Diagonal Feature Extraction

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ABSTRACT 3-7

The field of pattern recognition, handwritten character recognition is one of the complicated and broad research area for the last few decades. Recognition of handwritten character is difficult due to various writing styles of individuals. Handwritten character recognition come under the branch of optical character recognition. In this study we propose the offline handwritten character recognition approach. Compare with the printed character recognition accuracy, high handwritten character recognition accuracy is one of the challenging phenomena. Efficiency of recognition depend on feature extraction methods and classifiers use. In this propose solution we address character recognition base on diagonal feature extraction and k-NN classifier. Recognition system proposed consist with image acquisition, preprocessing, segmentation, feature extraction, classification and recognition. Different techniques used in each phases for obtain high accuracy and recognition level.

Categories and Subject Descriptors

D.5.19 [Intelligent Methodologies for Knowledge Management]: Image Processing– *character recognition, diagonal feature extraction, classification.*

Keywords

Offline Handwriting Text; Optical Character Recognition (OCR); Acquisition; Preprocessing; Segmentation; Feature Extraction; k-nearest neighbor classifier(k-NN)

1. INTRODUCTION

Handwritten characters identification is one of the most demanding and the interesting research area of the field image processing and pattern recognition in recent past years. This helps especially to the development process of the automation and which can improve influence across human and machine in several applications. Number of researches are focusing on new methods and techniques which will decrease the amount of time for processing while

making higher identification precision of handwritten characters [1].

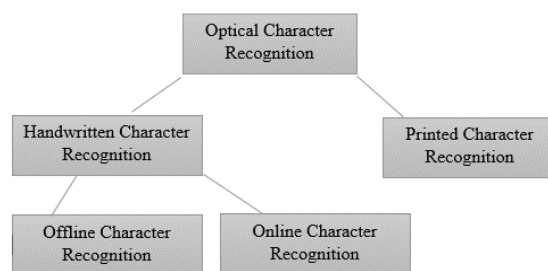


Figure 1. Classification of Optical Character Recognition

Handwritten text document segment into single character or digit is basic step in the document analysis, character identification and many other fields. On basis of text type OCR(Optical Character Recognition) can be consider as two types, HCR (Handwritten Character Recognition) recognition of intelligible handwritten input, origin like PCR (Printed Character Recognition) and paper documents recognition of printed documents [2]. Main reason for high identification complexity in HCR is due to the changing writing patterns of different peoples. In usually, handwriting has categorized into two main types as off-line and on-line handwriting identification. In off-line identification approach, the writing is normally captured using a scanner. This writing can accessible as an image. But, in on-line system the two dimensional coordinates of successive tips are show as a function of time. Also order of strokes made by the writer are also obtainable [3].

The neural networks have been successfully used in the off-line systems that used to provide corresponding high identification accuracy levels. Various applications types including the bank processing, mail categorizing, the document reading and address use in postal identification use off-line handwriting identification mechanism. The off-line handwriting identification to be an active area in research field continue latest techniques that would increase

identification reliability. The offline character identification method before process the document it has generated, digitized, stored in computer. In the online character identification method do while it has under creation. Factors associate with external sources like pressure speed of writing, stroke have significant impact on online method but less influence on offline method [4].

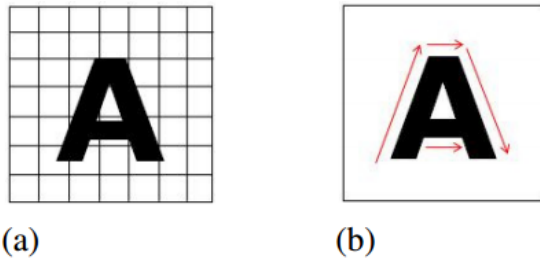


Figure 2. (a). Offline Character Recognition, (b). Online Character Recognition

The initial principal approach in any handwritten character identification mechanism is pre-processing go after the segmentation and feature extraction. The pre-processing integrates steps that needed to formation the input image form acceptable for segmentation [5]. In segmentation stage, input image divided into the separate characters and after that, each character can be resized into $m \times n$ pixels manage to training network.

The Optical Character Recognition (OCR) is an approach which converts the scanned images of handwritten text to the editable text for machine, or pictures of characters into a quality encoding scheme showing them in ASCII or Unicode. The OCR is currently doing by using various optical methods and digital character identification (using scanners and computer algorithms). OCR systems normally require training (the allocation of known sets of each character) to read a particular font. However, this approach is responsive to the size of the fonts and the font type [6].

In our system we have proposed solution for the specially bank forms and applications. In these bank forms or applications can have handwritten characters which are character segmented and well structured. Those forms or applications can contain elements such as text zones, check boxes, and signature fields. The recognition, analysis, correcting and also verification of handwritten input to such elements are key challenging problems that can be identified. In the propose system we need to reduce noise of bank form and need to identify bank form handwritten text as well as printed text in the form or application. In bank form system should support for filter out the text in printed and handwritten areas.

As the hardware device for offline handwritten text identification normally a scanner was used. By using scanner, a digitized static image has taken to segmentation and features extraction. There are

number of methods can be used to implement system which support for handwritten text extraction and optical character extraction from documents. K nearest neighbor classifier can be considered as one of the simplest supervised learning algorithm which can be used to classify the data. The majority of votes use to classify the data in this method. The value of k decides search space for the data [7], [8], [9].

2. HANDWRITTEN CHARACTER RECOGNITION

This section proposed handwritten character recognition system described in details. In this section mainly focus on feature extraction phase. Generally, character recognition system consists with preprocessing, segmentation, feature extraction, classification and recognition. The stages of proposed system shown in Figure 3.

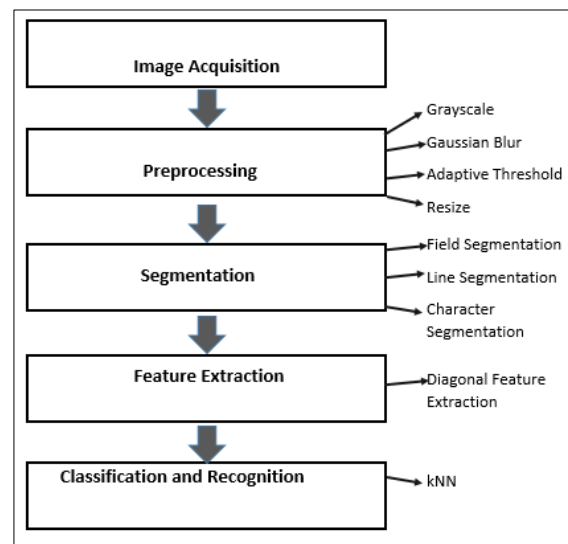


Figure 3. Stages of Proposed Handwriting Character Recognition System

2.1 Image Acquisition

The offline identification system take the input image as scanned image. Digitization in handwritten character identification is the kind of transform a handwritten document into format of a digital one. A scanner or digital camera takes an image of text and changes it to an image files format such as a bitmap, jpeg, png etc. The quality of scanned image is important to recognition of the characters in the document.

2.2 Preprocessing

There are several preprocessing approach can be used to increase the quality of the scanned input image before further procedure. These are the set of actions that can be accomplished in proposed system on the scanned input image to increase the quality of image for effective feature extraction. Main steps under pre-processing are:

1. Grayscale
2. Gaussian Blur
3. Adaptive Thresholding
4. Resize

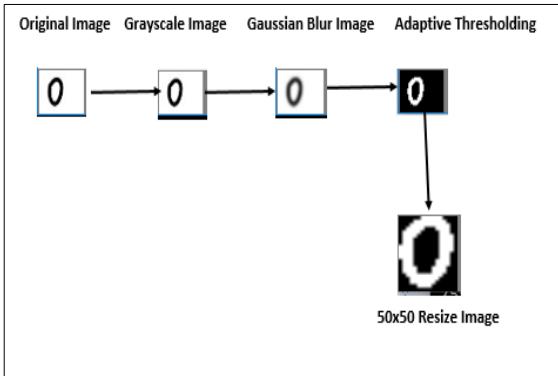


Figure 4. Preprocessing Stages Apply in system

Grayscale method use to convert RGB space to gray scale space. This can be performed adding or removing alpha channel, reverse the channel order, convert to 16-bit RGB color etc. By applying grayscale to color image helps to make preprocess smoothly. Noise initiates in an image at image acquisition. It creates a random differential of image intensity and occasionally will be shown as grains in the image. Noise removal is the action of removing or reducing the noise from the image. There are some existing algorithms and filters for noise reduction and removal. The different types of noises that present in document images are Salt and Pepper noise, Gaussian noise, Gamma noise, Uniform noise etc. Different type of clarifying methods like Gaussian filtering method, Min -max filtering method etc. are applying for noise removal. In this process used Gaussian blur for filtering the image. Gaussian kernel is slid through image to build the smoothed image. We need to carefull when choosing size of the kernel and standard deviation. Binarization is the method of converting gray-scale or color image into binary image with the help of thresholding. The various methods of binarization are Global thresholding, Otsu's method, Local thresholding, Adaptive thresholding etc. In thresholding we are applying if pixel value is greater than threshold value, one value assign (white) otherwise assign another value (black). In this approach we are applying Adaptive thresholding. That is calculating threshold value for small regions of the image. That will provide better result and varying illumination.

Size normalization is the preprocessing step that change size of the character image into a standard size. Skew identification and rectification is also a section of character image preprocessing. In this approach we resize the image into 50x50 image. That helps to extraction of features with standardize size image.

2.3 Segmentation

Segmentation is the step that separates individual character from handwritten character image. Segmentation divided into Implicit and Explicit segmentation. This can be considered as most important step in character recognition. In indirect segmentation, words are forecasted straight without segmenting word as single letters but individual characters are taken form the word in direct segmentation approach. Segmentation can take out using the clustering methods, edge based, threshold based, region based etc. The different stages in segmentation are fields, lines, words and character segmentation.

In line segmentation, horizontal projection profile method is used. Original document with sentences segments in to word chunk first. Then segments it in to individual isolated character. After extracted the characters we are applying the normalization process for make normalize the size of each individual character in the segmented process. There can be large variation of characters and we need to normalize it.

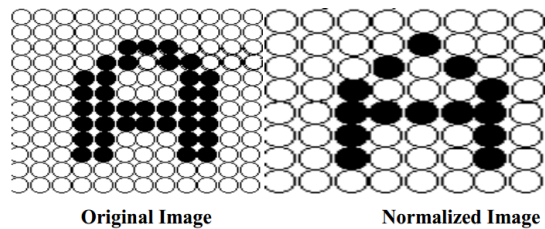


Figure 5. Normalization of the image

2.4 Feature Extraction

This technique is most vital and incontestable one and therefore the characteristics should be extracted accurately, that measures the effectiveness of the classification. Effectiveness of this stage is very much important to recognition the characters. In this propose solution used diagonal feature extraction algorithm to extract the features in offline handwritten character recognition. In proposed solution, given image is resized into 50x50 image before extracting the features. This resize image divided into 25 zones as shown in Figure 5. Features are extracted each pixel by moving diagonally on each zone. Before extracted the features image need to apply preprocess techniques and background need to be black color and foreground pixels need to be white color. Approach calculate the number of foreground pixels' values and sum-up values diagonally. After calculated total diagonal pixels values average need to be get for each zone. We will be able to obtain n features relevant to every zone. The process of steps applied for extract these features shown below.

Step 1: Resize image is divided into n (25) number of zones. Each zone size is 10x10 pixels.

Step 2: Moving along the diagonally white pixels' values are calculated for each zone to extract features.

Step 3: Each zone has 19 diagonals and all together there are 19 diagonals values for each zone. Foreground pixels summed up to get sub feature value.

Step 4: These 19 sub features values are averaged and get single feature value for each zone and add that value as feature value for particular zone.

Step 5: Zones diagonals which do not have foreground pixels, the feature value is consider as zero.

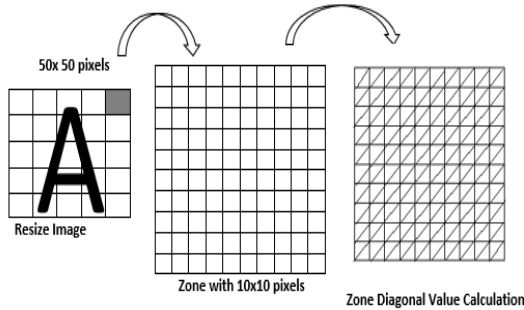


Figure 6. Diagonal Feature Extraction

2.5 Classification and Recognition

Conclusion part of the any identifying system can be considered as the classification. Different processes for classification approach in character recognition systems are analyzed. Most widely seen classifiers are artificial neural network, SVM, back propagation network and k-nearest neighbor classifier. In our solution we have used the k-nearest neighbor classifier method. The input creates up of the examples of closest training in the characteristics space. In the output of k-NN classification is a class membership. A classify an object is used large part vote of an object's neighbor and with the object being allocated to class most usually among k nearest neighbors (k is a positive integer, normally small). This is a type of instance-based learning, or lazy learning, which is the function only equal roughly locally and all computation is put off in until classification. In k-NN approach Euclidean distance from the candidate vector to stored vector calculated [10]. This can be represented as below,

$$d = \sqrt{\sum_{k=1}^N (X_k - Y_k)^2}$$

(1)

N represent total number of features in feature set. Library stored feature value given by X_k and candidate feature value given by Y_k .

K-nearest neighbor classifier can be considered as non-parametric approach use for classification and regression in supervise leering method. Output of this approach depend on whether k-NN is used for regression or classification. This approach object is classified by a greater vote of its neighbors. Also object assign to the class most common among its k

nearest neighbors. If k value is 1 object is simply assign to the class of individual nearest neighbor. In regression approach output consider as property value of object. Value is average value of its k-NN. In our approach we have used k-NN algorithm to extract the feature values from characters. The input variables need to be ordered and output variables can be either categorical or ordered.

2.6 Dataset

The Chars74K dataset used as training data set [11]. Before used for features extraction, images are preprocessed and resize to 50x50 pixels images. In this data set different handwritten styles can be found as natural images. The dataset, symbols used English and Kannada available in the dataset. In English language, Latin script and Hindu-Arabic numerals are included in the dataset. That consist with,

1. 64 classes (0-9, A-Z, a-z)
2. 7705 characters got from natural images
3. 3410 hand drawn characters help of a tablet PC
4. 62992 synthesized characters from computer fonts

The name of dataset denoted by over total images of 74K. In the system we used digit 0 to 9 and uppercase A to Z all together 36 images in each character set. All together used 55 sets of characters of different handwritten users.

3. EXPERIMENTS

Under experimentations we have used mainly three methods to evaluate accuracy rate of handwritten character recognition system.

First method is measure the classification accuracy for output characters. In this method input can be considered as images with ten characters and with that image we use sample ten with different uppercase handwritten character images which are not used in the training phase. Output can be predicted as identification of number of character occurrences in input images. In measurement process we need to check accuracy of each image in sample of ten images giving each image as input to the system. We can measure the accuracy rate by using below equation,

$$\text{Classification Accuracy} = \frac{\text{Number of correct characters occurance in image}}{\text{Total characters occurance in image}}$$

(2)

Applying values to each sample images we can measure the classification accuracy in our experiment.

Second method is measure the accuracy of sample images applying different colors to each image with same text. In this method input can be considered as give different color input image with same character set. Output can be predict accuracy rate of each character set with differ colors. We used 6 images as

sample. In measurement process we need to check rate of accuracy of each color image input and identify the accuracy level related to each color. We can measure the accuracy rate by using below equation,

$$\text{Accuracy Rate} = \frac{\text{Number of correct characters occurrence in image}}{\text{Total characters occurrence in image}} \quad (3)$$

Final approach of experiment based on apply the partitioning strategies for the dataset. In the first strategy we have taken 50% data for training set and other 50% data for testing set (A). Second strategy used 60% of data in training set and 40% data in training set (B). Third strategy used 70% training data set and 30% testing data (C). Final strategy used 90% training data set and 10% testing data set (D). Then applied diagonal feature extraction for each combination and examined the result of each strategy.

4. EXPERIMENTAL RESULTS

Table 1. Classification Accuracy of Output Characters

Expected Result	Classification Accuracy (%)	Actual Result
A	0.9	AAAAAFAAAA
B	0.8	BBDBBBBVBB
H	0.9	HHHHHPHHHH
N	0.9	NNNNNNNNAN
M	0.8	MMHMMMMMYM
T	1.0	TTTTTTTTTTTT
X	0.9	XXXXAXXXXX
K	1.0	KKKKKKKKKK
U	0.8	UUQUUUUUU
I	0.7	ITTTTTIIIT

Accuracy level of the tested ten characters sample have given above table. According to character set used image with “I” having minimum classification accuracy level 0.7. Accuracy level with 0.8 having character “U, M and B”. According to results there are four characters having accuracy level 0.9, “X, N, H, A”. Maximum accuracy level 1.0 can obtain two characters, “K, T”. Thought we expected accuracy 1.0 for all characters’ output given as different accuracy level. The problem depends on training data accuracy, quality of input images, preprocessing techniques apply to the image and feature extraction and segmentation mechanisms used in the system.

According to result we need more focus on training the characters with high accuracy.

In this approach we have measured the accuracy rate using input as different pen colors. We used blue, black, red, purple, light blue as input colors. Then with same text image (7 characters) set with different colors checked the accuracy rate. According to result we have identified best accuracy level given by blue color and second highest accuracy level given by black color. After that accuracy level decreased purple, light blue and red respectively. It is better if we use blue color or black color pen when we fill the form use to feed the system.

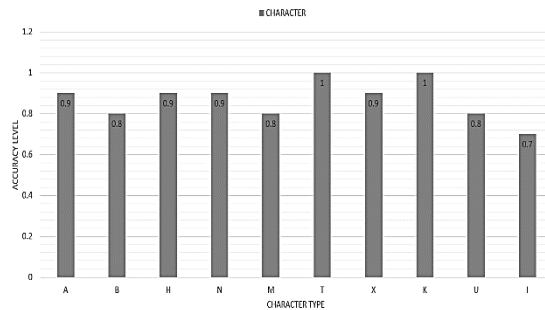


Figure 7. Classification Accuracy for Output Characters

Table 2. Pen-Color Wise Accuracy Level

Color of Image	Accuracy Rate (%)
Blue	87.15
Black	86.57
Red	72.15
Purple	82.37
Light Blue	78.23

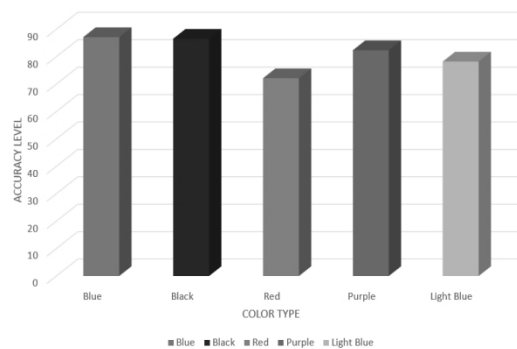


Figure 8. Accuracy Rate for Different Pen Colors

Table 3. Recognition Accuracy for Diagonal Features With k-NN

Strategy	K=1	K=3	K=5	K=7
A	21.5	22.45	23.57	31.4
B	55.4	56.2	62.27	65.45
C	74.5	75.6	78.5	83.4
D	84.8	85	87.5	92.57

This approach we checked the accuracy level for the four partitioning strategies (A, B, C, D). The approach base on diagonal features extracted and classification k-NN we applied for obtain result set. We have achieved 84.8% accuracy for strategy A and 92.57% for the strategy D. Result obtained from experiment represent in the above Figure 9.

