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Original Article

An Impact Analysis of Marpol Annex 1, Legislative Developments on Oil Spills From Tankers

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Abstract

Gradual growing trend of marine transportation of oil inevitably results in accidental oil spills. The safety and preventive measures introduced internationally and nationally resulted in the reduction in the number of spills and amount of accidental releases to the sea in the past decades. However, recent incidents show that marine oil spills are unpredictable events that may cause significant damage to the environment, flora- fauna and coastal communities. The statistics of ITOPF- International Tanker Owners Pollution Federation and UNCTD- United Nations Conference on Trade and Development reports shows the percentage of tanker incidents which has occurred per year. Above databases are used for various studies in Shipping and found consistent and cross checked and continually updated. This paper analyzes the implementation of maritime environmental legislative Marpol regulation Annex 1 and impact on oil spills by tankers. The paper will focus on Marine oil spills worldwide over a 50 year period from 1970 to 2020 and discuss the relationship between Marpol Annex 1 versus Tanker oil spills.

Keywords: Marpol convention, Marpol Annex 1, Oil spills, double hull, Tanker Management and Self-Assessment programme-TMSA, International Tankers Oil Pollution Federation- ITOPF.

Introduction

Maritime transportation is the major form of international trade. Population growth, increasing standard of living, rapid industrialization, road congestion, and the development of technology, all of these contribute to the continuing growth in maritime transportation. Since 1980 the total international seaborne trade has increased by 69% in terms of weight. Tanker cargo has increased modestly as oil being the main source of energy provider for the world. Tankers carry nearly 2.0 billion metric tons of oil each year. With evolution of the Tanker fleet and transportation by sea, there is serious risk of oil pollution, both operational as well as accidental. The oil spills may cause serious harm to marine environment and can also cause heavy economic impacts to coastal states. [2].

In this study, key focus is to discuss how far world has succeeded achieving the goal of minimizing oil spills by analyzing the Marpol convention Annex 1 developments on oil spills by tankers during last 5 decades.

Main objective of the Study is to analyze maritime environmental legislative developments of Marpol Annex 1 on number of oil spills by tankers and oil spill volume.

Literature Review

The world's first oil tankers appeared in the nineteenth century and carried kerosene for lighting, but the development of the motor car fueled demand for oil. At the time of Second World War, the standard oil tanker was the T2 - 16400 tons deadweight, but tankers grew swiftly in size from the 1950's onwards. The first 100,000-tonne oil tanker was delivered in 1959 to cover the route from the Middle East to Western Europe round the cape of Good Hope. Shippers saw economies of scale in larger tankers and by the middle of 1960's, tankers of 200,000 tons weight, the Very Large Crude Carrier or VLCC had been ordered. [2]

The prospective for oil to pollute the marine environment was recognized by the International Convention for the Prevention of Pollution of the Sea by Oil in 1954 (OILPOL 1954). The Conference adopting by the United Kingdom government, and the Convention provided for positive functions to be undertaken by IMO when it came into being. The Convention established by International Maritime Organization has entered into force in 1958 just a few months before the OILPOL convention entered to force. So, International Maritime Organization effectively managed OILPOL from the start, firstly through its Maritime Safety Committee. [2]

MT Torrey Canyon built in 1967 ran aground when entering the English Channel and spilled her entire cargo of 120,000 tons of oil into the sea. T incident raised questions about procedures in place to prevent oil pollution from ships and also uncovered deficiencies in the present system for providing compensation following accidents at sea. It was fundamentally this incident that set-in motion the series of events that finally led to the adoption of MARPOL. [4]

Due to the enormous growth in the maritime transport of oil and the size of tankers, the increased amount of oil being carried at sea was a growing concerned for the world. Many countries feel that the 1954 OILPOL Convention was not adequate, despite the various amendments which had been adopted. In 1969 the International Maritime Organization decided to convene an international conference to adopt a completely new convention, which incorporate the regulations contained in 1954 OILPOL. At the same time, the Sub-Committee on Oil Pollution was renamed as the Sub Committee on Marine Pollution, to widen its scope, and this became the Marine Environment Protection Committee (MEPC), which was in time given the same standing as the Maritime Safety Committee, to deal with all matters relating to maritime pollution. The conference was set in October to November 1973, and introductory meetings began in 1970. [5]

The 1973 conference incorporated much of 1954 OILPOL and its amendments into Annex I covering oil, while other annexes covered chemicals, harmful substances conceded in packaged form, sewage and garbage. Annex I lengthened and improved on 1954 OILPOL in several ways. It specified requirements for constant monitoring of oily water discharges and incorporated the requirement for Governments to provide shore reception and treatment facilities at oil dealing terminals and ports. Also established many Special Areas in which stricter discharge standards were applicable, including the Mediterranean, Red Sea and Gulf and Baltic Sea areas. As it turned out, there was slow movement at ratifying the Convention and the non-ratification of MARPOL became a main concern. The same time, a series of accidents involved with tankers in 1976-1977, mostly at or near United States

waters and including the grounding of the MT Argo Merchant, led to demands for more rigorous action to control accidental and operational oil pollution. The MT Argo Merchant ran aground off Massachusetts on December 1976. It was a small tanker which carried 27,000 tons of oil, but effected huge public concern as the oil slick endangered New England resorts and Georges Bank fishing ground sea areas. [2]

The MARPOL Convention was adopted on 1973 at International Maritime Organization. The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. The 1973 MARPOL Convention had not however entered into force, the 1978 MARPOL Protocol absorbed the parent Convention and the combined instrument entered into force in 1983. [5]

IPIECA- (International Petroleum Industry Environmental Conservation Association) is the global oil and gas industries association for environmental and social issues. IPIECA was formed in 1974 which subsequently initiated the United Nations Environment Programme (UNEP). IPIECA is the global association connecting both the upstream and downstream oil and gas industry on environmental and social issues. IPIECA's membership covers more than half of the world's oil production. IPIECA is the industry's main channel of communication with the United Nations. As per their annual report 2020, while the amount of oil produced and transported has amplified as the world's economy has expanded, the general number of large spills has significantly decreased. This reduction is mainly due to efforts by companies operating throughout the oil supply chain to develop more efficient preventive measures. [6]

There are lot of published literature that explains or preaches oil spills and trend but there is relative lack of empirical studies examining oil spills by Tankers and environmental legislative developments. This study focuses on analysis of maritime environmental legislative regulations Marpol Annex 1, and developments of tankers to minimize oil spills.

Oil spills can appreciably affect the environment and surrounding of local communities. Even with advanced safety measures in place, the risk of an oil spill still remains. Since new oil resources in remote and sensitive environments are developed, there are new risks and challenges to be attended.

Research Methodology

The study focuses on secondary data of oil spill statistics 1970 to 2020 and convenience sampling method used in the study. Oil spill data used in this study are from the Environmental Research Consulting Spill Databases which collected data from a large number of sources and databases, including International Maritime Organization, International Tanker Owners Pollution Federation-ITOPF, United Nations Conference on Trade and Development- UNCTD statistics and other national and regional environmental agencies. On a continuously updated basis, the data are crosschecked and corrected with current information and new information on past events. Above Data gives more realistic picture on Tanker oil spills and they are reliable and approved by IMO.

A Least Significant Different test (LSD test) was utilized to analysis the relationship between Marpol Annex 1 legislative developments and Marine oil spills. MS Excel and SPSS software

were utilized for the purpose of analysis of the collected data.

Limitation of the study:

I. Less than 7 tones oil spills not taken into consideration as most of them are not reported and
unable to get correct figures.
II. Oil products as cargo transferring taken into considerations and tankers and non-tanker vessels'
bunker oil not taken in to account.
III. Study analyses is limited to Maritime Environmental Legislative developments of Marpol
convention Annex 1.

Discussion

The International Convention for the Prevention of Pollution from Ships (MARPOL) is that the main international convention aimed toward the prevention of pollution from ships caused by operational or accidental causes. Marpol consists of 6 annexes. In this study, main focus is on Annex 1 and how its implementation helped to minimize oil spills in Marine Environment.