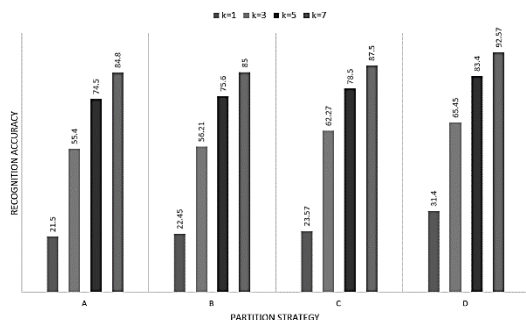


Figure 9. Recognition Accuracy for Diagonal Features with k-NN

5. CONCLUSION

The approach presented in the paper represent the offline handwritten English character recognition system. This paper suggests efficient and high accuracy feature extraction approach which can be performed using diagonal feature extraction method. In classification performed with feature extraction used k nearest neighbor approach to train the data set. There are three experiments done related to this approach. Classification accuracy of output characters, accuracy rate for different pen colors and recognition accuracy for diagonal features with k-NN. There can be different accuracy levels obtain for above experiments. Maximum accuracy level of classification accuracy of output characters can be obtained for the T, K characters. Highest accuracy level for the pen color 87.15% obtained for the blue color. Recognition accuracy level for diagonal feature with k-NN can be obtained for the strategy D with 92.57% for the k value seven. Accuracy level of recognition can be increased through increase the data set size in training phase. It is essential of choose more relevant and efficient feature extraction and classification methods to perform high recognition level. The system we present in this paper would provide promising result to recognize handwritten characters with high accuracy level.

7. ACKNOWLEDGMENTS

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WEB ENGINEERING, INTERNET OF THINGS, AND ECOMMERCE

Z-BIN - IoT Based Smart Garbage Disposal System

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ABSTRACT 4-1

Owing a paradigm shift towards the Internet of things, IoT services have been conducted to wide range of fields. This paper presents an IoT based Smart Garbage bin solution to address the major problem in waste dispense in households. The absence of efficient waste management has caused serious environmental problems and cost issues. Overflowing garbage bins have been another cause of concern for residents in developing countries. With increase in population, the scenario of cleanliness with respect to garbage management is degrading at a pace. The smart garbage bin discussed in this paper allows people to continue a proper garbage dispense efficiently. Another vital benefit of the product is to fulfill customer satisfaction thereby bringing the product more user friendly and affordable at the same time. In the future, the product is to be developed in various ways regarding technology wise as well as design wise. This smart garbage bin may lead to make the household environment cleaner and this smart way of disposing will ease the day to day life of the people.

Keywords

Smart Garbage Bin, passive infrared, Ultrasonic, vacuum inlet, Server motor

1. INTRODUCTION

Waste management is an important issue for smart city, as world cities in 2012 generated about 1.3 billion tons of solid waste per year, which will be projected to increase to 2.2 billion tons by 2050 [1].

Each time we sweep the floor, we must give an extra effort on cleaning the dust particles and food crumbs. Also, due to the lack of understanding about the weight limits of the garbage bags, we must face the issue of spilling the garbage bag.

In this project, we aim at an automatic garbage level detecting system informing the concerned authorities

timely and classification among the wastes aiding efficient waste management. Here we are classifying waste into 3 categories:

- Biodegradable waste
- Recyclable waste
- Plastic waste

Whenever the garbage is full information can be send to the concerned authority to clean the bin.

Many researchers have proposed smart trash bin systems [2]. However, most of the existing smart trash bin proposals have failed to identify the issue that smart trash bins are often power-constrained. It becomes an important issue where trash bin is often placed in an area that electric plugs are not available, or electricity cable installment is considered as impractical.

The purpose of this project is to design, develop and evaluate a smart garbage disposal system and a mobile app to monitor the processes of the bin. This product will target the indoor garbage users to have a proper and effective disposal system. The Z bin primarily consist of two main sensors as passive infrared sensor and the ultra-sonic sensor.

Ultra-sonic sensors measure the depth of the bin and return the bin percentage as an alert. Infrared sensors detect the motions of the user and open the lid when the user wave the hand.

To evaluate our proposed system, we implemented it a smart trash bin system and measured the actual garbage level fluctuation behavior. Based on our experiment results, the feasibility of our proposed system has been confirmed. We also confirmed that our proposed system can reduce the power consumption of smart trash bin up to 81% compared to the smart garbage systems.

2. SMART GARBAGE SYSTEM ARCHITECTURE

Mainly garbage is collected in 3 ways. First method is the Kitchen Waste. Most of the waste are bio degradable which give a bad odor after some time. Secondly is by sweeping and vacuuming. Most of these are dust particles, so these are collected in small quantities. Lastly and mostly trash is collected by package materials. According to records there are 300,000 items in the average American home, on average 10-year-old owns 238 toys most of these came in packaging which end up as garbage. Because of these average people generates 4.3 pounds of waste per day. To collect this waste an average house hold, use about 6 garbage bags per week all these get collected in a trash cans [2].

2.1 Similar products

A Japanese inventor appears to have put an awful lot of effort into enabling laziness. A Modder going by the handle of "FRP" looks to have designed a mobile wastebasket that can ambulate around to catch any falling (preferably with a high arc) trash you toss in its general direction.

FRP replaced the bottom of the can with some wheels attached to something similar to an Arduino board. On the other end of the system is a wall-mounted Kinect that watches for flying debris, calculates the landing spot, and then sends the can to catch the garbage like an outfielder going after some rookie's pop-up [3].

The Clean CAP keeps its users informed in real-time about the bin's fill-level. The Clean CUBE also utilizes sensor technology, but it can even compact trash automatically. In densely populated areas, a rapid and unexpected waste generation often leads to overflowing trash bins and this results in unsightly public spaces.

In order to eliminate such occurrences, Ecube Labs' sensor devices provide users the capability to knowing the fill-level in real time so that they can take data driven actions ahead of time. As an added benefit, the Clean CUBE secures even more room inside the bin through its compaction function, up to 8 times that of traditional bins [4].

2.2 Overall demand for a smart garbage bin

Contrary to what some analysts say, the Internet of Things (IoT) is living up to all the hype as increasing standard of living fuels growing demand for "effortless" devices, systems and equipment. The global IoT services market is projected to grow at a compound annual growth rate of more than 24% during 2016-2021. [5]

Over 50% of the world's population now lives in cities and the figure is set to rise to 75% by 2050. [6] While the world's cities only cover 2% of the global

land area, they account for a staggering 70% of the burden of responsibilities for global population.

To solve this problem, the households have installed IOT based smart garbage bins, enabling the household waste disposal management more efficient.

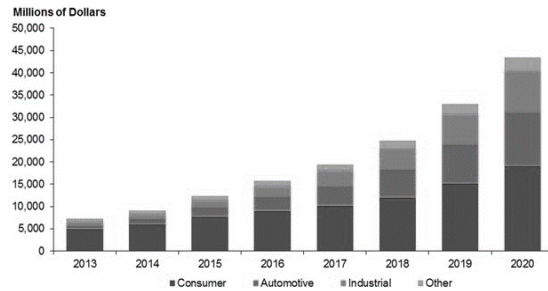


Figure 1. Semiconductor Revenue by Electronic Equipment (Millions of Dollars)

Despite the government's effort to promote recycling and reduce waste generation, including the enactment of supporting laws, recycling rates remained very low at 5% until the late 1990s [7]. Low incentive for households was pointed out as one reason behind the poor participation as waste collection was charged on a fixed rate through property tax or house size, which was criticized for being illogical. Under these circumstances, promotion of the recycling of wastes while minimizing its generation at the source surfaced as a main policy agenda.

2.3 Architecture

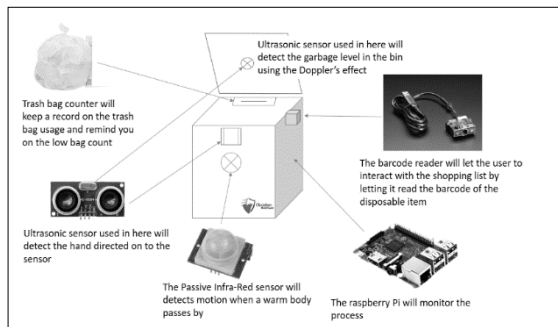


Figure 2. Upper compartment

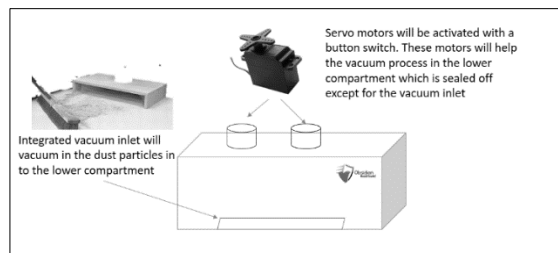


Figure 3. Lower compartment

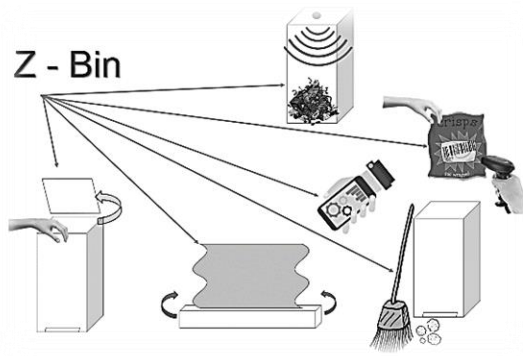


Figure 4. Main features

3. IMPLEMENTATION

3.1 PIR (Passive Infra-Red) Based Motion Detection

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects [8]. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason, they are commonly found in appliances and gadgets used in homes or businesses. Along with the pyroelectric sensor is a bunch of supporting circuitry Micro Power PIR Motion Detector IC(BISS0001) This chip takes the output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor [9].

The IR sensor is more complicated than many of the other sensors because there are multiple variables that affect the sensors input and output. Because of that the pyroelectric sensor itself is housed in a hermetically sealed metal can to improve noise/temperature/humidity immunity. There is a window made of IR-Transmission material (typically coated silicon since that is very easy to come by) that protects the sensing element. Behind the window are the two balanced sensors each slot is made of a special material that is sensitive to IR. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change.

These change pulses are what is detected [10].

3.2 Ultra sonic sensor

The Ultra-Sonic Sensor sensor is a device you can use with any IoT devices to measure how far away an object is. The HCSR04 ultrasonic module has a ranging distance from 2cm to 500cm with a resolution of 0.3cm. It requires a voltage supply of 5V and a

standby current of less than 2mA. The module transmits an ultrasonic signal, receives its echo and measures the time duration between the two events and generates a waveform where the high time peak is modulated by measured time and is proportional to the distance.

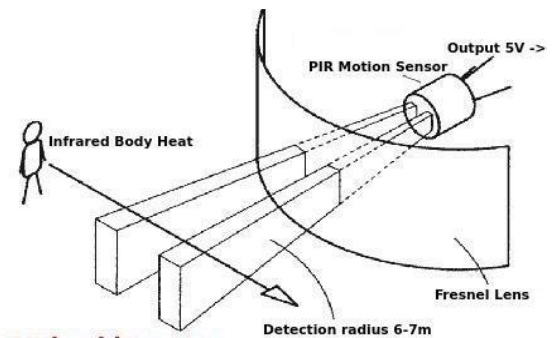


Figure 6. Detection Radius

A Very low frequency sound below Acoustic is defined as "Infrasound", with high frequency sounds above, called "Ultrasound". Ultrasonic sensors are designed to sense object proximity or range using ultrasound reflection, like radar, to calculate the time it takes to reflect ultrasound waves between the sensor and a solid object. The Ultrasonic transmitter which will send a signal out into its surrounding area 40KHZ. The Ultrasonic Receiver will detect this signal once it bounces off from an object/obstacle.

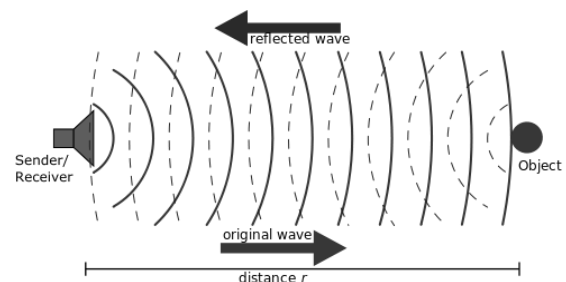


Figure 8. Example About How Ultra Sonic Sensor Work

The ultrasonic sensor works based on the principle of Doppler Effect. It consists of an ultrasonic transmitter and a receiver. The transmitter transmits the signal in one direction and this transmitted signal is then reflected back whenever there is an obstacle and it is received by the receiver. So, the total time taken by the signal to get transmitted and to received back will be used to calculate the distance between the ultrasonic sensor and the obstacle [11].

4. EVALUATION

Subjectivism is not an absolute principal; it is a necessary but not sufficient condition for sound methodology [3]. Project will be more perfect if it has the basic sections that should include in a methodology. It means if we use research, development and management methodologies perfectly, the percentage of being a better project is

high. Every single part of the z-bin is developed using proto-typing methodology. For an example, we have fixed the passive infrared sensor in the Z-bin and checked whether it detects life according to how we want or not. Then we reworked according to the work breakdown structure until we achieve an acceptable final prototype. Then and there we use proto-type methodology because we were familiar with that method and it has a minimum risk percentage that the system will go wrong or give a fatal error.

Good products are made up of by doing many researches, research implies more than simply the methods you intend to use to collect data.

To be a better product, we thought that there should be both qualitative and quantitative wise developed methodology. So, we use mixed method system to develop our project. By doing surveys, questionnaires, interviews and also a comprehensive literature review. Due to the limited time frame, we had to use cross sectional method during halfway through. We were aware about how we use our technologies and also design of the product. So, we did many literature reviews on similar products in the market and what were their capabilities and what were their scope. Then we researched about what kind of business background they had. According to that we got an idea about the target market that we should focus. The literature review goes beyond that because in the first stage of the product we had to get an understanding about the main functionalities. So, every basic step we did were solemnly based on using a good literature review strategy.

To get the work done step by step, we used Prince 2 management methodology. With that technique things went perfectly. How we divide the work load, how we manage the time all according to the prince 2 method. We use that methodology because it always aims the delivery of the product.so to get a final product we follow that method with their roles, principles and phases.

5. CONCLUSION

Cities around the world are facing great challenges due to increasing urbanization and one of the major challenges is the rising amount of generated waste and littering due to high demand for food products and other essentials. In private properties waste bins are not properly control. The waste bins also not a user-friendly product in present.

One of the worst things about trash cans can be the odor. Most of the present trash cans doesn't have lids or proper way to close the can product, mostly people face a huge difficulty when removing the dust and

food crumbs and more importantly people can keep a track of the kitchen stock. So, our project aims to change the regular garbage bin to a smarter level. To reach our aim we used some technologies to fulfil our smart specifications of our product such as Motion Detection, vacuum Cleaner, barcode Scanning and many IOT based services.

This project has given so much of knowledge about many areas. These areas can be mainly divided into three sections, those are in research area, documentation and development. Especially this time has been an asset in improving many skills mainly can have pointed as researching skills, report writing and time management. The prototype of the project covered main base of the project but there are many parts that can add to further improve this application.

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Workplace Sedentary Behavior Prevention System

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ABSTRACT 4-2

With the rate of computer users increasing from 15% to 69% over the past two decades, the number of workers who undergo prolonged sitting during their office work hours is also increasing at an alarming rate. Studies have found that half the world's population spend about 55% to 33.34% of their workday seated down. With the growing body of evidence that prolonged sitting is negatively associated with health, we found this as a health hazard which needs to be addressed. Several researches prove that sedentary behavior could be taken under control and/or prevented by taking frequent breaks. Healthy Office+ is a smart IOT device which is helpful in preventing sedentary behavior and Office Workers Syndrome among office employees, by detecting the user's presence in their workstation and giving them email and SMS notification to their android based smartphone. This paper presents the detailed overview of the prevailing problems and how we came up with Healthy Office+ to overcome these problems.

Keywords

Prolonged Sitting, IOT device, Sedentary Behavior, Office Workers Syndrome, Sitting Pattern

1. INTRODUCTION

Sedentary behavior is the absence of physical activity due to prolonged sitting [1]. The time that is spent in sedentary behavior (i.e. sitting time) adversely effects health. This could lead to cardiovascular diseases, type 2 diabetes, various types of cancers, obesity, organ damage and often lead to Office Workers Syndrome, this is a condition where a group of symptoms

resulting from prolonged sitting and/or improper sitting habits, causing body pain and disrupting the nervous system [2]. Due to the lengthy computer working sessions, this is highly prevalent among office workers. Prolonged sitting not only negatively associates with health but also causes psychological problems such as anger, job un-satisfaction which could lead to job inefficiency [3].

In this work, we have explored technologies for monitoring health. And after comparing the potentials between all these technologies, we believe that an effective and efficient workspace sedentary behavior prevention device could be developed. We propose a system in which the input data is gathered using ultrasonic sensors and a webcam and identify whether the user is being seated or not, with that analyze whether user is undergoing prolonged sitting or not and provides real-time feedback accordingly.

2. SEDENTARY BEHAVIOR

2.1 Office Workers Syndrome

“Office Workers Syndrome” is not an actual medically diagnosed syndrome; it is a group of symptoms commonly found in office workers caused by unhealthy work habits. This syndrome results in musculoskeletal pain, headaches, aching arms, wrists and fingers, numbness of wrists or feet, eye strain, and dry eyes. It may also be due to a chronic underlying illness, such as arthritis or neuritis [2].

2.2 Prolonged Sitting

How prolonged sitting could be harmful to health is pointed out by several studies [4]. Epidemiologic

evidence from the 20th century proves that men whose job involved in sitting for prolonged period have demonstrated health effects such as obesity, metabolic syndrome and diabetes, markers of cardio-vascular disease risk, and premature mortality [6]. Sedentary workers show a twofold increased risk of cardiovascular disease compared to those whose jobs require physical activity, 5% increase in risk of overweight and obesity and 7% increase in risk of type 2 diabetes with each two hours per day increase in sitting time at work [7,8].