Annexes	Date of Entry into force
Annex I – Regulations for the Prevention of Pollution by Oil	2 October 1983
Annex II – Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk	2 October 1983
Annex III – Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form	1 July 1992
Annex IV – Prevention of Pollution by Sewage from Ships	27 September 2003
Annex V – Prevention of Pollution by Garbage	31 December 1988
Annex VI – Prevention of Air Pollution from Ships	19 May 2005

Table 1 – Marpol Annexes , Constructed by Author
Source : https://www.researchgate.net/Marpol

Marpol Annex I (Oil) came into force on 02nd October 1983 and contains conditions for discharge of mixtures containing oil and additionally needs applicable to the development and instrumentation of tankers larger than 150GRT and other ships larger than 400GRT. This Annex relies on the principle that oil and water is not easy to separate. It contains requirements relating to the operation, construction and instrumentation of ships. The operational needs stipulate the conditions that ships could discharge water/oil mixtures into the ocean. The different construction needs are such to minimize the probabilities of oil freight tank penetration within the event of accident, i.e. double hull construction and protecting locations with segregated ballast tanks. Needs for minimizing oil pollution from oil tankers within the event of bottom damages penetrating the freight oil tanks. [2]

The development and instrumentation are needed to suit the discharge conditions. Other construction needs are such to reduce the probabilities of oil leaks in case of accident i.e., double hull construction and protecting location of segregated ballast tanks. Requirements for minimizing oil pollution from oil tankers within the event of bottom damage are enclosed as below. [7]

A. Control of Operational Discharge of Oil (Discharges outside special areas)

Any discharge to the sea of oil or oily blends from the cargo area of an oil tanker, shall be proscribed except where all the following conditions are satisfied:

a. The tanker is not in a dedicated special area;
b. The tanker is over 50 nautical miles from the closest territorial land.
c. The tanker is making way, enroute;
d. The rapid rate of discharge of oil content does not exceed 30 liters per nautical mile;
e. the total quantity of oil discharged into the sea does not exceed for tankers delivered on or

before 31st December 1979, as defined in regulation 1.28.1, 1/15,000 of the total quantity of the particular cargo of which the residue formed a part, and for tankers delivered after 31st December 1979, as defined in regulation 1.28.2, 1/30,000 of the total quantity of the particular cargo of which the residue formed a part; and

f. the tanker possesses operational an oil discharge monitoring and control system and a slop tank pre arrangement as required by this Annex. [5]

B. Marpol Annex 1 Special Areas

There are several particular sensitive areas defined by Marpol as special areas .By definition special area is an ocean area where for recognized technical reasons, oceanographical, ecological and traffic conditions special obligatory plans are required. [5]

MARPOL Annex I: Oil

Special Areas	Adopted on	Entered into force
Mediterranean Sea	2-Nov-1973	2-Oct-1983
Baltic Sea	2-Nov-1973	2-Oct-1983
Black Sea	2-Nov-1973	2-Oct-1983
Red Sea	2-Nov-1973	2-Oct-1983
"Gulfs" Area	2-Nov-1973	2-Oct-1983
Gulf of Aden	1-Dec-1987	1-Apr-1989
Antarctic area	16-Nov-1990	17-Mar-1992
North West European waters	25-Sep-1997	1-Feb-1999
Oman area of the Arabian Sea	15-Oct-2004	1-Jan-2007
Southern South African waters	13-Oct-2006	1-Mar-2008

Table 2 – Marpol Annex 1- Oil, Special Areas _Constructed by author Source: https://marinerscircle.com/special-areas-marpol

Oil or oily mixtures discharges in special areas into the ocean totally prohibited. The provisions of this regulation shall not apply to the discharge of clean or segregated ballast.

C. SOPEP - Shipboard Oil pollution Emergency Plan

To help Administrations and shipowners meet these necessities, IMO has formed rules and regulations event of oil pollutions at sea.

Regulation 37 of MARPOL Annex requests that oil tankers of a 150 gross tonnage and more and over 400 gross tonnage cargo ships to carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP) [2]

It is recommended to have onboard tankers marine oil spill kits. Marine oil spill kits are designed as a marine oil spill response measure to be deployed easily and effectively. They must be used in combination with the vessel's response plan as required by Marpol Annex 1 regulations. Contents of the kit are, 1 roll of plastic bags, 2 sorbent pads , 6 pairs spill kit gloves, 6 disposable boiler suits, 6 pairs safety boots, 25 liters aqaubreak PX a water based cleaning chemical, 1 jet spray tool, 1 oil spill kit bag with 1000 liters capacity. [8]

Figure 1 - Oil Spill Response Kit, Source: https://survitecgroup.com/

D. Marpol Annex 1_ IOPP Certification

After satisfactory of survey of each vessel, International Oil Pollution Prevention (IOPP) certificate will be issued by Classification society certifying that the vessel occupied with all mandatory equipment, complying requirements and regulations as well crew are trained and familiar with Marpol Annex 1 procedures. [2]

The validity of the IOPP certificate is five years and certificate subjected to annual and intermediate verifications by Classification societies where vessel is inspected to make sure that the vessel following all required regulations and requirements as per Marpol Annex 1.

E. International Maritime Organization, Flag states and Port State Control

The International Maritime Organization (IMO) is the administrative body that is chargeable for all shipping activities. As of 2020, there are 174 member states of the International Maritime Organization. With legislative of international conventions, IMO follows mandatory regulations and requirements to control pollution from Ships. [9]

The flag state is the country where the respective Ship registered and Flag state maintains regulations and requirements on board their ships as per Marpol conventions.

On the other hand, Port State Control (PSC) is responsible of inspection of foreign ships in national ports to validate that the condition of the ship and its apparatus comply with the requirements of international protocols and the ship is crewed and functioned in compliance with rules.[9]
During every port State control inspection, the ship's Oil Filtering Equipment, IOPP certifications, crew training, preparedness for the emergency and maintenance are verified as per MARPOL Annex I. For this purpose, Port State control officer (PSCO) uses a questionnaire listing items that covered the essential information to investigate whether a ship complies with the requirements. In case vessel fails to demonstrate the compliance of Marpol regulations, recommendations and corrective actions will be suggested by Port State Control Officers which should be attended by Ship staff promptly and take necessity corrective measures.[9]

F. Tanker vetting Inspections

A review of Tankers to measure that a vessel, its employees and its management's meet the terms with international legislation and trade standards, so as to facilitate a prospective charterer to achieve the suitability of a vessel to carry their cargoes. Vetting and approvals can make sure that the Tankers are appropriate to carry prescribed consignment of shipment and obliging mandatory Marpol and safety standards. [2]

G. Double hull Tanker constructions

Double hull tanker constructions were introduced to make sure protection against pollution at the event of a collision or stranding.

The amendments introducing double hulls were contained in Regulation 13F - prevention of oil pollution in case of collision or stranding. The amendments were adopted in 1992 March and entered into force in 1993 July. Regulation 13F applies to new tankers defined as delivered on or after 6th July 1996, while existing oil tankers must fulfill with the requirements of 13F not later than 30 years after the date of their

delivery.

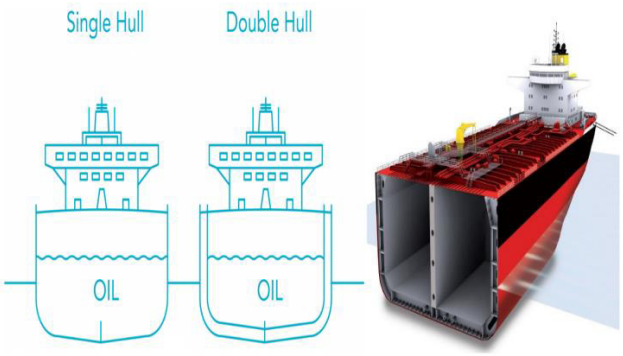


Figure 2 – Double hull tanker construction Source : https://pbs.twimg.com/media

Tankers of 5000 dwt and above must be fitted with double bottoms and wing tanks lengthen the full depth of the ship's side. This regulation allows middeck height tankers with double sided hulls as a substitute to double hull construction tankers. Oil tankers of 600 dead weight and above but less than 5000 dwt must be fitted with double bottom tanks and the capacity of each cargo tank is restricted to 700 cubic meters, if not they are fitted with double hulls. The MEPC also adopted regulation 13G, alarmed with existing tankers which makes provision for an enhanced survey programs .[7]