The findings from National Health and Nutrition Examination survey conducted in 2003-2004 also reinforces the fact about the deleterious health consequences of sitting time. These new insights into the health risks of sedentary behavior broaden the accepted perspective on physical activity and health by identifying the need to reduce prolonged sitting and increase light-intensity activities (e.g., standing and incidental walking) [1]. Office workers are encouraged to develop good working habits, in order to prevent the health risks due to prolonged sitting. Experts recommend practices such as “micro-breaks” or “dynamic sitting” to help this cause.

2.3 Micro-Breaks

Micro-breaks suggest that workers should frequently move their positions in-between tasks so that prolonged sitting could be avoided. This ensures a healthy level of musculoskeletal system activity and prevents ergonomic injury.

The recommended level of taking micro-breaks are different among various studies, as follows:

- Liebenson [9] mentions that if one gets up every 20-30 minutes, a long micro-break is not necessary. Otherwise, exercises and breaks should be taken every 30 minutes.
- Stanford Environmental Health & Safety [10] suggests that continuous computer use or repetitive lab tasks lasts for 30 minutes' maximum before taking a short break for 2 minutes or performing another task. And for micro- breaks, 30 seconds to 1 minute should be taken every 10 minutes.
- OSHA [11] suggests that employers encourage workers to change their positions frequently. Micro-breaks of 3 to 5 minutes should be taken every 20-30 minutes. And after 2 hours of moderate computer work, there should be a 10- 15 minutes' break.
- Canada's Ministry of Labor [12] mentions that shorter but more-frequent breaks were more effective in reducing discomfort, comparing to working for long periods of time and taking longer breaks. The ministry encourages workers to take frequent breaks of about 5 minutes every hour.

2.4 Why workplace is a key setting to focus on sedentary behavior?

With the advancement in technology, people have become more apt towards the use of computers. In 1970, only 2 in 10 workers were in jobs requiring only light activity (predominantly sitting at a desk). By 2000, more than 4 in 10 adults were in light-activity jobs. In 2003, nearly 6 in 10 used a computer on their job for major part of the day [1]. Between 1989 and 2009, the rate of computers used increased from 15% to 69%. With this we can state that that there is a striking increase in sedentary behavior and reductions in human energy expenditure over the past years. Office-based workers are one of the largest occupational groups who are also highly sedentary. For many full-time employed adults, the bulk of this sedentary time occurs at work, where they typically spend an average of over eight hours of their weekdays. World Health Organization estimates that “Globally it is estimated that 60% of world's population is part of the workforce and spends 60% of their waking hours at work”. Given that workers represent half the world's population; studies have found that working adults spend about one half to one third of their workday sitting down [13]. With increasing use of computers, interest, involvement and greater number of hours spent in front of the computer screens, users need to know about the proper posture and the need to take short breaks, which, if forgotten, ends up in multiple complications.

2.5 Existing Solutions

Intervention is defined as specific services, activities or products developed and implemented to change or improve individuals' risk, attitudes, behavior, and awareness. Identifying reduction of time that people spend sitting while at work will improve health, many workspace interventions have been made over the past years.

2.5.1 Alternate workstations

Through substituting light to moderate physical activity in place of sitting improves insulin sensitivity of tissues, and results in improved metabolism of glucose. It also increases lipoprotein lipase activity that breaks down triglycerides and enhances their uptake into cells. Thus, these interventions are built keeping in mind that these benefits are seen highly when sitting is replaced with a light to moderate physical activity like standing or walking [15]. Interventions to reducing sitting time at work includes replacing the normal workstation of an employee by a sit-stand desk or a so-called hot desk, which allows the user to alternate posture between sitting and standing by being height adjustable [16], a stepping/pedaling device placed under the desk that allows the user to pedal while being seated at work [17], or a vertical workstation that allows the use of a personal computer while walking on a treadmill at a self-selected velocity. Or changing the layout of the

workplace to be more physically demanding, like placing the printers or lockers further away from desks. Even though all these interventions are effective they are not rather efficient they have their drawbacks. The sit-stand workstation which is highly acceptable even though through epidemiologic evidence suggests that it could have a considerable impact on cardiovascular disease and type 2 diabetes prevention, it appeared to be least successful due to postural changes, causing the user to experience musculoskeletal discomfort. Also, even though sit-stand workstations have been useful in reducing the sitting time, they have not provided any significant difference in the length of each episode of sitting nor have they provided any significant effect of strategies to increase walking on sitting behavior [15]. The workers on a treadmill would have to compromise with their productivity, since they need to divide their attention between work and personal safety to ensure that they do not trip and fall. Therefore, the treadmill/peddling workstations may decrease the user's efficiency. Even though by changing the layout of the working environment the worker could be forced to take break and low level physical activity, like taking a walk to the printer, it also means that the organizational policy should be changed and the organization should be viable to spare such changes. Even if such changes could be made, it cannot be stated for sure how often the worker might be forced to take a break, for example when the worker never needing a printout on a given day.



Figure 34. Alternate Workstations

2.5.2 *Darma the smart cushion*

Darma is the world's first "inactivity tracker" - a smart cushion to monitor your sitting habits, posture, stress level, and teaches you to sit better. It ports all the data gathered back to an iOS app via Bluetooth 4.0. While being seated on it, the embedded sensors on it would detect the user's sitting position (like being slouched for so long) it would give a reminder to straighten up. The in-built sensors are can measure heart rate, heartbeat waveform, respiratory rate, and breathing waveform, these statistics are collected within the app and the algorithms determine if the user is becoming stressed. If the user's stress level is high, or if the user is being seated for too long then the smart cushion would vibrate to notify the user that he/she needs to get a break. The drawback of Darma is that, it is only available for iOS platform and not for Android. Also,

one of the main complaints which has been received is that pairing the smart cushion with the mobile app, the developer has agreed this is due to a bug. And the connection between the cushion and the app should be established every day before use. Furthermore, it uses battery to power it up, which lasts for only 10 days and shuts off if not being used within three days. And the buzz that is given when the user is seated incorrectly and the buzz that is given to remind the user to take breaks are similar which often confuses the user what the device wants them to do without having to check their mobile notifications. Which defeats their argument that smartphone reminders are 'noisy' and disturbing [18].

3. METHODS

3.1 Participants

Potential participants were informed of the project's objectives, foundation, and protocol during a question-and-answer session which was conducted using online forms. All participation was entirely voluntary. Eligible project participants included health promotion department employees with sedentary jobs, including administration, customer service, account management, and much more.

3.2 Project Protocol and Measures

We used a non-randomized interrupted time series approach and data was collected using the quantitative methodology. The project was implemented over a 9-month period with a baseline period of 4 months (period 1: core functionality) in which all participants were monitored without interference; an intervention period of 4 months during which the IOT based sit device was installed for the intervention group. During the remaining period (period 2: Remaining of the product) additional improvements to the IOT based sit device and API's related to cognitive services and cursor movement were implemented for the potential group of participants. For Objective 1: we monitored the sitting pattern of the potential participants by using experience sampling methodology (ESM), a methodology that described real-world situations by frequent sampling of a situation or behavior. ESM has been used successfully in studies related to various health factors, populations, and settings, including the work place and found the distance of them of them sitting from the IOT sit device using ultra sonic sensors. The following data from the IOT sit device will be sent to the participant, once he/she confirms to receive the following data after configuring the mobile application. Data will be directly sent to the mobile application from the IOT sit device and the participants can save his/her details to the cloud database if necessary. For Objective 2: we used surveys to assess the effect of reduced sitting time on selected health related outcomes, mood states, and office behaviors. IOT sit device was further improved and cognitive service API and wrist movement API were introduced. The following data collected from the participant's

machine related to eye blink and cursor movement will be sent to the cloud database. Statistics of each participant could be viewed in cloud.

4. RESULTS

The research independently analyzed and assessed 34 articles/papers/book chapters of interest. Overall, 14 articles, describing 11 distinct studies that met the search criteria were included in the review. Four addressed an increase in the number of breaks in sedentary time, three implemented strategies around postural change, four implemented ergonomic changes to the individual workstation, one made changes to the built design of the broader workplace and three had multiple strategies that incorporated breaks in sedentary time, postural change and ergonomic changes.

The differences between periods were assessed by using corresponding tests. Similar analyses were applied to the survey data for self-reported sitting time, health-related outcomes, office behaviors, and mood states.

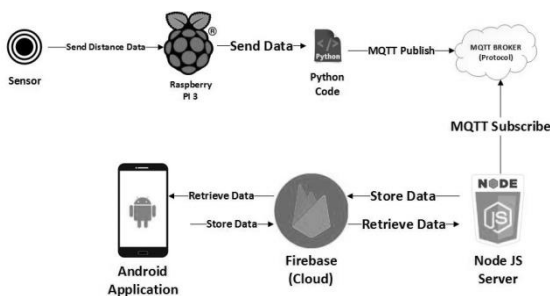


Figure 2. Rich Picture Diagram

The key results or the findings based on the sensors and the APIs that were used to gather real time data from the user (Mainly targeted towards Office Workers).

4.1 Results of the Ultra-Sonic Sensor

The distance between the sensor and the user will be recorded and stored in a real-time database, so that the mobile app would be retrieving and showing real time data. The distance between the sensor and table can be in the range of 20-100cm depending on the place where the user is keeping the device. The amount of time the user can stay seated continuously before getting notified is 20 or 30, the user has the flexibility of picking the most convenient sitting plan out of these two. And the user gets to select the duration of the break as well varying from 5 to 15 minutes.

4.2 Results of the Cognitive Service API

This will detect the person's facial expressions and to check whether that person is looking at the screen of the computer or not. The result of this API integration to the device will give an extra validity to confirm the

presence of the user and to notify the user to prevent Computer Vision Syndrome (CVS).

4.3 Results of the Mouse Recognition API

This will detect the mouse movements of the user. The result of this API integration will be helpful in preventing Carpal Tunnel Syndrome and to give an extra validity for the confirmation of the presence of the user.

The two variables that we record from the Sensor along with the two APIs will detect and confirm the presence of the user at the desk. Every 30 minutes the system will send a notification to the user to take a break for 5 minutes, if the user is refraining from doing so in their own.

4.4 Results of the pulse sensor

The pulse sensor placed with the IOT device could be used by the user to check his/her pulse at any given time, and the output would be displayed in user's mobile app. The pulse rate taken over a long period of time would also be stored in our real-time database, since this could be used to medically evaluate any chronic conditions.

5. CONCLUSIONS AND FUTURE WORK

We have focused on providing a thorough insight into project 'Healthy office+', which is a system used to monitoring office workers in order to prevent Sedentary behavior and Office Workers Syndrome and the systems key features, the best approach, technique and technology through the comparison of the existing systems and integrating them into the current prototype build. Even if only a small number of solution exist for the current problem of sedentary workplace behavior, we propose to conduct a fresh breath based more innovative thinking to fill the gaps identified and a further improved system which would help us to gain the upper hand in terms of efficiency and overall effectiveness. For future work, we are planning to implement machine learning where we will search through each individual's statistics to detect pattern and to adjust the break time accordingly to provide a personalized break duration for each user. The system would also be extended to detect postures and provide more detailed feedback, if the user's posture is not healthy.

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IoT Security Assurance to Emerging Smart Cities; A Review

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ABSTRACT 4-3

In the last decade Internet has made vital impact in our societies by bringing in remarkable communication and networking infrastructure. The Internet of Things is spreading the development of the internet. As well as the present world popular concept in developing cities is the smart city concept. A smart city is concept of urban development to gather many Internet of Things (IOT) solutions and Information and Communication Technology (ICT) in a secured approaches to manage city's resources. In this review describe how to apply IOT security assurance to smart cities through exploring the security issues and challenges of smart cities and overcome it by using security aspect. This review is composed of limitations and issues faced by smart cities in the development and solutions are proposed using Internet of Things (IOT). IOT architecture defines the core processes needed to be performed. There are three layers, namely, Perception layer, Network layer and Application layer. IOT is equipped to tackle various types of issues that can come with the development of solutions to smart cities that are describes in details in the review. All these techniques are used to make the life of the public in the smart city more convenient and efficient.

Keywords

IOT, smart cities, security

1. INTRODUCTION

The internet of things (IOT) is the infrastructure of the information society as well as physical devices in network such as vehicles, buildings, electronic devices, sensors and network connection that enable this objects to collecting and exchanging the data. IOT consent objects to be controlled and sensed far across through existing network infrastructure, create a chances for more efficiently integration of whole world into computerized systems and resulting in enhanced efficiency, economic benefit and accuracy [1].

At the present world popular concept of smart city can be defined as an urban development concept to gather many IOT solutions and ICT to a secure manner to

manipulate a city's assets. Such as information systems (IS) in local departments, libraries, power plant, schools, hospitals, transportation system, water supply networking system, waste management, law enforcement, and other kind of community services. Technology allows community services aspects to enhance efficiency of services and fulfill civilian's need.

City smartly to cope with city infrastructure, the community and to analyze how the city is evolving, what is happening in the city and way of enabling a better perfection of life style. As well as there are some sort of problem with this concept that are new technologies are being deployed without any security testing, many possible ways to abuse and attack services, No action plan to influence to able cyber-attacks on city infrastructure, service etc. IOT applications which are ubiquitous connectivity, analyzing and big data are facilitate smart city founding's to the whole world. These new applications offer excellent novel possibilities to the society. There are ability to remotely manipulate, analyze and manage devices in order to establish modest aspect and active information from considerable flow of real time data [2].

By leading an independent study on vital field of IOT Security Assurance to Emerging Smart Cities, this paper will talk about the topic including the importance of the IOT security, what is smart cities, major issues and solutions in smart cities, how to enhance security to smart cities and overcome the drawback of smart cities using IOT concept.

2. IOT (INTERNET OF THINGS)

2.1 What is Internet of Things

IOT is the infrastructure of the society as well as physical devices in network such as vehicles, buildings, electronic devices, sensors and network connection that enable this objects to gathering and transmitting data. IOT consent objects to be controlled and sensed far across through existing network infrastructure, create a chances for more efficiently integration of whole world into computerized systems and resulting in enhanced efficiency, economic benefit

and accuracy. IOT is implementing sensors such as IR, IRID, GPS tracking etc. for each and every aspects of things and involving them with the help of internet via particular protocols for communications and information exchange, to get the objectives such as achieve monitoring, tracking, smart recognition and management of system. As well as IOT provides automation of daily routine leads to better monitoring of devices, efficient and saves time and cost, and maintain better quality of life [1].

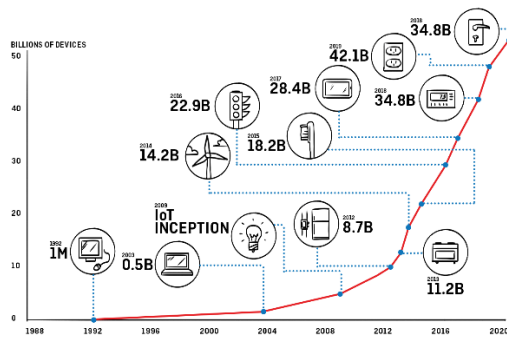


Figure 1. Growth in the IOT [2]

2.2 IOT Architecture

In each layer is described by its specific functions and which devices are used in that each layer. Different places mentioned different ways of number of layers in IOT architecture. According to many researcher, the IOT architecture has mainly three layers. There are as Perception, Network, and Application layers. Each layer has major respect to the devices as well as technologies that circumscribe each layer.

2.2.1 Perception Layer

The sensor layer also called perception layer in IOT. The main function of this layer is to gather the data from the particular environment by using of actuators and sensors. In this layer first detects then collects and processes information finally transmits it to the network layer. This layer also acts as local and short range networks of the IOT node collaboration.

2.2.2 Network Layer

In the network layer provides the function of transmission and data routing to particular IOT hubs and devices by using the Internet. In this layer contains the internet gateways, cloud computing platforms, routing devices switching etc. manipulate with the use of some common technologies such as Bluetooth, 3G, Zigbee, Wi-Fi, LTE, etc. The network gateway provides as the intermediate between different IOT nodes that are aggregating, filtering and transmitting data from different sensors and actuators.

2.2.3 Application Layer

The application layer responsible for data authenticity confidentiality and integrity. This layer is most specific layer which creation of smart environment [3] [4] [5] [6].

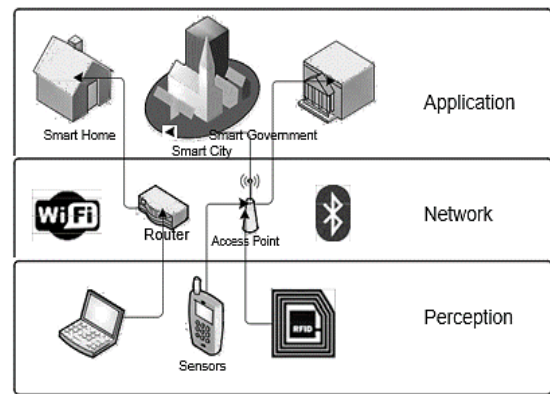


Figure 2. IOT Three-layer architecture [3]

2.3 Applications of IOT

Internet of things applications spread from small object to broader areas. At the present IOT is becoming part of every aspect of our lives. As well as internet of things applications are extending the comforts of our lives and also it giving us more control by simplifying our daily routine work life and specific tasks. Since the power of IOT markets are large, there are some domains that will progress better speed than the rest. Internet of things has been applied wide areas such as Smart homes, wearables, Smart cities, Smart grids, Industrial internet, Connected car, Connected health, Smart retail, Smart supply chain, Smart farming. IOT applications could be grouped in different categories. There are Smart home, Smart city, Retail, Agriculture, Lifestyle, Smart factory, Supply chain, Transportation, Healthcare, Culture and Environment. Among these smart home, smart grids, transportation and healthcare most vital [7].

2.3.1 Assisted Driving

Now a day there many types of transportation ways van, car, trains and buses. Which were along with the road and the rails on the actuators, sensors and powered processors will gather helpful information for drivers as well as for passengers. Such as traffic congestions, accidents, temporary and permanent road closure that were prevent and provide safety as well as better navigation.

The many organizations may be advantage from governmental authorities used for construction planning objective, gathered road traffic patterns and auto mobile companies use vehicle repairing purposes.

2.3.2 Mobile Ticketing

Billboards and electronic posters collecting information relevant to transportation services will be prepared by the NFC tag. Particular user has the ability to obtain details from web by hovering user's mobile phone over the NFC tag. It retrieves and combines information automatically from the particular web services. Such as departure and arrival time, number of passengers, suggestion about tickets, costs, available seats which were provide for suitable user.

2.3.3 Sensing

Sensor device which enable multi-purpose function focused on diagnosing patient conditions providing current status and all patients' treatment and health indicators. Remote patient analyzing system (heterogeneous wireless access-based) can be deployed close to the patient everywhere with multiple wireless collection of technologies support continuously monitoring in their pulse rate and heartbeat.

2.3.4 Authentication and Identification

These are the two terms that described the basic phases of the security and privacy in computer systems as well as that could apply to healthcare as an example maintenance for current electronic medical records, identifying to decrease harmful occasions to patient and cause of mismatch of infant identification in hospitals. An authentication and identification procedure is mostly used to grant access, manage and improve addressing patient safely issues. Besides authentication and identifications, most vital parts to be met are the requirements of security schemes and obstruct theft or losses of precious instruments and products.

2.3.5 Smart Homes and Offices

Sensors and actuators spread in houses and offices to make our life comfortable in many ways. Such as room heating can be adjusted as user preferences and weather and climate also, according to the time of day the room lighting can automatically change, perilous incidents can be overcome with particular alarm system, by using automated switching off systems the electrical tool such as light bulb, television, air condition, fridge, kettle when not used then energy cost can be deducted [8].

2.3.6 Social Networking

Social networking which can be used for automatically update current status of details and location of our activities in social websites. RFIDs which generate activities about the people and places to relevant to user's current status updates in the social networks. The mobile or web application users can be seen feed of activities that their friends have basic idea about that, the user can manage their profile and other user can be seen what events done go on.

2.3.7 Thefts

An application indicates to the user to know if expensive equipment is moved from a limited area then indicates that the equipment is being stolen. So this event need to be stated immediately to the owner or security guards through SMS, call, e-mail and using alarming system surround can be knowing what type of incident happen this place and get action against that particular incident etc.

2.3.8 Losses

A search engine which can be used to find tool which lost for long time period. The web-based application or mobile application is best approach to discover lost tool that retrieve the latest update location for tagged tools or retrieve for that particular tool's location. Further this application allows use define the owner or security guards either via SMS, call, e-mail and using alarming system surround can be knowing what type of incident happen this place and get action against that particular incident etc.

In case there are sensors such as IR, RFID, GPS tracking etc. Everything connected to internet for communications and information exchange, in order to achieve monitoring, tracking, intelligent recognition and management [9].

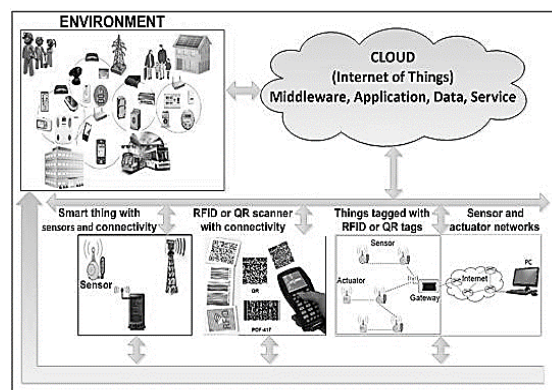


Figure 3. Ecosystem of IOT [4]

3. SECURITY OF SMART CITIES

3.1 What is Smart Cities

A smart city is developed urban cities that collect multiple information technology (IT) and Internet of Things (IOT) answers in a specific manner to handle every things of cities. These cities contain government offices, schools, libraries, markets, transport facilities, hospitals, power plants, water supply systems and other community services. The main focus of constructing a smart city is to enhance the status of life by using urban science and technology to raise the efficiency of service and meet citizen wants. Across the use of these factors with respect to real time analytical systems, secured data are gathered from people and devices afterward processed and analyzed can be done [10].



Figure 3. Smart City Structure [4]

3.2 Security Issues of Smart Cities

Citizens compose urban system using solution. Which are platforms, frameworks and applications. And those implemented on mechanisms to receive data and use it. In urban systems limitations of security imply problem to the whole infrastructure [11].

Access to information from applications, lack of security in depth, citizen data loss, information tracking, citizen tracking, viral effect in urban environment such are the security issues in smart cities.



Figure 4. Security Issues in Smart Cities [12]

3.2.1 Access to information from applications

Forward packets to be explored for applying effort to insert security and for ensuring data privacy and protections. Traffic between devices and network can be transferred.

3.2.2 Information Tracking

This part is essential part for having an interoperable and particular environment to the systems that authorize interact smart city. So important to this communication and to help this particular data communication in a safest manner but keep away that novelty information origin revealed.

3.2.3 Citizen Tracking

There are various sensors using smart cities, by using that particular sensors gather data from part of city and origin on this, more helpful to handle city's management.

So sensors tracked many kind of people work. Then track everything of all people in the city after the next get particular decision about these.

3.2.4 User data loss

Within smart cities, there are so many log on to devices such as smartphones, TV, tablets and other smart devices etc. These devices contribute the smart system wider scope of data and information. As well as those devices control depends on data types. So it is credible to have private values such as Bank Accounts, specific Contacts and others essential things.

This drawback deals with the opinion that particular applications are storing worthy data in the device. If it is not well managed, those particular essential things could be destroyed creating significant trouble to the user.

3.2.5 Information Hacking

Exchanging secure information in smart software more possibility to threat hacking any kind of system. When access to main functions of any kind of devices that hacking can identify system issues. It causes user's private and confidential data cause to harassment. Threat most focus on sensitive data and change it. Hackers gather all kind of possible information of organization's secret perspective. Before transmitting data to another specific person must consider about whether way is secure or possible to face hacking and fill the gaps as well. So system must have capabilities to hold data. Hacker search every part and find strength and weakness and if found small hold in the particular section hacker can attack through go to sensitive or privacy open to world. Then it is most important issues in the world and find many ways to overcome this type of attack considering specific way. As well as modern society have huge threat to this attack.

There are so many hacking techniques there are vulnerability scanners, brute-force attack, password cracking, packet analyzer, social engineering, malwares, keystroke logging, spoofing attack etc. This are some hacking techniques and system might be risky at any time. So many kind of way to attack to most secured place and mess people's essential situation and destroy everything to important to us [13].

4. SECURITY SOLUTIONS FOR SMART CITY

In this sections focused on how to overcome security issues [13]. So smart cities that there are lots of security issues then prevent challenges proposed security assurance using IOT technological aspects. So using IOT technology should be properly analyzed to make certain that are secure before use. Appropriate actions should be taken to right time cities more secured and prevent drawback. In case IOT security assurance most dominate for emerging and improving smart cities around the world.

In here look at system from a lower level then attempt to increase strength of security concern for the servers and also personally devices as well. Comparing other network such as internet number of servers will be rationally deducted. So using concert security applications can secure data and applications on servers.

The proposed security assurance will have below parts:

4.1 The data secured application for the server

In this particular system analyze all data which exchange between server and other networks to prevent any malicious information. To get maximum security software run on the system frequently. The security application like to antivirus software which are used for security purpose for PC. Which added many operations such as blocking any risky data then cognizing the source providing unique Id number for each device. The application software only headed that particular information to sever in safe manner. And also data centers security is increased as well as only server accessed into data center from network. So unless sever secure then data centers are secured.

4.2 Data scrutiny layer

The devices are not allowed to access to sever. The information which the devices need to transmit to the network of smart city's network so firstly sent to data scrutiny layer. And this layer devices send information always checked. Because of enough data received for network in addition to smart software which is limitation of data, particular source of data issue is data come from similar sources. And also using technologies such as AI (Artificial Intelligence) and spam filtering to share with malicious information. Most important thing in data scrutiny layer to share tracking issue previously mentioned. Both the data to the server and data to server are track traces. Filtering data before send to the network.

4.3 Secure smart software for devices

Each and every device should be secured from more threated applications. So smart software consists such as data protection, privacy, security, anti-eavesdropping functionality, uploading information when scan data in the network. As well as when detect any kind of vulnerability in device then indicating to the network. While problem solve data scrutiny layer may have blocked all the information.

4.4 Constant penetration Analyzing

So considering about smart cities there are various issues and find specific solutions and overcome improving quality of smart city. By using particular technologies can reduce various problems in Smart cities. Then city become safe and comfortable place to

all human being as well as can live peacefully and harmony. If we secure smart cities, use both software and hardware specification and then city become more vital place. So "constant penetration analyzing" is one most suitable thing for find solutions for smart city. Which is important testing smart city become update. Smart cities are updating each and every times. So always analyzing new holes and how to defense attacks and threads using constant penetration analyzing. This test one approach of make sure measure security and take decision how to fix it.

4.5 Secure Socket

Main cities are provided free Wi-Fi as result of this large network traffic in ports in every day. So port security in most essential thing to protect private and public network as well. In this case more important to outgoing and incoming, basic traffic and monitor other necessary stuff. Implementing port scanners can be overcome this particular problem and successfully ensure security in smart cities.

4.6 Firewall

Another important fact improving software and hardware firewalls in smart cities. Considering many kind of traffic are approved go through firewall most vital way to protect network from attack and threads. Firewall is the key part of any kind of network in secured smart cities as well as important to day by day operations. Although Smart cities can be constantly understock in every times but each and every people get dissatisfaction from it. Firewall has best improving methods to improving protection over SCCI (Smart City Cyber Infrastructure). To protect SCCI (smart city cyber infrastructure) there exist any hardware or software in the world but there is not proper trained or certified person then SCCI might be risk. So most important thing to secure SCCI have more knowledgeable persons such as certified developer, trained developers, and engineers to maintain the SCCI. Let's consider person are trained in IT (Information Technology) field and he doesn't know hardware side. So particular person should have proper certified in SCCI security and ensure security of SCCI potential attack as well. In addition, SCCI is most complex system so there must located specific person otherwise SCCI is going to be huge trouble. If SCCI down for one day, the city become crucial thread.

4.7 Network Traffic

Variety of public Wi-Fi policies another kind of solution. Most of the time urban cities offering free public Wi-Fi zones. Routers are located in public places such as bus stand, railway stations and other most frequently people are use places. This is one of most important factor by using this multiple problem can be solved. All network traffic can be reducing large amount of cost by spending small amount of cost. Before we discussed major important issue lagging time because of network traffic. We can reduce cost of

network traffic, paid for service which is transmitting network each and every day so finally monitoring and analyzing parts done more interactively with available particular resource. When city handle initial cost of installing routers and charging small amount of fee for cover before investments done by city. So considering these facts reducing overall network traffic and easily manipulate security and continue it further. Access Wi-Fi services most dominant solution that relevant to smart cities and this is valuable fact among administrators and authority officers.

4.8 Protection of SCCI

Analyze existing security systems in market and other specific areas that can be more related to privacy in SCCI. Most preferred system of all other systems which are designed with specific security factors. Considering this cope safest and secured solutions helps to prevent terrorism, people's restlessness and crimes. In case both law enforcement, emergency medical services response to quickly for user specific requirements. This must manipulate the traffic flow and other are set to SCCI. Let's consider about an example physical and cyber threats as well as this particular system solve so many issues of smart cities. And also any security provides more advantage from particular system by using this improve security related to smart cities. As an example such kind of overcome issues of smart cities. Such as improve more interactive to workers and business. So person who do many activities police and neighbors then ability informed incident. Most important thing protect secured system confirmed doesn't into wrong hands such as thief. So fulfilling this achieved security goal completely and success fully.

4.9 Policies and regulations

Beside government legal framework, policies and knowledge of users are effected to secure data and integrity of smart cities. At the present there are different stakeholders in convergent roles in different areas. All citizen and service providers in Smart city should have proper knowledge of government policies and regulation how to manage data usage and also implement proper structure to over the limitations of government frameworks and policies. By detecting risky systems, society remedial measurements, estimating what type of risk such as against to cyber-attacks or implementing smart services can be maintained system security and citizen safety. In this case all authority and capabilities are included into digital court because of when growth of smart cities so SCCI have many interconnections and there might be risk also spread. Compact and constant digital architecture must implement in place. All system developers want to particular specific ways to clarify measurements before what are the confidential data and secured data of user accessed, what type of privacies that need to transmitted data. Service providers should share and data repository and other essential things with particular service provider with

most secured manner. Preventing prohibitory data accessed processing suspicion domain, well protected key management, cancelling guaranteed users, well-grained handle through shared data such ways to privacy measures. In this case since regulations and operations of other related parties, security providers adapt to old security way such as encryption, authentication and identification, digital certificate and signatures and another particular specific way to protection of data. Because of threads and attack increment then increase of the security and privacy of smart cities. Again and again ensure security and protection of all objects in city and build more specific applications, necessary protocols for against attack and threads [14][15].

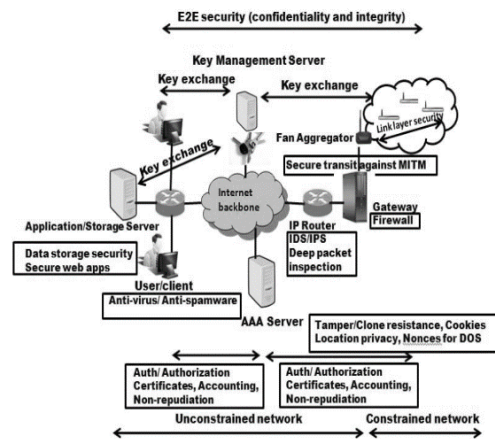


Figure 5. IOT Security [9]

5. DISCUSSION

According to my point of view use of IOT security assurance to emerging Smart Cities section has a huge impact of change the future world move to IOT Smart cities. IOT is new concept for the present society. But in near future because of evolve in smart cities security may risky, so future world will be more comfortable than present. The statistics in this review paper has shown that most of people are moving to smart city concept. IOT is new trend which can easily adapt to modern world. According to the review there are security issues in smart cities and how to overcome issues by using IOT security aspects. Enter to the information from applications, information tracking, citizen tracking, users data loss are specific security issues of smart cities then mostly gradually reduce value of smart cities. IOT is the best approach to reduce these drawback and increase value of smart cities and become safest place to live peacefully and happily to all human being. IOT mainly focus objects to be controlled and sensed far across through existing network infrastructure, create a chances for more efficiently integration of whole world into computerized systems and resulting in enhanced efficiency, economic benefit and accuracy. In this review mentioned about three layer in IOT architecture as Perception, Network, and Application layers. Beside described by its specific functions and which devices are used in that each layer. Each layer has

specific respect to the devices and technologies that circumscribe each layer. In the present world popular concept is smart city which is an urban development concept to gather many Internet of Things (IOT) solutions and Information and Communication Technology (ICT) in a secure manner to manage city's assets. In this paper describe how to applied IOT security assurance to smart cities through exploring the security issues and challenges of smart cities and overcome it by using security aspect as well. After discussed about internet of things applications spread from small object to broader areas. At the present IOT is becoming part of every aspect of our lives. As well as internet of things applications are extending the comforts of our lives and also it giving us more control by simplifying our daily routine work life and specific tasks. IOT applications could be grouped in different categories. There are Smart home, Smart city, Retail, Agriculture, Lifestyle, Smart factory, Supply chain, Transportation, Healthcare, Culture and Environment. Among these smart home, smart city, transportation and healthcare most vital. In this example mention about Assisted Driving, Mobile Ticketing, Sensing, Authentication and Identification, Smart Homes and Offices, Social Networking, Thefts, Losses and further discussed in this paper. A smart city is developing urban cities that collect multiple information technology (IT) and Internet of Things (IOT) solutions in a specific manner to manage every things of cities. Further described Smart cities security issues and challenges. Finally mentioned in this review some solutions for that particular issues happen in smart cities how to overcome using IOT safest manner. Describing solution of overcome issues in smart cities the data secured application for server, data scrutiny layer, secure smart software for devices, constant penetration analyzing, secure socket, firewall, network traffic, protection of SCCI, Policies and regulations. In today IOT broader with many technologies. As well as most popular in new generation. Because of teenagers have proper knowledge about these type of technologies and cope with this items and update many sources about these related subject. So they are really interesting about these IOT concept and smart city concept. Related to my point of view I hope to IOT to be more specific thing to spreading the development of the internet. So future researches may search more and more solutions for current issues and challenges in Smart cities better to live secured way.

6. CONCLUSION

As diverging of the society people need to more facilities to live peacefully and harmony. Smart cities are most appropriate to ensure security their lives. But it may several problems happen so to overcome that drawbacks by using IOT technologies and find solutions for this issues.

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Case Study: Adopting BAW-MVC Style into Development of Browser-based Web-based Applications

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ABSTRACT 4-4

The Balanced Abstract Web-Model-View-Controller style can be seen as a conceptually sound abstract architectural style for web-based applications, which provides higher module separation with lower coupling. However, the adoption of the style into development has not been demonstrated or discussed yet in any forum. Discussions on the adoption of the style via demonstrations can assist in understanding the full potential of the style and utilization of it in actual development environment. This paper demonstrates and discusses how to adopt the Balanced Abstract Web-Model-View-Controller style into development, through a case study of developing a browser-based web-based application. The case study is designed to demonstrate all possible utilization of the characteristics of the style, with a minimal set of features. The knowledge delivered in this paper will be helpful in understanding the adoption of some popular frameworks into the Balanced Abstract Web-Model-View-Controller based development, and also to discuss the possibilities of adopting the style into mobile apps and Internet of Things systems.

Keywords

Web based applications, software architectural style, MVC.

1. INTRODUCTION

Software architectural styles increase the realization of the system; and the architectural styles can be considered as abstract description of tried and tested good practice of the generic forms of the architecture [1]. In other words, styles provide a means for capturing the knowledge about successful solutions in software development. The Balanced Abstract Web-Model-View-Controller (BAW-MVC) architectural style [2] can be seen as a comprehensive style for web-based applications [3], however, the adoption of the style into the development is not discussed yet in any forum.

This paper presents the findings of a case study towards adopting the BAW-MVC style into the development of a simple browser-based web-based application, also discussing some aspects like selecting designing and development techniques and

technologies (TTs) and best practices to be used. The scenario is designed to demonstrate all the aspects of the BAW-MVC style, towards understanding the utilization of all the characteristics of the style.

The rest of the introduction section discusses the background and the methodology used for the research. The section 2 status the scenario for the case study, also providing the design of the class diagram and the GUI. Section 3 discusses the development of the browser-based web-based application discussing some best practices. Section 4 concludes the paper, stating the limitations of this paper and possible future work.

1.1 Background

This section discusses the background of the web-based Applications and the BAW-MVC style.

1.1.1 Web-based Applications [3]

Nowadays there is a wide variety of distributed systems like cloud computing systems and Internet of Things based systems, with different processing components in remote locations, which utilize the service of the web via the data networks, to communicate with other components. The term “web-based applications” can be seen as an umbrella term, which covers these distributed systems, which use the service of web [3]. Considering the abstract architectural formalism of these systems, web-based system is defined as “*Web-based application is a system, with application component(s) in client-side [client-component(s)], which communicate(s) with application component(s) in a web server [server-component(s)], for processing data. They utilize the service of web, based on the client-server architecture, request-response model, standard HTTP, and other related techniques and technologies.*” [3].