Position	Shipname	Year	Location	Spill size (tonnes)
1	ATLANTIC EMPRESS	1979	Off Tobago, West Indies	287,000
2	ABT SUMMER	1991	700 nautical miles off Angola	260,000
3	CASTILLO DE BELLVER	1983	Off Saldanha Bay, South Africa	252,000
4	AMOCO CADIZ	1978	Off Brittany, France	223,000
5	HAVEN	1991	Genoa, Italy	144,000
6	ODYSSEY	1988	700 nautical miles off Nova Scotia, Canada	132,000
7	TORREY CANYON	1967	Scilly Isles, UK	119,000
8	SEA STAR	1972	Gulf of Oman	115,000
9	SANCHI*	2018	Off Shanghai, China	113,000
10	IRENES SERENADE	1980	Navarino Bay, Greece	100,000
11	URQUIOLA	1976	La Coruna, Spain	100,000
12	HAWAIIAN PATRIOT	1977	300 nautical miles off Honolulu	95,000
13	INDEPENDENTA	1979	Bosphorus, Turkey	95,000
14	JAKOB MAERSK	1975	Oporto, Portugal	88,000
15	BRAER	1993	Shetland Islands, UK	85,000
16	AEGEAN SEA	1992	La Coruna, Spain	74,000
17	SEA EMPRESS	1996	Milford Haven, UK	72,000
18	KHARK 5	1989	120 nautical miles off Atlantic coast of Morocco	70,000
19	NOVA	1985	Off Kharg Island, Gulf of Iran	70,000
20	KATINA P	1992	Off Maputo, Mozambique	67,000
21	PRESTIGE+	2002	Off Galicia, Spain	63,000
36	EXXON VALDEZ+	1989	Prince William Sound, Alaska, USA	37,000
132	HEBEI SPIRIT+	2007	South Korea	11,000

Major oil spills since 1967 (quantities have been rounded to nearest thousand)

Table 3: Major oil spills since 1967, Source ITOPF 2020

VI. Data Analysis

Before implementation of Marpol Annex 1 1983 versus after implementation of Marpol Annex 1

International Tanker Owners Pollution Federation (ITOPF) maintains a database of oil spills from oil tankers. This contains information on accidental spillages since 1970.

The data collected includes the type of oil spill, the spill amount, the cause and location of the incident and the vessel involved. Spills are generally categorized by size, <7 tones, 7–700 tones and >700 tones Information is now held are nearly 10000 incidents. The vast majority of which (81%) fall into the least category <7 tones, These spills are small (few tones less than 7 tones) and information on numbers and amounts is incomplete due to the conflicting reporting of smaller incidents worldwide.

It is apparent from Table 4 that the number of large spills [>700 tons] has decreased considerably during the last 4 decades during which records have been kept. A turn down can also be observed with medium sized spills [7–700 tons] in Table 2. Here, the average number of spills in the 2000s was 18, whereas in the 1990s the average number of spills was almost double this number. It can be seen that the number of accidental oil spills in both size groups has reduced in each successive 10 year period over last 40 years.

Year	Oil Spills 7 to 700 tons	Oil Spills over 700 tons	Total Oil spills over 7 tons	Average Total spills for last 10 years
1970	7	30	37	
1971	18	14	32	
1972	48	27	75	
1973	28	31	59	
1974	90	27	117	**78**
1975	96	20	116	
1976	67	26	93	
1977	69	16	85	
1978	59	23	82	
1979	60	32	92	
1980	52	13	65	
1981	54	7	61	
1982	46	4	50	
1983	52	13	65	
1984	26	8	34	**45**
1985	33	8	41	
1986	27	7	34	
1987	27	10	37	
1988	11	10	21	
1989	33	13	46	
1990	51	14	65	
1991	30	7	37	
1992	31	10	41	
1993	31	11	42	
1994	26	9	35	**36**
1995	20	3	23	
1996	20	3	23	
1997	28	10	38	
1998	25	5	30	
1999	20	6	26	
2000	21	4	25	
2001	17	3	20	
2002	12	3	15	
2003	19	4	23	
2004	17	5	22	**18**
2005	22	3	25	
2006	13	5	18	
2007	13	4	17	
2008	8	1	9	
2009	7	1	8	
2010	4	4	8	
2011	5	1	6	**7**
2012	7	0	7	
2013	5	3	8	
2014	4	1	5	
2015	6	2	8	
2016	4	1	5	
2017	4	2	6	
2018	4	3	7	
2019	2	1	3	
2020	3	0	3	