Web-based systems can be mainly divided into two groups – according to the nature of the client components – as: browser-based web-based applications and non-browser-based applications [3]. A web-based system, which consists with only the client and the server tiers – based on the 2-tier architecture – is considered as a standalone web-based application; and this standalone web-based application can be extended into a multi-tier web-based

application by adding more layers via the server tier [3].

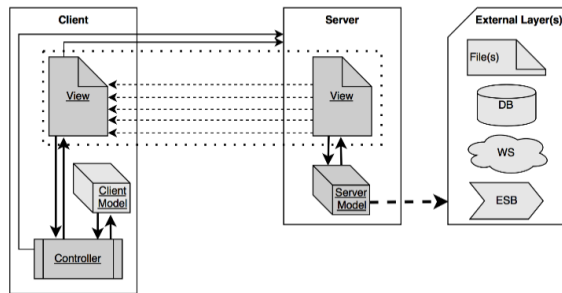


Figure 1. The BAW-MVC style

1.1.2 Balanced Abstract Web-MVC style [2]

The BAW-MVC style – shown in figure 1 – provides an abstract conceptual implementation of MVC for the web applications, which does not depend on any TT. The BAW-MVC helps in higher module separation with lower coupling, by satisfying the requirements: 1) Multi-tier expansion supportive Client-Server partitioning, and 2) MVC based modularization. It also satisfies a list of nonfunctional requirements related to the architectural properties like Visibility, Performance, Maintenance, Modifiability, etc.

Even though the BAW-MVC is conceptually sound, its adoption into the development is not straightforward, since it has not been demonstrated yet. The adoption of available TTs into this style should be experimented, presented, and discussed for it to be practically more usable [2]. This paper presents and discusses the experience of adoption of the BAW-MVC style into a browser-based standalone web-based application, stating some identified best practices.

1.2 Methodology

A series of experiments were conducted towards realizing the style and identifying the implementation of the characteristics of the style. These experiments were prototype based and continued in iterative and incremental manner. Different techniques of implementing the features of the BAW-MVC style were experimented in the latter iterations, and the findings were utilized in the later iterations and further refined. The experimenting was continued till the realization of all the characteristics of the BAW-MVC style and optimization of the identified implementation techniques.

For the development of the Views of the prototypes HTML5 was used, for the controllers JavaScript (JS) and jQuery were used, and the Model was developed using PHP. The databases for the prototypes were implemented using MySQL. The prototypes were locally hosted using the Apache web server.

The empirical evidence gained via the experiments was consumed to design and develop the case study discussed in this paper.

2. CASE STUDY SCENARIO

The scenario for the case study is a simple system, which maintains an inventory of items. The scenario is designed to demonstrate all possible utilization of the characteristics of the BAW-MVC style, with a minimal set of features for easy referencing and understanding. The figure 2 illustrates the UML Use Case diagram for the scenario.

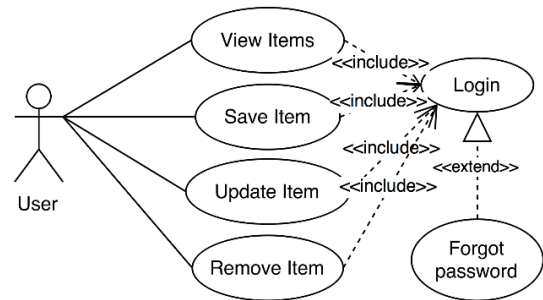


Figure 2. Use Case diagram for the case study scenario

The system uses a login to validate the users. The login feature contains a password-requesting feature, for the users who have forgotten the passwords. A logged-in user can perform CRUD operations [4] on a data set of items via View, Save, Edit/Update, and Remove features.

Figure 3 illustrates the class diagram for the scenario of the case study.

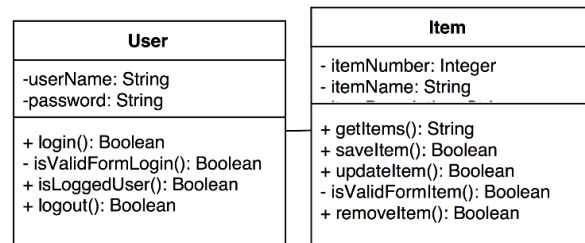


Figure 3. Class diagram for the BAW-MVC case study

Note that the persistence layer, and the related design and development concerns are not covered in this study.

Instead of the classical feature-per-page paradigm, the approach of developing multiple related features in a single-page has become popular, in browser-based applications. Therefore, the features related to the item management are included into the same GUI, for the case studies. The GUI for the items page/view is illustrated in the figure 4 below, which contains all the CRUD operations for the inventory.

Logout

Item Name

Item Description

Save

Saved successfully

ItemNo	Name	Description	Edit	Delete
5	item1	description1	Edit	Remove
8	item2	description2	Edit	Remove
12	item3	description3	Edit	Remove

Figure 4. The GUI of the Items Management page

Note that all the development of the case study is done, aligning to the methodology and TTs specified in the methodology section.

3. DEVELOPMENT

This section discusses the adoption of the BAW-MVC style, through development of a sample browser-based web-based application for the scenario given in section 2. Note that, to demonstrate the maximum possible strength, and to specify the limitations denoting the scope of the BAW-MVC based applications, a rich GUI arrangement in a single page is used to develop all the CRUD operations related to the items management. In the application, there will be three pages: 1) a login page, 2) a forgotten password request page, and 3) the items page, which contains all the CRUD operations related to the items.

Note that in the class diagram in figure 3, in both User and Item classes, there are two private methods *isValidFormLogin()* and *isValidFormItem()*. These methods can be developed into the client-Model to perform the form validations in the client-side. In order to have better security, the validations also could be done in the server-side, and it is up to the engineers to decide, which components should be developed in which modules.

The complete project of this case study can be found in GitHub [5].

3.1 Best Practices to be followed

According to Ginige [6], the researchers who first proposed the need for an Engineering approach – for developing large complex Web systems – have defined Web Engineering as “*Web Engineering deals with the establishment and use of sound scientific, engineering and management principles, disciplined and systematic approaches to the successful development, deployment and maintenance of high quality Web-based systems and applications*”. While experimenting, we have identified best practices regarding the Directory structure, Controller files, and Server-side code of the Views, which can assist towards successful development and maintenance of the web-based applications. This section discusses some techniques identified through the series of experiments, which can be utilized as best practices in

the development of the BAW-MVC-based applications.

3.1.1 Directory Structure of the Source of the Application

It has been understood that a sound process for developing web-based systems should support the maintenance and management of the content [6]. When a system grows with features, the complexity of writing code and maintaining the files in the file system also increases [7]. Different tools and frameworks use their own directory structures to maintain the resources in development. The directory structure proposed here is based on the modularization of the BAW-MVC style.

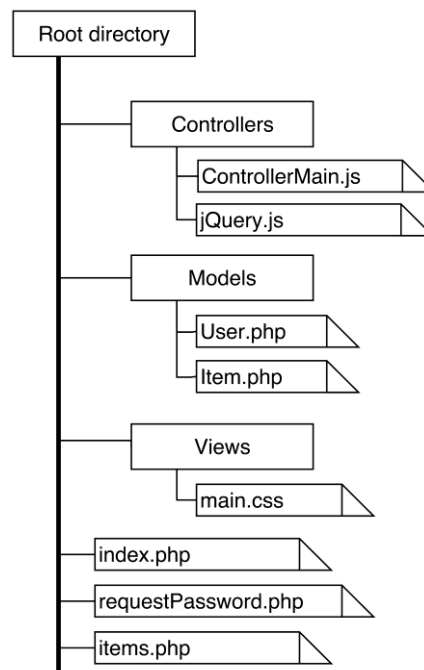


Figure 5. Directory structure for the BAW-MVC case study

All the Views (Web pages) should be contained directly in the root directory. The Controllers and the related files (including frameworks, libraries, etc.) should be included into a subdirectory named Controllers; the Model classes and the related files (including frameworks, libraries, etc.) should be included into a subdirectory named Models. The files related to the Views (like CSS, images, etc.) should be included into a subdirectory named Views. Aligning to these suggestions, the directory structure for the case study is given in figure 5. The subdirectory names are not constrained, however the directory and the files arrangement needs to be maintained.

3.1.2 Practices for Controller Files

Since the Controller files contain the code for event-handling of the Views, and as they could be developed using event-driven paradigm, the code for multiple – may be all (depends on the nature of the system) – Controllers can be included into a single JS file. This

file can be linked to the relevant Views as required. In the sample web application, all the components of the Controllers are developed in a single file named ControllerMain.js.

When setting the event-handlers, the use of HTML event setting attributes in the Web page – as in DOM Level 0 inline model [8] – is not recommended. Instead, use JS implementation of setting the handlers, as in the Controller code snippet in the snippet 1. JS event handlers setting technique lowers the coupling between the View and the Controller, and increases the modifiability and maintenance in development aspect.

```
$(document).on("click","#btnLogin",function()
{
    .....// code
});
```

Snippet 1. JS event handlers using jQuery

When developing the Controllers, it is recommended to use other JS-related best practices in the direction of better performance, maintenance, and modifiability of the system.

3.1.3 Server-side Code in Views

One of the main problems in traditional web application development is that the code of the logic is mixed with the presentation [9]. The modularization of the BAW-MVC simplify this problem by separating the business logic from the Views. However, when implementing the link between the View and the Model – which is used for the communication in the initial load of the View – some server-side code should be written in the View. Since the business logic is completely in the Model, the server-side code segment in a View is only needed for communicating with the Model and utilizing it. Therefore, a View can contain server-side code for loading the Model class(es), create object(s), call the necessary method(s), and display the result(s) on the GUI.

Sometimes a View might need to read the inputs from the request and pass them to the Model, when calling the methods. Additionally, some session management related server-side code can also be contained in View(s).

However, still the blend of server-side code into the View might lower the maintenance, modifiability, etc. To increase the separation between the server-side language code and HTML in a View, the following technique is proposed. All the server-side codes should be written on the top of the View as shown in the code snippet of the *items.php* View in the snippet 2.

When the dynamically generated results are needed to be displayed inside the HTML elements, it is recommended to assign the result to a variable, within the server-side code section of the View, and display the content in the variable inside the HTML element(s), instead of writing the whole segment of code for communicating with the server-Model, inside

HTML. With this technique, just a single statement is needed to display the content of the variable inside the View.

```
<?php
session_start();

//User management
include("Models/User.php");
$usrObj = new User();
$usrObj->isLoggedIn();

//Items management
include("Models/Item.php");
$itemStsMsg = "";
$itemObj = new item();

//If not the initial load
if(isset($_POST["hidMode"]))
{
    if($_POST["hidMode"]=="save")
    { $itemStsMsg = $itemObj->saveItem(
        $_POST["txtItemName"],$_POST["txtItemDesc"]);
    }
    if($_POST["hidMode"]=="update")
    { $itemStsMsg = $itemObj->updateItem(
        $_POST["hidID"], $_POST["txtItemName"],
        $_POST["txtItemDesc"]);
    }
    if($_POST["hidMode"]=="remove")
    { $itemStsMsg = $itemObj->removeItem(
        $_POST["hidID"]);
    }
}
$itemTable = $itemObj->getItems();
?>
```

Snippet 2. php code snippet on the top of the items.php View

This technique is utilized to display the status message(s) and the data table, in the *items.php* View of the case study. Refer snippet 3 for the code of displaying the data table on the *items.php* View.

```
.....<!-- some html -->.....
<?php echo $itemTable; ?>
.....<!-- some html -->.....
```

Snippet 3. Display dynamically generated content on View

3.2 Communication Flows between the BAW-MVC Components

This section explains how the sample application of the case study complies with the communication flows between the components of the BAW-MVC style.

Usually a browser-based application is initially requested by the user, by typing the URL on the browser and applying; then, the initial request will be

sent to the server by the browser. This communication is not included in the BAW-MVC architecture, since it is triggered from outside the system, and expected to be common understanding.

In the case study, the *index.php* page will be requested initially, which is the entry point into the sample application. The *index.php* View contains HTML for the login feature and server-side code segment, to start the PHP session in the initial load. The Controller for this View contains the click event-handler for the Login button, and the client-Model contains the validations for the login form.

3.2.1 View-to-Server Communication

The *index.php* View contains a regular HTML hyperlink directed to the *requestPassword.php* View. When the user clicks on the link, a request will be sent to the server, for which the server will respond with the *requestPassword.php* View. This is a View-to-server communication link, as in BAW-MVC architecture. Any View-to-server link is developed as a standard HTML hyperlink.

3.2.2 Communication between the View and the Controller

When the user enters the login details and clicks the login button, the button's click event will be fired and the event-handler in the Controller will be invoked. This is a View-to-Controller link. Any View-to-Controller link is developed by setting event handlers in the Controller, for the GUI elements on the View.

The event-handler in the Controller will do the needful and render the results on the View, if there are any. In the sample application, when there are validation errors in the login form, the login button's click event-handler will update the View with error message. This is an example of Controller-to-View link. The Controller-to-View link is developed by generating or manipulating some GUI content on the View by the Controller.

3.2.3 Communication between the Controller and the Client-Model

The login button's click event-handler in the Controller will call the client-Model's *isValidFormLogin()* method to validate the login form. This is a Controller-to-client-Model communication. Controller-to-client-Model communication is developed by writing some code in Controller to call and utilize functions in the client-Model.

If the login attempt is considered not valid – according to the client-Model's logic – then the *isValidFormLogin()* method will return an error message to the Controller, which will be displayed on the GUI of the View by the Controller. If the form is valid according to the domain logic, the client-Model will return the value “true” back to the Controller, then the Controller will proceed with the execution. The return of the results from the client-Model to the

Controller denotes the client-Model-to-Controller communication.

Even though there is no direct communication between the View and the client-Model, there exist some coupling, since the client-Model may read the inputs directly from the View, for validations.

3.2.4 Controller-to-Server Communication

Once the login button's click-handler in the Controller is returned by the client-Model, indicating that the login form is valid, the Controller submits the form to the server. This is an example of the Controller-to-server link in BAW-MVC. A Controller-to-server link can be developed as a form submission, or also as a JS page redirection – when needed – using the *window.location.assign("URL")* function call.

3.2.5 Communication between the View and the Server-Model

The submission of the login form is directed to the same *index.php* View, to continue the authentication process. The *index.php* View's server-side code distinguishes this request from the initial request, as a form submission. Then it will call the *login()* method in server-Model to perform the actual authentication based on the domain logic, by loading the *User.php* file for the *User* class, creating an object of the *User* class, and then using it. This is an example of View-to-server-Model communication. Any View-to-server-Model communication link is developed as a call to a function in the server-Model. The sample code snippet for the *index.php* View is given in the snippet 4.

```
<?php
session_start();

$loginMsg="";

//If not the initial load
if ( !empty($_POST) )
{
    include("Models/User.php");
    $usrObj = new User();

    if(isset($_POST["txtUserName"]))
    {
        $loginMsg = $usrObj->login();

        if($loginMsg=="true")
        { header('Location: items.php');}
    }
    elseif(isset($_POST["hidLogout"]))
    { $usrObj->logout(); }
}
?>
```

Snippet 4. php code segment on top of the index.php View

The *login()* method of the *User* class in the server-Model will perform the user authentication, based on the domain logic, and will return the results back to the server-side code of the View. This is an example of the server-Model-to-View communication.

In the cases of invalid authentication, the server-side code of the View embeds the results (error messages) – returned by the server-Model – on the *index.php* page; then once the View is loaded into the browser, the embedded – error – messages will be displayed to the user.

If the user is identified as valid, then the server-side code of the *index.php* View will redirect the page to the next View; in the case of the sample application, to the *items.php* page. View to View redirections, which take a place in the server – without interacting with the client-side components – are considered as a part of the navigational logic, and they are not denoted in the BAW-MVC style.

3.2.6 Further Explanations on how the Sample Web Application Aligns with the BAW-MVC Style

The *items.php* View's server-side code contains two main sections: 1) user management and 2) items management (refer the snippet 2). In user management section, codes for loading the *User* class, creating the *User* object, and calling the *isLoggedUser()* method are included. The *isLoggedUser()* method is utilized to ensure that the user is an authenticated and logged-in user. If a user is trying to access the *items.php* View using a direct URL, without logging in, that user will be redirected to the *index.php* View. This feature is developed assuming the availability of a business constraint, which explains to provide access to the *items.php* View, only for the logged-in users. Server-Model-to-View redirections similar to this scenario are not shown in the BAW-MVC architecture; therefore, the communication link from the server-Model-to-View in BAW-MVC does not point out any redirections similar to this.

The items management section in the *items.php* View, loads the *Item* class from the server-Model, creates an object, and calls various methods of the class, using the object, to perform various actions. The *getItem()* method is called for all the requests to the View – including the initial request – to load and display the available data from the database, on the View. The *saveItem()*, *updateItem()*, and *removeItem()* methods are utilized, as needed by the submission of the items form, only for the requests other than the initial request. In the cases of save, update, and remove features, the user's inputs and/or other needful parameters are read using the `$_POST` super global variable – since the form method in the *items.php* View is set as POST – and passed to the methods of the server-Model, as arguments.

4. CONCLUSION

This paper has discussed the adoption of the BAW-MVC style into development through a case study of developing a simple browser-based web-based application. The case study is designed in a way to demonstrate the development of the features of the sample web-based application, covering all the characteristics of the BAW-MVC style. Some best practices to be utilized in the BAW-MVC based browser-based web-based application development are also discussed towards better modifiability. We think that all the basics of adopting the BAW-MVC style into the development of browser-based web-based applications have been covered by this case study.

However, adopting the BAW-MVC into advanced web-based applications should be further experimented. Additionally, using different frameworks for both the server-side and the client-side development of BAW-MVC based applications should also be experimented. In future, we expect to demonstrate adopting some popular frameworks into BAW-MVC based development, and also to discuss the possibilities of adopting the BAW-MVC style into mobile apps and IoT systems.

We continue this research to extend the BAW-MVC to address specificities of the Rich Internet Applications. We expect to exploit the best practices suggested in this paper to continue experimenting towards extending the BAW-MVC style to cater the characteristics of the Rich Internet Applications.

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A Comparative Study on Predictive Models for the Global Cryptocurrency Market

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ABSTRACT 4-5

This research paper focuses on the discussion of the need for a holistic Cryptocurrency Market Prediction System, and the relevant technologies and methodologies that are applicable for its success. While the popularity of Bitcoin and a few other leading cryptocurrencies - Ethereum, Ethereum Classic, NEM, Dash, Litecoin and Ripple - is evident in the vast number of predictive models that are available or under study in the cryptocurrency market, very little research has been carried out on predicting the behaviour of altcoins (alternative coins). Precisely 820 altcoins are known to exist today, a number that is growing daily. As a result, the global cryptocurrency market is extremely fragile and subject to illiquidity and high volatility, thus making it difficult for traders of cryptocurrency to effectively predict price fluctuations, and profit from the buying and selling of cryptocurrencies (CryptoCurrency Market Capitalizations, 2017). The authors attempt to first, assess the various factors that can be used to predict the price of cryptocurrency. This is followed by an analysis of the accuracy of various machine learning techniques and how effectively they can be applied to derive information on the various factors that influence changes in the behaviour of cryptocurrency. Finally, the results from these are then used to outline an approach to use a hybrid of technological methodologies to not only strengthen the basis of predicting market fluctuations of Bitcoin prices, but also assesses how powerful Bitcoin is in influencing the prices of altcoins in the cryptocurrency market.

Categories and Subject Descriptors

Prediction system for cryptocurrencies.

Keywords

Cryptocurrency, Bitcoin, Altcoins, Machine Learning, Sentiment Analysis, Price Prediction, Predictive Models.

1. INTRODUCTION

In today's highly commercialized global landscape, the demand for a more accessible and transparent medium of currency has grown rapidly [2]. While gold and fiat currencies have been utilized as a mode of

exchange thus far, the ability to easily abuse their use in transactions has led to some of the largest financial scandals of our time. The Libor Scandal of 2016 is one such example where it was discovered that banks were falsely manipulating their interest rates to better profit from trade [15]. However, the rapid pace of technological innovation has led to the emergence of cryptocurrency, a new and trending form of digital currency that assures a faster, more secure and democratized mode of commercial exchange using Blockchain technology. 'Bitcoin', also known as the 'Internet of Money', emerged in January 2009 as the world's first and most popular cryptocurrency to date. It currently holds a market cap of US \$46,261,730,690 and a 24 hour trading volume of over US \$1,000,000,000 (CryptoCurrency Market Capitalizations, 2017).

Data from the first global cryptocurrency benchmarking study draws 4 main conclusions on the global cryptocurrency market [6]:

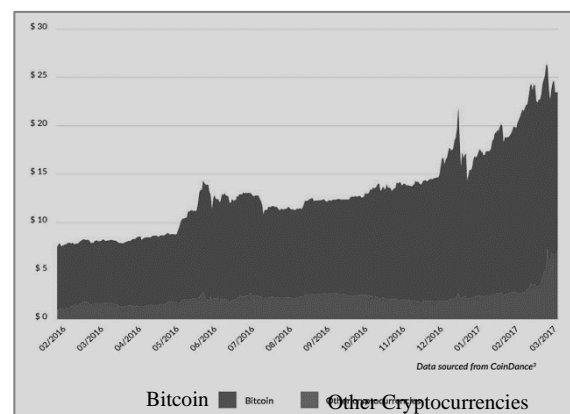


Figure 35. The Cryptocurrency Market in 2017

1.1 Cryptocurrency market capitalization has increased dramatically

Since early 2016, the total cryptocurrency market capitalization has increased threefold to reach US \$ 27 billion as of April 2017, as evidenced in Figure 1. This attests to the growing strength and acceptance of cryptocurrency as a digital asset from both a consumer

and governance standpoint. Richard Branson, entrepreneur and founder of the Virgin Group, is an example of a strong promoter, stating in a press interview “Banking as we know it is changing radically. We accept alternative currencies payment at Virgin Galactic.” [17].

1.2 Bitcoin remains the dominant cryptocoin

Bitcoin holds 71% of the overall cryptocurrency market capital (as shown in Figure 1). This highlights how powerful Bitcoin is as a digital currency amongst the cryptocurrency community, and thus how it can influence the behaviour of altcoins. Bitcoin is able to maintain this position because the vast majority of altcoins are largely clones of Bitcoin with minor changes in parameter values (different block times, currency supplies or issuance schemes).

1.3 Traders hold the largest market stake

Irrespective of geographical distribution, cryptocurrency exchanges offer the highest number of operating entities in comparison to the other cryptocurrency taxonomies of mining, wallets and payments, as illustrated in Figure 2. As a result, out of all possible interested parties (traders, miners and investors), traders engage the most with the cryptocurrency market to profit from buying and selling digital assets in online cryptocurrency exchanges such as Poloniex and Bittrex; to date, 61 active exchanges exist [4].

1.4 The market is extremely volatile

While it is evident from the above that the market is certainly growing at a rapid rate, at the same time it is also subject to extreme volatility. As Bamburic (2017) observes, “In a short period of time, it [the cryptocurrency market] can reach all-time highs and crash, repeatedly, seemingly out of nowhere”. Buy Bitcoin Worldwide has a Bitcoin Volatility Index which measures the change in price of Bitcoin by looking at the standard deviation of daily returns over 30 and 60-day time windows. The research team concludes that as of August 2017 the Bitcoin Volatility Index for the past 30 days is estimated at 4.18%, 3.5 times more than the estimated volatility of gold is 1.2% and over 4 times more than other major currencies that average between 0.5% to 1% [1]. For traders, the user group with the biggest stake, the significantly higher volatility of digital currencies makes it riskier for them to hold or trade their assets when the value rises and drops so substantially and frequently.

2. FACTORS THAT CAN BE USED TO PREDICT THE PRICE OF CRYPTOCURRENCIES

Research has shown that there are three main factors that have been identified which have an effect on the

volatility of the cryptocurrency market. All of these factors are discussed below.

2.1 Public Perception

Virtual economies such as the global cryptocurrency market have grown as a result of the interactions of its virtual users [14]. As with all things digital, the online hype and chatter about cryptocurrency is going viral on the internet via blogs, forums and social media [8]. Research carried out by Kaminski (2014) on online user opinion data (user’s opinions and sentiments in online reviews of various cryptocurrency-related taxonomies) argues that what people say about cryptocurrencies has a significant effect on the market [13]. Further analysis carried out by D’Alfonso et al. (2016) highlights the extremely high correlation between Bitcoin and Ethereum prices, and Google searches for each respective currency, concluding that their high growth and volatility are as a result of news, hype and speculation [2].

2.2 Trading volume

Greaves and Au (2015) suggest overall trading volume as a second factor that affects the volatility of Bitcoin prices, where the delta in trade volume from cryptocurrency exchanges can be used to ascertain how stable digital currency assets are on an almost real-time basis [12]. Research by Madan et al. (2014) further build upon and validate this theory by using trading information to automate the trading process and predict price deltas 10 minutes into the future [16].

Over time, people have become more aware and accepting of the benefits of cryptocurrency, leading to the establishment of online exchanges such as Poloniex and Bittrex where digital currency is traded, just like how fiat currency is traded on the stock exchange. The exchanges have developed to a level where they now expose trading data to the public via API’s, which further suggests that there is a significant demand for information on futuristic trading data.

2.3 Historic Price Data

Similar to how trade volume data can be extracted through API’s, the online exchanges also allow users to obtain the price of various cryptocurrencies today, based on analysis and calculation of historic price data. For example, the exchange Poloniex allows historic price data to be extracted by specifying details such as the relevant start and end date/time, time intervals between data points, and the currency pair [20]. Using this information, machine learning techniques can be applied to predict the price of various cryptocurrencies by identifying patterns and trends in the data.

Considering the fact that Bitcoin has been around since 2009, Kim et al. (2016) highlight the vast availability and ease of access to historic data on cryptocurrencies, in order to train and test various types of machine learning algorithms that can be applied [14]. Patel et al. (2015) use this same concept to predict the change

in price of a select number of companies trading on the Indian Stock Market using a variety of machine learning techniques, one of which was proved to reach an accuracy of 90.19% [19].

2.4 Price fluctuation between bitcoin and altcoins

Research done by Ciaian et al. (2016) proposes that there is an interdependency between the fluctuations of Bitcoin and Altcoin prices. The research states that there are two main reasons why this hypothesis was proved true: the first being that Bitcoin dominates the cryptocurrency market with over 71% of the market share as of 2017; the second factor being that, due to Bitcoin's strong dominance, it provides a medium of exchange for altcoin transactions. The paper also states that altcoins and Bitcoin have similar price developments, further strengthening the interdependency between the two [7]. This information alone doesn't allow the price of Altcoins to be predicted. But machine learning techniques can be used to monitor the change in Altcoin based on the change in Bitcoin behaviour.

It is evident that all three of these factors play an equally important role in predicting the price of cryptocurrencies. However, research thus far shows that only one, or a combination of two (at most), of these factors have been taken into account with any given study. This can prove to have significant limitations on the outputs of such studies. For example, the market effect of a scenario where there is a major drop or rise in price as a result of new forks in the source code or new feature releases can only be captured by the public perception variable; use of the historic price or trading volume variables would not be very successful in predicting market prices in such a scenario as there will be no pattern of data to these events. On the other hand, when there is less chatter online about a specific cryptocoin, factors such as trading volume, historic price and the price fluctuations between Bitcoin and Altcoins will come into play. These scenarios prove that one factor alone will have limited success in predicting the price of cryptocurrencies. Alternatively, if a predictive model that factors in all three of these variables was developed, it would prove to have a considerable improvement in the accuracy of predicted results, even when patterns in data are broken.

3. MACHINE LEARNING

Machine learning has led to various technological improvements in a plethora of industries. Along with the rapid growth in this area, many new algorithms and tools have come to light since. However, while some algorithms have proved to be highly accurate in solving one type of problem, they may not always be as useful when applied to a problem of a different nature. Therefore, the various machine learning techniques and their applicability are assessed and discussed further below.

3.1 Machine Learning Techniques

3.1.1 ANN (Artificial Neural Networks)

ANN is a very commonly used technique in machine learning as it is known for its non-linearity and data driven aspects. The biggest advantage in using ANN is its capability of only having a finite number of hidden properties and yet being able to accurately predict values for any continuous function, this property is known as the universal approximator [3]. With continuous developments and advancements over the years, ANN has proved itself to maintain a good and reliable performance in predicting stock prices [23].

Byvatov et al. (2003) compares the performance of ANN and SVM (Support Vector Machine) techniques for drug/non-drug classifications. The first implementation of the ANN algorithm was a two-layered network with a single output neuron, which means that the decision function will be chosen from a family of functions. Using optimum weights for the functions generally results in a low error function. The study further experiments with an implementation where the input layer has multiple connections to the output layer; this was done to reduce the error function. Multiple training algorithms were used to optimize ANN. The algorithms were default versions by MATLAB. The results of the experiment show that both implementations of ANN had an average accuracy rate of 80%. Despite the relatively high accuracy of the ANN technique, the study concludes that the SVM algorithm performed slightly better [5].

3.1.2 SVM (Support Vector Machine)

SVM is a supervised learning model. This algorithm classifies data into different classes based on boundaries created from training data; the algorithm also takes error tolerance into consideration [12]. If the algorithm faces a data set which is not linearly classifiable, the boundaries will be defined in a more complex scale through the kernel implementation (also known as the non-linear kernel). However, it is evident that SVM performs better when the data set has clear boundaries, in comparison to data sets that do not have clear boundaries [22]. Patel et al. (2015) use the SVM algorithm with the kernel implementation to predict the movement of stocks and the stock price index of the Indian Stock Market using four different algorithmic techniques; the SVM algorithm reaches an accuracy of 89.33%, the third most accurate algorithm overall. The most accurate algorithm was Naive-Bayes with an accuracy of 90.19% [19]. Similarly, Madan et al. (2014) use machine learning techniques to create a Bitcoin trading bot; the study reveals that the error percentage of SVM increases with time, which, it is suspected, is as a result of the data not having an artificial separation as Bitcoin prices are generally always increasing. However, the study also claims that, given more frequently timed data, SVM has a chance of performing better as it is known for its ability to identify patterns [16].

3.1.3 *Random Forest*

Random Forest is an ensemble learning method for classifications. The base of this algorithm is decision trees. The ensemble learning approach creates multiple classifiers, as one classifier is not sufficient to determine the class of a given value of a data set [19]. The same study experiments with 'n' number of trees generated, where each tree is analyzed choosing three random features. The final output is the decision that uses the greatest number of trees; results show an accuracy of 89.98% for this specific algorithm. Madan et al. (2014) claim that high accuracy is achieved when using Random Forest; the reason for this is the very fact that this algorithm creates multiple trees instead of just one. Although it has been argued that this algorithm may have low precision as a result of multiple trees being created, it has been concluded that this does not have an effect on the overall accuracy of the algorithm. The study further highlights that clearer trends were identified with data collected in ten minute gaps rather than ten second gaps [16].

3.1.4 *Naive Bayes*

Naïve Bayes uses probability to classify the data set into classes. The algorithm assumes that each feature is completely different from the others. This algorithm is known to be extremely fast and is a very highly scalable model. The scaling is done in a linear way, where each feature is defined into the prediction model. The only drawback to this technique occurs when new points are added to the training data, as the training of Naïve Bayes has to be recalculated [23].

Pang et al. (2002) states that Naïve Bayes is a standard text classifier. Although this algorithm makes assumptions that the functions are completely independent, which is certainly not the case in real world scenarios it performs surprisingly well. The study concludes that Naïve Bayes wasn't the best algorithm according to the experiments carried out. This was because the data set used did not have independent functions, which could be the reason for the low accuracy [18]. This factor was tested out and it was identified that in instances where highly dependent functions are present the accuracy of Naïve Bayes tends to be higher [26].

3.2 Areas of Machine Learning Applicability

Considering the factors that affect cryptocurrency price volatility as discussed in Section 2, and the range of machine learning techniques highlighted in Section 3.1, this paper now looks at how various machine learning techniques can be applied on the different factors affecting cryptocurrency price volatility in order to effectively predict the price of cryptocurrencies.

3.2.1 *Machine Learning with Sentiment Analysis*

Goncalves et al. (2013) argue that the use of emoticons is the easiest way of detecting if a particular post has a positive or negative connotation to it. Users try to express their feelings through the use of emoticons in their social media posts or tweets in an attempt to emotionally convey how they feel. This is advantageous when carrying out sentiment analysis as it makes it easier to determine the exact emotions of a particular user, in relation to a specific topic of discussion. The analysis is done by training classifiers to identify that certain emoticons co-relate to a specific type of emotion, using machine learning techniques. For example, a classifier will assume that a 'smiley face' emoticon generally indicates a positive review, whereas a sad face would generally denote a negative sentiment [11].

Read and Jonathon (2005) experiment on the various dependencies identified when applying machine learning to sentiment analysis. Their study identifies three main dependencies, where they test the validity and accuracy of these dependencies using two different machine learning techniques. The first dependency factor that is tested is "Topic Dependency"; three data sets were used to train the classifiers, where the third data set was a mixture of the first and second. The results of the experiment indicate a positive correlation between the performance of algorithms and test data belonging to the same topic. Furthermore, the results show that when the classifiers were trained with mixed data the algorithms suffered a great drop in accuracy; however, it was interesting to note that training the classifiers in one specific topic and testing it on another topic showed better accuracy as opposed to the mixed data set. In general, the algorithm Naïve Bayes was the most accurate, attaining the highest level of accuracy of 80.3%. The second dependency tested for was "Domain dependency", where the experiment shows very clearly that training data and the data tested upon should belong to the same domain. Naïve Bayes was only able to reach a high of 57.6% in this instance, while SVM reached a high of 63.3% accuracy. The third factor tested was "Temporal Dependency", where data sets from different points in time were trained and tested. Data from the same period of time resulted in better accuracy with the algorithm Naïve Bayes performing at an accuracy of 78.9% and SVM at an even better accuracy of 81.5% [21].

3.2.2 *Machine Learning applied to Trading Volume*

Greaves and Au (2015) attempt to identify information in the Blockchain itself which could be used to predict Bitcoin prices. However, there was very little success with this analysis. Consequent research by the authors then sought to use data from exchanges in order to predict the price of Bitcoin, due to the fact that exchanges hold an abundance of information about the

trading of cryptocurrencies. As the initial approach to predict prices using the Blockchain was unsuccessful, the authors moved forward by using cryptocurrency trading information to do so. The study shows that the price of Bitcoin can be predicted based on the demand for Bitcoin; for example, it was found that when an exchange sells more Bitcoin than is bought, the price of Bitcoin is likely to increase as a result of the higher demand for it [12].

A study by Madan et al. (2014) uses information from cryptocurrency exchanges to make predictions of Bitcoin prices. Based on these predictions the process of trading has been automated. The authors take into consideration over twenty-six factors related to Bitcoin trading in order to influence its price prediction. Data was gathered at different time intervals to experiment with and identify which conditions would offer better prediction performance. The research concludes that 10 minute data helped them identify clearer trends rather than data collected more frequently, such as in 10 second data[16].

3.2.3 *Machine Learning applied to Historic Price Data*

Patel et al. (2015) use historic price data from seven companies listed on the Indian Stock Market to make price predictions. They experiment with four different algorithms to compare the performance of each model in predicting the price of stock. Sample data was collected for the time period 2003 to 2012 for training as well as testing purposes. Ten technical attributes related to the stock and stock price index are considered to weigh in for the prediction methodology. A trend-deterministic data preparation layer is used to determine if these ten attributes' continuous value is either +1 or -1, which indicates if there is an increase or decrease in price respectively. The study concludes with the algorithm Naive-Bayes showing much success with an accuracy of 90.19% [19].

Similarly, Rowland (2014) built a piece of software that uses price data specifically to predict the price of Bitcoin. Two machine learning techniques are concurrently run to gain more accuracy. The project was supposed to use the exchange "mtGox" for trading but the exchange was declared bankrupt. However, historic data from the site was used for training. The system uses an ensemble voting system to enhance accuracy, and the study proves the use of this strategy has a greater effect on improving prediction accuracy versus classifiers alone [22].

4. SENTIMENT ANALYSIS

The highly globalized cosmopolitan day and age we live in has given rise to the wide use of social networks for conveying information about all aspects of life. People post a great deal of information online, especially about how they feel in relation to a particular topic of discussion. Facebook, being the largest social media network, has 1,280 million active users per day. Twitter, another popular micro-blogging

site, has up to 500 million tweets per day [10]. Most of the users make the content they post online public, allowing anyone to access it; this creates a huge user base for sentiment analysis. Moreover, with the new trend of using hashtags, posts can be easily categorized to form generalized or specific topics. This makes social media a massive base of user opinions, and therefore the beckons the need to apply sentiment analysis to make use of all this information.

Sentiment analysis, also referred to as "Opinion Mining" is the technique of understanding the polarity of text. Polarity is the terminology used in this area of study to evaluate if the analysed data is positive or negative [18]. In relation to applying sentiment analysis to cryptocurrency price prediction, Kim et al. (2016) consider the factor "Public Perception" and its effect on the cryptocurrency market to predict the prices of cryptocurrencies. The research was limited to Bitcoin, Ethereum and Ripple, as other coins didn't have a big enough market for the study. Information was gathered by crawling online communities relevant to cryptocurrencies, and sentiment analysis was then performed on this information. Based on these results, machine learning techniques were used to predict the price of the three coins. The study concluded with Bitcoin having the most accuracy, which was attributable to the large amount of data collected as the user base was comparatively bigger [14]. Kaminski (2014) uses a similar approach, but with information collected through tweets on Twitter feeds. Tweets are pulled from Twitter API's and thereafter categorized into models with the use of sentiment analysis. The information is then compared against trading data and prices. The research shows a moderate correlation between Tweets, trading data and the closing price of Bitcoin [13].

5. CONCLUSION

The cryptocurrency industry has grown gradually over the years since its origination in 2009, and its success overtime has piqued a considerable degree of interest within the past few years. Now, the industry is growing faster than it ever has. And although Bitcoin, (the world's first cryptocurrency) continues to dominate the market with 71% of market share, 820 other known altcoins exist in today's cryptocurrency market. In a growing but very volatile industry like this, a prediction system would be very useful to parties such as investors, traders and miners, to determine the performance of all cryptocurrencies.

Consequently, many studies have been developed to build cryptocurrency prediction systems aimed at discounting this volatility and thus helping users trade more profitably. However, one key observation made by Kim et al. (2016) is the limitations of past studies to predicting the behaviour of Bitcoin and a few other dominant and mature cryptocurrencies (such as Ethereum, Litecoin and Ripple). They seek to justify this limitation by highlighting the vast availability and ease of access to data on Bitcoin, which they claim

eliminates the need to build a system that also predicts the behaviour of altcoins. White (2014), however, disagrees, arguing that in comparison to these select few cryptocurrencies, 820 altcoins exist, each demonstrating improvements in speed, robustness and profitability as the difficulty to mine Bitcoin increases day by day [24]. Furthermore, what research thus far does not show is how these altcoins behave and react to various factors that influence the digital currency market. This has a significant impact on buyers and sellers of digital coins, as it reduces the amount of information they have access to in order to make profitable trades.

Therefore, it is evident that there is a need for a holistic cryptocurrency prediction system that takes into account key factors that affect the volatility of cryptocoin prices, and can thereby be used to effectively predict the overall prices of all cryptocurrencies. While predictions cannot be made on newer currencies as they don't have a substantial user base or sufficient data, research does prove that there is an interdependency between the price fluctuation of Bitcoin and Altcoins, as elaborated in section 2.4. This interdependency could be used to predict the prices of the newer cryptocurrencies, thus overcoming the limitation of not having a big enough user base and data patterns to build a predictive model upon. Furthermore, in order to predict the price of an Altcoin, the price of Bitcoin will also have to be predicted as both prices should be reflected at the same point in time.

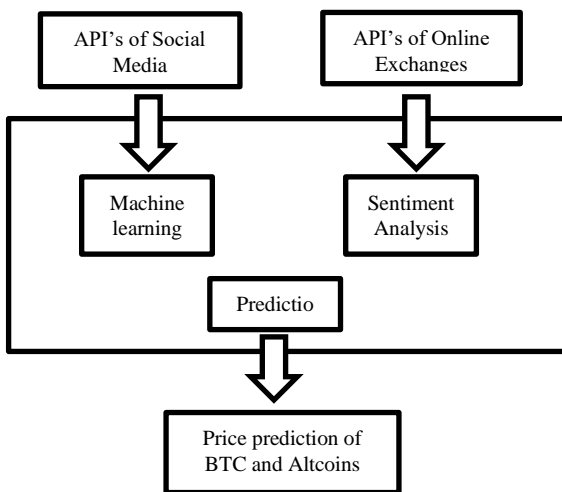


Figure 2. High level architecture diagram

Much research has also been carried out in the area of predicting the price of Bitcoin, where most findings talk about using one of the factors affecting volatility to predict the price of cryptocurrencies. This has been discussed in the second section of this paper. The cryptocurrency market is very volatile and therefore a system that considers all the factors identified would be useful. A formula can be created where each factor would be assigned a weightage in predicting the final price of Bitcoin. This can have a significant improvement in accuracy especially in situations

where the market could reach an all-time high, and seconds later, completely crash. This would be a hybrid solution with improved accuracy in predicting the price of Bitcoin, and, based on this prediction, the price of the Altcoins can also be predicted. Figure 1 shows a high-level architecture diagram of the solution described, where APIs can be used to extract data on public perception, and trading and historic price data from online exchanges to effectively predict the price of Bitcoins and, consequently, Altcoins.

Such a system will help establish more stability and engagement in the industry by providing users with a more transparent platform where they have access to reliable cryptocurrency trading information which they can better profit from, and thereby contribute to the growth of this emerging, futuristic industry.

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Towards Hybrid of HTML and JSON for Delta Communication

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ABSTRACT 4-6

JSON and HTML provide good data serializing solutions for the Delta Communication (DC) of RIAs. This paper looks into their characteristics in depth, related to development productivity and communication efficiency, towards understanding the similarities and differences. The knowledge gained in this study highlights that the JSON is good in communication efficiency, but lacks in productivity, where the HTML exhibits the opposite behavior. The paper analyzes these findings in the direction of isolating a problem of not having a data serialization solution for DC, which is good in both the development productivity and the communication efficiency. Then the paper proposes a possible concept as a solution to the identified problem, to support initiating a research. Our ongoing research is supposed to be built on top of the foundation laid by this paper.

Keywords

Rich Internet Application, Delta Communication, Serialization, HTML, JSON

1. INTRODUCTION

The world of WEB2 [1] is mainly comprised of Rich Internet Applications (RIAs) [2]. RIAs overcome the limitations in user experience in traditional web applications, such as slower responses and poor Graphical User Interfaces (GUIs) [3]. The RIAs combine the web's lightweight distribution architecture with desktop application like GUIs and interactivity, resulting improved elements of a web applications like data, business logic, communication, and presentation [4].

The power of the RIAs can be seen as its rich communication model, known as the Delta-Communication (DC) [5]. Different data structuring technologies are used to format data in DC, where JSON [6], HTML [7], and XML [8] are popular among them. There are some facts to consider when selecting a data formatting technique/technology when developing DC, where this paper focuses on development effort and size of the data.

During our ongoing research, we noted that these different data structuring/formatting technologies

support certain facts, where they show lack of support in some other. For an example, JSON can be used to format a message with the lowest size; however, we think that the JSON data structuring process needs more development effort. In this paper, we look into this situation in depth, stating the exact problem of selected data structuring technologies, then specify a hypothesis, followed by an overview of a possible solution.

Section [1]6.4.2 states the background of the DC and the data structuring technologies: XML, JSON, and HTML. Section states about the methodology while section [1]6.4.4 discusses the problem, giving examples, then the section [1]6.5 specify a hypothesis, proposing a possible solution to overcome the problem. Finally, the section [1]6.6 provides a conclusion, discussing the future work.

2. BACKGROUND

This section states the background of the DC and popular data structuring technologies available for the DC.

2.1 Delta Communication [5]

In Web 1.0 when a user performs a functionality, which needs to be communicated with the server, the client component will send a request to the server. The server performs the necessary processing and returns a response back to the client, where this response is a complete web page with related resources like images. The browser will then load this web page replacing the current page performing a page refresh, and then display the information to the user. Till this whole process is completed, the user has to stay idle, where this process is called the work-wait pattern [9].

The RIAs are capable of performing partial page rendering [5]. The RIAs use DC to communicate with the server, where the client components send DC requests and receive the responses, and these responses contain only the needful data for the requests instead of complete web pages. The client components of the RIAs then process this DC response and update only the needful areas of the current GUI, which is called the partial page rendering [5]. This entire work is processed in the background of the current GUI, avoiding page refreshes. Since the response is smaller

compared to a complete web page and its resources, the DC accomplishes faster, eliminating the work-wait pattern [5]. The synergy of the increased speed of the communication and the partial page rendering, increases the user experience, closer to the desktop applications [5].

DC can be implemented in data-pull, data-push, or in mix mode, using either synchronous or asynchronous approach. The simplest DC technique can be explained as the Simple Data-pull Delta Communication (SPDC) [5]. There are different implementation techniques and technologies available for DC like JS-SPDC [5]/AJAX [10], Polling [11], Server Sent Events (SSE) [7], and WebSocket (WS) [12].

In traditional web applications, the response is a web page, written in HTML; however, in DC, since only the needful data is sent to the client, the data should be formatted into a known structure for the client component to understand. Different data structuring technologies are used in DC to ensure good structure and semantic of the data communicated, such as HTML [7], JSON [6], and XML [8]. First the server component processes the data and structure into a common message format, which is called the serialization process [13]. Once the client component receives the response, it processes the message into the common format, read the data to be utilized, where this processing is called the de-serializing process [13]. After de-serializing the response, client component may further process the data to produce the necessary information and then do the needful to update the GUI with the information. The GUIs of the web pages are written in HTML, therefore, the de-serialized data is often re-serialized into HTML, to be displayed on the GUI. These re-serialized HTML snippets are appended into the HTML Document Object Model (DOM) to perform the partial page rendering.

Different data formatting technologies are engaged with some factors to be considered, such as different levels of development effort, processing time, and result size. These data formatting technologies use different algorithms to process data and format, therefore, may engage with different processing times. According to the algorithm used and other tools like libraries, the development effort can be varied. Moreover, when the same dataset is formatted using different technologies, the size of the resulting message can differ. It is important to understand these facts and select the proper technology to be utilized in DC.

2.2 Data Serialization Technologies Used in Delta Communication

This section states the popular data formatting technologies available for DC, discussing their features, and also reviewing them. When reviewing these technologies, we consider the development effort and the message size. Having a less development effort can increase the engineering productivity. Or in other

words, less input over output increases the productivity [14]. Furthermore, it can also increase the modifiability. Having a lower message size helps to perform the DC faster, which can improve the user experience. Moreover, lower message size reduces the server bandwidth, which can be seen as a useful factor for application with high number of frequent users [13].

2.2.1 *eXtensible Markup Language (XML)* [8]

XML is an early data formatting technology, which uses elements to describe data. An element consists with a start tag and an end tag to specify the element scope, and a body, which contain the data. These elements can be nested into other elements to wrap data into sections, using structural rules of DOM. This structure needs lots of meta-data, which increase the size of the final serialized message drastically. It has been identified that the message size of XML is larger than JSON or even HTML [15]. The large message size directly and negatively affects the bandwidth of the network and the server.

Serializing data into XML and de-serializing to extract data back from XML message involve lengthy algorithms, therefore, consist of heavy processing. For both the server-components and the client-components, dedicated packages or third-party libraries are used for XML processing. In such environment, using XML has a concern amount of workload in the server side as well as in the client side, which can make the total development workload sweaty.

2.2.2 *JSON* [6]

JSON is a text based data formatting technology, which doesn't use lots of meta-data when serializing data like in XML. Its structure is represented as a pair of curly brackets surrounding zero or more name/value pairs. JSON is a lightweight technology [13] and addresses the size issues in XML, providing lower message size.

Unlike DOM in XML messages, JSON objects are analyzed as string arrays. Compared to XML, with the abovementioned capabilities, JSON is engaged with higher parsing efficiency, hence the processing is faster [16]. Although it may have a better easiness on development than XML, it still has a concern amount of workload in both client and server sides where the server has to serialize data into JSON strings and the client has to de-serialize them, read data, and re-produce HTML to show the information in the GUI. Furthermore, in both JSON and XML, whenever the data structure is changed in the server side, the client side code needs to be updated to de-serialize the new message structure, which makes the workload of development sweatier, therefore lacks in development easiness and modifiability.

2.2.3 HTML [7]

Even though the purpose of the HTML is to develop the GUIs of the web applications, still it can be used to format the data in DC. Conceptually HTML is similar to XML, however, the size of HTML serialized message is lower than XML and closer to JSON in the context of DC [13]. Anyhow, in critical situations where even less than 100 bytes and 100 milliseconds are substantial, it is not recommended to use HTML due to its higher size of data size compared to JSON [13].

In terms of development, the HTML shows some advantages. The serialization of data into HTML is similar to XML, however, mostly it is developed as string concatenation, without using dedicated packages or libraries. If the data is serialized directly into the target structure of the GUI, in the client side the de-serialization can be entirely eliminated. The client component can directly update the GUI with the received HTML snippet as the response by appending the snippet into the DOM [13]. Thus, it reduces the workload in the client side drastically. Since the de-serialization can be eliminated, the changes of the data structure in the server side do not cause any code changes in the client side, which leads to have higher modifiability over JSON and XML. While HTML is proven better for faster development, it has a better processing efficiency than XML and comes close to JSON [13].

3. METHODOLOGY

A literature survey was conducted to gain the background knowledge and to learn all the related techniques and technologies like JS-SPDC/AJAX, XML, JSON, etc. It was mainly focused on the features of the RIAs, characteristics of the DC, and their implementation details. The literature survey was extended to the data formatting technologies used for the DC and their specifications.

Experiments were conducted to gain the empirical evidence of the knowledge gained through the literature survey. Prototypes were developed to learn and understand how the data serialization and de-serialization processes are working in DC, and these prototypes were examined to figure the data sizes of the messages and development effort of serializing and de-serializing components.

For the client components of the prototypes JavaScript and jQuery was used and for the server components PHP was used. The implementation of the DC was limited to the JS-SPDC/AJAX. These prototypes were hosted locally in Apache server and the databases were developed using MySQL server.

4. PROBLEM IDENTIFICATION

The concept of the problem discussed in this paper is focusing on two factors: 1) the development productivity, considering the workload of the initial development, as well as the easiness in modifications,

then 2) the communication efficiency, towards faster communication with lower bandwidth, caused by lower message size.

4.1 Development workload

Elaborating more on the case of the development workload, take an example of sending a simple dataset from the server to the client as the response to a DC request. Assume the dataset is supposed to be shown in a table on the GUI. The snippet 1 shows a sample PHP code snippet for serializing the dataset in the server component using JSON.

```
$dataset= array(
    'name' => 'John',
    'age'  => 32,
    'city' => 'Mount Lavinia');

$jsonDataSet = json_encode($dataset);
echo $jsonDataSet;
```

Snippet 1. Serializing a dataset using JSON

The first statement prepares the dataset as an array, then the second statement serializes the prepared dataset into JSON formatted dataset, and finally the third statement produces the output, which is the response to the DC request.

The snippet 2 shows a sample PHP code snippet for serializing the same dataset using HTML.

```
$dataset = "<table><tr>
<th>Name</th>
<th>Age</th>
<th>City</th>
</tr><tr>
<td>John</td>
<td> 32 </td>
<td> Mount Lavinia </td>
</tr></table>";

echo $dataset;
```

Snippet 2. Serializing the dataset using HTML

According to this snippet, both the dataset preparation and serialization is done in the first statement, then the output is produced by the second statement. The dataset preparation and serialization process development can be seen as a less complex string generation compared to JSON. We can think that, as

the complexity of the dataset goes higher, the complexity of generating the JSON serialized dataset may increase, where the HTML serialization complexity remains lower.

The actual development workload reduction of HTML is exhibited in the client side. The snippet 3 shows a sample code snippet for de-serializing the JSON dataset, serialized by the snippet 1. The DC request handling client component has to read the response, then de-serialize it, which is done by the first statement. The second statement produces the output to be displayed using the de-serialized JSON data, which is a table in this example. Finally, the produced HTML snippet – which contains the information to be displayed – is appended to the element with the ID “Result” in the DOM of the current page by the last code statement, using the jQuery html() function. This performs the partial page rendering and update the GUI with the information generated from the response.

```
var jsonData = JSON.parse(response);
var htmlData = "<table><tr>" +
"<th>Name</th>" +
"<th>Age</th>" +
"<th>City</th>" +
"</tr><tr>" +
"<td>" + jsonData["name"] + "</td>" +
"<td>" + jsonData["age"] + "</td>" +
"<td>" + jsonData["city"] + "</td>" +
"</tr></table>";

$("#Result").html(htmlData);
```

Snippet 3. JSON de-serialization in the client side

When HTML is used for the serialization, since the HTML is to update the GUI, is already produced by the server component, the client component has to just append the received response to the GUI and perform partial page rendering. This can be done using a single code statement, as shown in the snippet 4 below. This drastically reduces the development workload in the client side, increasing the development productivity.

```
$("#Result").html(response);
```

Snippet 4. HTML’s workload in client-side

Additionally, this setting increases the modifiability when HTML is used for serialization. For an example, think the dataset of the previous example needs to be changed after the initial development. When JSON is used, first the dataset preparation code in the server side should be updated, and then the output preparation code in the client side also should be updated to match

the changes in the server side. When HTML is used, updating the dataset preparation code in the server side is enough, since there is no de-serialization in the client side. Therefore, the use of HTML can increase the modifiability of the RIAs.

4.2 Communication Efficiency

In communication, there are several aspects related to the efficiency, which needs to be looked into, and our ongoing research is focusing on the speed of the communication and the server bandwidth. The size of the data affects both these aspects. When the size of the data to be communicated is high, the speed of the communication gets lower [13], and also large datasets consume more network bandwidth of the server [17]. Therefore, it is wise to keep the size of the datasets low as much as possible, to maintain a good communication efficiency. For the RIAs, with a huge client base, communication efficiency is an essential factor to avoid issues like the C10K [18] issue.

It has been already proven that the size of the JSON messages is lower than the XML or HTML [13], thus, suitable for the RIAs, specially which have critical communication data size requirements like overcoming C10k issue. Opposed to JSON, HTML message size is higher, thus, HTML lacks the communication efficiency.

4.3 The problem

According the above discussion, JSON is good in communication efficiency, but lacks in development productivity, where the HTML behaves in the opposite, providing good development productivity, but lacks in communication efficiency. It is questionable that: which serializing technology to use for DC to maintain the productivity as well as the communication efficiency? There is a clear tradeoff in JSON and HTML between the development productivity and communication efficiency.

For communication efficiency critical RIAs, it is advisable to use JSON, sacrificing the development productivity [13], otherwise the HTML can be used giving up the communication efficiency. For the rapid development with changing requirements, and for the systems with frequent modifications, it can be recommended to use HTML for serializing the DC, only if communication efficiency is not serious.

5. OVERVIEW OF A POSSIBLE SOLUTION

During our literature survey, we were looking for a solution to satisfy both the development productivity and the communication efficiency, which we could not find so far. Furthermore, we were experimenting towards identifying some good techniques to balance between the aforementioned two aspects. We assume that to enhance the developer’s productivity of developing the DC in RIA development, while maintaining the communication efficiency, it may be

helpful to combine the advantages of both HTML and JSON. We hope a hybrid of JSON and HTML would provide a solution. Therefore, we propose a method for encoding HTML into JSON in the server side, which can help in generating the HTML output in the client side.

However, if the developer has to code for both serialization and de-serialization and in JSON, it would not be a useful solution, so we think a library, which can be used to develop the serialization in the server side and the de-serialization in the client side would be optimal. The library will do the de-serialization in the client side and produce the target output based on the HTML encoded in the JSON, then the developer can simply append the output of the library into the DOM, similarly when the HTML is used.

6. CONCLUSION AND FUTURE WORK

Over the past few years of Web2.0 and Web 1.0, the data structuring technologies has been focused either on development productivity or communication efficiency, but not for both. This occurrence has lead the developers to abandon either of them and fulfill only the other factor. The most obvious example being HTML and JSON. HTML eases the DC development process in RIAs, increasing the development productivity, including the modifiability than when the JSON is used. However, HTML lacks in communication efficiency, with its larger message size compared to JSON. There is no available technology to maintain both the development productivity (as in HTML) and the communication efficiency (as in JSON). We propose to combine the development productivity of the HTML with the communication efficiency of JSON, to introduce a hybrid technique to maintain both the aspects. We think that a library with components to serialize data in the server side and to de-serialize back in the client side can provide an optimal solution for this.

In the future, we hope to conduct a cross-sectional survey to understand the importance of solving this problem and a need for a solution. Then we expect to continue our experiments, in the direction of designing technique to combine the HTML and JSON for serialization of data for DC, maintaining the communication efficiency. Then we hope to introduce a library with two components for both the client side and server side, to maintain the development productivity of the development DC in RIAs.

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Internet of Things (IoT) for Smart Agriculture

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ABSTRACT 4-7

agriculture has become the main occupation of people in developing countries of the world. There are numerous difficulties for agriculture. Among these difficulties, the managing of resources is the major problem for farmers. Internet of Things (IoT) can provide effective and efficient solutions for the agricultural sector by connecting all the physical things into one package with use of hardware Technologies and Synergistic Technologies. Further, the uplifting of a lifestyle of farmers can be obtained from Smart Agriculture. Reviewing applications of IoT for Smart Agriculture, current issues of IoT and identifying future directions of IoT for Agriculture sector is the purpose of the review paper.

Keywords

Internet of Things (IoT), Smart Agriculture, Enabling Technologies, Synergistic Technologies, IoT Applications

1. INTRODUCTION

Internet of things has been gently bringing different changes to our lives and made it more comfortable through numerous applications [1]. Agriculture is one of the elementary occupation of man from thousands of years to even today [2]. When considering the agriculture field, IoT can be identified as a portion which can promote and affect it individually. From the development of the world Agriculture and internet, technologies have become interconnected. It can be easily distinguished when considering this electronic era. There are main areas which can affect the agriculture in IoT, such as expanding the agriculture by researches, promoting the condition of prevailing agriculture systems. Identifying locally-specific modules and expanding them, helping to continue agriculture as long as possible without outer effects to it.

The internet of things is a technology that used in worldwide for interconnecting devices [3]. These technologies, it has developed the capability of getting decision among farmers and their management. Anyhow, day by day the IoT and issues related to agriculture change rapidly. Therefore, the researching area also should be changed day by day. Traditional

methods are still used in agriculture which makes low yielding of crops [4]. Ancient Industrialization technologies and human life style had been replacing by sensor-based electronic machines and yield have been raised due to the advancement of technology. Data has been gathered by sensor-based monitoring systems and transfer them into decision support systems for analyzing data and decision making. Internet of things has been captured the attention of whole world [5]. IoT facilitates "anything can access from anywhere at any time for anyone". IoT is always bound with Smart objectives like smart cities, smart wearable, smart home, smart enterprise, smart education and smart environment.

The second section offers a summary of existing concerns of IoT in development of agriculture Third Section designates current problem areas inside the agriculture field and find out increasing trend in the direction of IoT and agriculture. In the fourth section identify the issues which affect the process of IoT with Agriculture. The fifth section explains about the new trends of the IoT and sixth section for discussion and the seventh section is about future directions.

2. IoT TECHNOLOGIES

IoT technology is based on the object whose IP address makes it identifiable on the internet [6]. IoT can consider as interconnecting of physical and virtual things using communication technologies. Three types of networks can be identifying in IoT. Namely, things to things, things to people and people to people.

IoT technologies can be divided into two parts. They are Enabling building blocks and Synergistic Technologies. Application software interfaces and protocols of electronic communication, Microcontrollers, Wireless communication, RFID technology provide communication between devices while Energy harvesting technologies, Sensors, Actuators, Location technology (GPS), Software. Geo-tagging/geo-caching provides the opportunity to catch data for analyzing Biometrics, Machine vision, Robotics, Augmented reality [3] belongs to Synergistic Technologies.

Interconnecting of heterogeneous entities is a major challenge in IoT. Some of enabling technologies are construed in this passage.

2.1 Sensors

Sensors are the real world requirement that facilitates to sense their environment and help humans to manage the environment without their presence [7]. Sensors are depended on application scenario. Various kinds of sensors like Gas sensors, Humidity Sensors, Water Quality Monitoring Sensors, Animal monitoring sensors can use for Smart Agriculture for gathering data. With help of microcontrollers, sensors are integrated into smart devices [2]. Security devices facilitate data collection also [8]. Furthermore, Cameras, Microphones also be used for enabling Smart devices. The application servers support for water management, fertilize and ventilate and temperature control automatically [9].

2.2 Communication Technologies

To interconnect devices, Communication technologies to be used. There are many of them. Such as Radio Frequency Identification (RFID), Wi-Fi, ZigBee, Mobile Phone Technologies, WirelessHART, Ethernet...etc. Additionally, wireless Radio Frequency information exchange solutions like ZigBee and Bluetooth are facilitate high data rates with in restricted area at very small cost [10]. Communication technologies make link between sensors and cloud computing. Transferring data for analytics and further use is done by communication Medias.

2.3 Cloud Computing Technologies

Cloud Computing provides the opportunity for on-demand connection to shared many assets such as servers, storage, networks, applications, services...etc. Software as a service (SaaS), Platform as a Service (PasS), Infrastructure as a service (IaaS) are three service types in cloud computing where farmers can store, analyze and interpret the data for making decision making.

The following figure (Figure 1) is about the Architecture of the IoT framework and the connectivity between the layers. Devices are used for capturing data, for connecting devices with cloud technology Wi-Fi, Ethernet, broadband services are used together with REST, Soap and Custom web services. Analyzing, Decision making and send the output to the cloud is performed by the Application layer.

IoT has a significant impact on Agriculture field for empowering its efficiency and effectiveness. In order to apply IoT for Smart Agriculture following prerequisites should be satisfied. The model should be robustness. Before start designing and implantation of the right kind of products and services, features and uncertainties should be considered. Most applications should be scalable because farm sizes vary with each

other. Inexpensiveness of products and services is the key to success. The cost has to be suitable with large benefits. Costs of infrastructure can be brought down by using Standardized platforms, tools, products, and services [3].

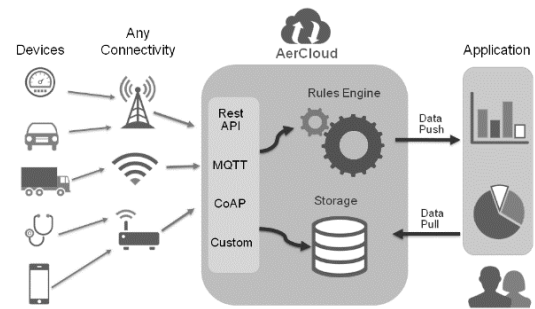


Figure 1. Architecture of IoT for Smart Agriculture [26]

3. IoT IN SMART AGRICULTURE

So many researchers have been gone for researches to find the areas that can be improved by IoT for Smart agricultural. The following areas of Agriculture have been empowered by IoT. Weather forecasting, Farm Monitoring, Smart Irrigation for water management, Smart market systems are the improved Agricultural areas. Digital agriculture and a fine combination of the modern agriculture production methods and the latest technologies is very important [11].

The following figure (figure 2) shows the areas that can improve by IOT framework and how these areas have been connected each other. The following areas of Agriculture field can be empowered by IoT Framework. Many researchers have discovered following areas of Smart Agriculture.

3.1 Monitoring and control systems

According to Funmilayo and Emmanuel research about how to apply IoT for Nigerian agriculture, they have identified that monitoring and controlling systems are very important. Predictions for management of pest, humidity, precipitation, crop type, soil fertility, leaf wetness, temperature, winds and soil moisture are collected at the local level through sensors [12]. RFID for stock and animal monitoring facilitate farmers to protect their resources from theft.

Based on correlation analysis between the crop statistical information and agricultural environment information are made IoT based agricultural system, to facilitate analyze existing conditions and forecast future harvest [3]. According to Deepak Sharma's research on Indian agriculture, he said that monitoring of temperature, moisture, pH level of soil is very important for farmers to increase their productivity through decision support systems.

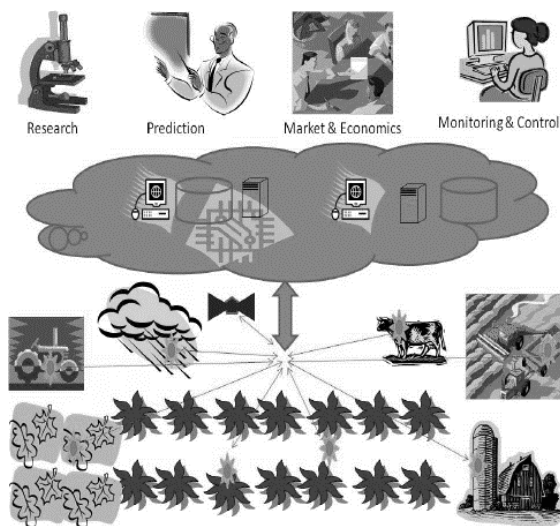


Figure 2. IoT for Agriculture applications [27]

For implement monitoring and controlling systems, many researchers work on identifying the technologies that can use for developing Smart agro monitoring and control systems. Nikesh Gondchawar has suggested following technologies for automation. Microcontrollers, ZigBee Modules, Raspberry Pi, different types of sensors for measure temperature, humidity, moisture and obstacles [13]. Using of these technologies for agriculture field help to farmers to raise their yield of crops.

IoT devices produce accurate information on a broad range of parameters that are required for improving farming methods and cultivation [14]. Soil miniaturization, water tank, and water level are measured by sensors placed in the agriculture field. These values are sent through the wireless network. That information is then sent to an intelligent software application for the analyze data automatically and act according to them [15].

Veld fires are also another bad situation that farmers can't avoid in rural areas. By using Satellite technology veld fires can be detected through heat-sensitive sensors and photos can transmit through the wireless network to relevant stations [16]. NomusaDlodlo and JosephatKalezhi said that the importance of monitoring different kinds of factors has a critical impact on yield of harvest. It can be seen from all the research works even though there is high technology, it is hard to avoid natural disasters.

3.2 Smart Irrigation system

Water management is an essential thing in the agriculture field. Many researchers said that for the used water inefficiently there should be IoT based smart irrigation management system for optimum water usage. Water level detecting sensors are used for this scenario [17]. By analyzing of data, decision support systems can predict the level of water that needs for future usage.

Flooding is a difficult situation in river basins. A web application can be set up with real-time performance of a river basin. The capability to see what is happening in a river basin and respond immediately to changing hydraulic and weather patterns can save a lot of lives in agricultural society. Sensors monitor surroundings and water level of the river basin and send information to web application [16]. The decision support systems could able to forecast about floods.

3.3 Organic Green Houses

In the past era greenhouses, it was sufficient to have one measurement point in the middle of a greenhouse to provide the information to the greenhouse automation scheme. The system is usually simple and facilitates opportunities to controlling of lights, heating and ventilation activities which changed the climate of greenhouse [18].

Sensor-based monitoring and controlling of temperature, humidity, soil aeration, soil moisture and drainage, fertility levels and light are the technologies used in Organic greenhouses. The integration of these techniques with the system to manage the green houses helps to farmers to utilize their assets in effectively for farming [16].

3.4 Agri-Business management

For uplifting the life style of farmers as well as improve the productivity. In order to facilitate the delivery of crops, fisheries, and dairy to the market RFID, GPS technologies can be used. For the selling and buying farm products to consumer, websites, and smartphones are utilized for effective communication.

Branchless banking services can be implemented with help of IoT technologies which facilitates farmers to do transactions. This will be beneficial for rural society who don't have banks within a reasonable distance [16].

3.5 Smart Food Processing and Manufacturing

Machines become IoT systems and embedded systems and local data processing procedures can make food processing phases more effective. Machines become autonomous because of intelligent systems and decision support systems [19]. Food processing becomes more efficient due to IoT based systems. Agricultural products like Dairy products, Grains can be processed using sensor based controlling systems are providing best products while minimizing wastage of crops.

3.6 Animal feed controlling

Feed controlling system another important application of IoT. It makes farmers' lifestyle easier while managing their animals like chickens, goats, and cows [20]. Without the presence of farmers, intelligent robots can feed animals. This will lead to more effectiveness in farming and lifestyle of farmers.

Using of these technologies farmers can make smart farming to empower their life style [21]. Though these technologies having drawbacks they are still very useful for farmers rather than manual processing of above application areas.

4. IoT ISSUES IN SMART AGRICULTURE

There are various issues identified in IoT for Smart Agriculture.

4.1 Educational level and computer literacy.

The major challenge is to spread the knowledge and awareness of such systems to the various stakeholders, particularly to the farmers [22]. In rural areas education facilities are lower than city areas. It has an impact on their literacy as well as computer literacy. Make awareness about computers, networking, and mobile technologies is some kind of challenge for farmers because of their lack of literacy and knowledge in particular areas. Then troubleshooting of the computers and network devices also challenge for farmers.

4.2 Cost of infrastructure

For smart farming, computers, routers, various types of sensors are needed. From the installments of the smart devices maintenance cost also happen during the utility. Cost of infrastructure become higher because of these reasons. Therefore, farmers are not willing to leave out their traditional way of farming.

4.3 Awareness about laws and Rights

Capturing recording and redisplaying can be done by it. New users had no awareness of using IT in early times. Therefor the data should be secured from the theft and pyramid schemes. Also, it is needed to understand the rights regarding IoT usage and knowledge of securing the privacy. Technologies should not only be used for "turning off cookies". Also should be careful about incredible information requires for the existence of the digital field of activity. There should be a clear understanding of human rights among the rural people. And also understanding about the black mark which can be happened consecutively after a crime. ICT is also should be emphasized that even when teaching technologies and internet regarding its usage.

4.4 Complexity, confusion and integration issues.

Multiple platforms, various API's and large number of protocols together with IoT system integration and testing will be difficult. The confusion between developing standards is make adaptation slow. Very quick developments in APIs increase abilities and new functionalities of the system [23]. Even though development of technology is good for farmers, it is

somewhat difficult to integrate those technologies to make hybrid systems.

4.5 Trust and Privacy

With remote sensors and managing systems are core of IoT, there is a large sensitiveness to managing and controlling and possession of property [24]. Privacy is urgently important problem which should solved with increasing number of end-users [14]. Dealing with large number of devices and sensors to be secured and trusted. But currently, there is a problem with trust and privacy. By improving network and devices more secured future of smart farming can be changed.

4.6 Handling large amounts of data from agricultural equipment

Agricultural equipment like tractors, green houses, and robots contain many sensors and devices which are generated a lot of data. The Agricultural sector has to work with these managerial load by handling a large amount of information to make accurate decisions [25]. Information has been generated by so many devices, then handling of all these data within the smart system is a challenge for those implement smart devices for the agricultural sector.

Even though IoT used Smart Agriculture has many problems, there are a lot of advantages of Smart Agriculture. Smart agriculture support for farmers to uplift their lifestyle with use of IoT. Surveillance schemes which facilitate to guide agriculture interferences [16]. Smart applications in agribusiness management, irrigation management, and organic greenhouses made farmers agro life more worth.

5. FUTURE DIRECTION OF SMART AGRICULTURE

Since IoT is in research level, still it can have developments in future in order to increase effectiveness and efficiency of agriculture sector.

- Development of more reliable sensors.
- Algorithms and systems for energy management efficiently and secure communication
- Development of agriculture specific-standards for IoT and cloud platforms
- Development of effective visualization and decision support systems
- Automation of agricultural processes
- Data analysis for planning, management, agricultural bio-informatics, and for finding new and improving existing process, methods and system.

6. CONCLUSION

The conflation of IoT with rural agriculture is very important for the worldwide economy. It can enhance the agriculture and can influence immensely toward rural division via applications. by using IoT, the services and information toward the farmers can be shared timely, accurately and relevantly. This causes

renaissance in agriculture. These data are important in individually as well as community manner. Also, they are used by public and private organizations. And the demand of them effects on the farmers in different areas. In order to these reasons adopting IoT is successful sometimes, also it can be failed. But the lesson learned from these failures can be used as experience. When combining IoT and ability of farmers it produces a particular impact on farm productivity as well as the socio-economic improvement. But the last result cannot be predicted without applying IoT completely. The common problem regarding adopting IoT can be identified and they are IoT illiteracy rural segment, unmatched irrelevant with their languages, lack of easy and affordable accessibility. Also the awareness and willingness of IoT effect on the rural people. Also sharing data is human dependent and it is needed to identify that which percentage of the need is to be addressed by the farmers. Also through this, it is required to find the solution for their problems. Not only this but also through IoT, farmers should be able to recognize and express their unmet needs.

In Sri Lanka, there are less number of IoT applications for Agriculture and most of them are still in research level. Government and academic sector can attain for developing IoT applications for smart agriculture as Sri Lankan primary occupation is agriculture.

Below table is about Current issues in Agriculture and the way of technology can be used for solve problems.

Table 1. Current issues in agriculture and IoT based solutions

Problem	Solution(s)	Other Technologies need	Future Direction
1. Lack of literacy and lower level of Education	Using computers and internet facilities Education level can be uplifted. Making an awareness sessions, technical sessions for improve knowledge	Wi-Fi, Ethernet, Mobile technologies , basic electrical and electronic technologies	Provide mobile applications made with their mother tongue Provide more reliable education system for learning
2. Water management	Smart Irrigation systems	Satellite technologies , GPS, networking, Cloud technology	Using big data, image processing technologies for decision support systems

3. Animal and Farm monitoring	Monitoring and controlling system for protect farms and animals from theft, protect crops from pest and making decisions about farming Internet facilities to be available for farmers	Wi-Fi, Ethernet, Mobile technologies , Various kind of sensors (temperature , humidity, moisture, obstacle), Cloud and networking	More reliable, need based and effective sensors Wearable virtual displays
4. Weather forecasting	Satellite and IoT based weather forecasting system.	Satellite, Wi-Fi, mobile technologies , sensors, Decision support systems	using Artificial Intelligence for weather forecasting
5. Baking and Access to market	Providing e-banking services E-marketing	Wi-Fi, Ethernet, Networking, Computers and mobile technologies	Virtual banking Virtual markets
6. Transport and logistics management	RFID, GPS tracking systems for vehicles is more effective to check about the delivery of goods.	RFID, GPS, microcontrollers, network technologies and mobile technologies	Robotics, artificial Intelligence for transport
7. Electric Power	Electrical technologies	Transformers	Solar power

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