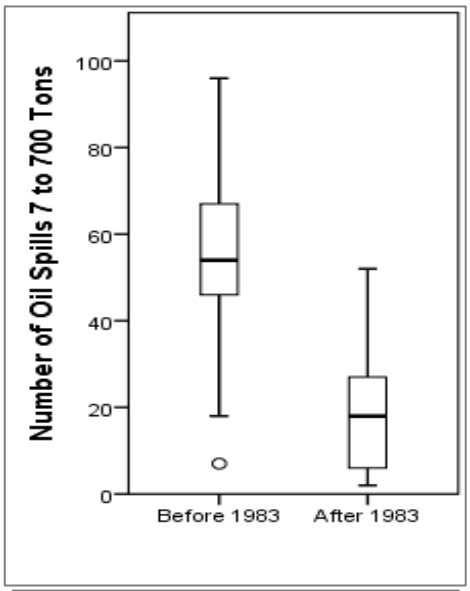
Table 4 : Annual number of oil spills (>7 onnes) Source ITOPF ,constructed by author

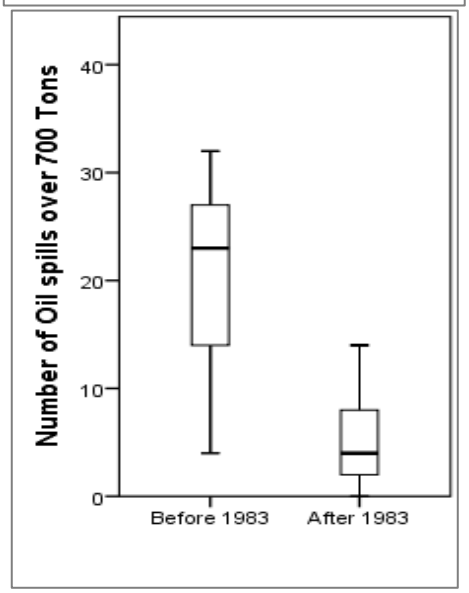
It is apparent from Table 5 quantity of Oil spills has decreased considerably during the last 4 decades during which records have been kept. There was a distinguishable incident at Table 1 where "Sanchi" tanker which collided with a Cargo ship in 2018. Due to this 113000 tons of oil spilled to sea. When evaluating the reason for this spill it is evident that spills occur due to Collison and Fire mainly due to human error. Apart from above occurrence there is clear downward trend of quantity of oil spill.

Year	Quantity (Tonnes)	Year	Quantity (Tonnes)
1970	383000	1997	72000
1971	143000	1998	13000
1972	313000	1999	29000
1973	159000	2000	14000
1974	173000	2001	8000
1975	351000	2002	67000
1976	364000	2003	43000
1977	275000	2004	16000
1978	393000	2005	18000
1979	636,000	2006	23000
1980	206000	2007	19000
1981	48000	2008	3000
1982	12000	2009	2000
1983	384000	2010	12000
1984	29000	2011	2000
1985	85000	2012	1000
1986	19000	2011	7000
1987	30000	2012	5000
1988	190000	2013	7000
1989	174000	2014	5000
1990	431000	2015	7000
1991	167000	2016	6000
1992	167000	2017	7000
1993	140000	2018	116000
1994	130000	2019	1000
1995	12000	2020	1000
1996	80000		

Table 5 : Annual quantity of oil spills (>7 tonnes) – Source ITOPF ,constructed by author.
[Quantities have been rounded to nearest

thousand]





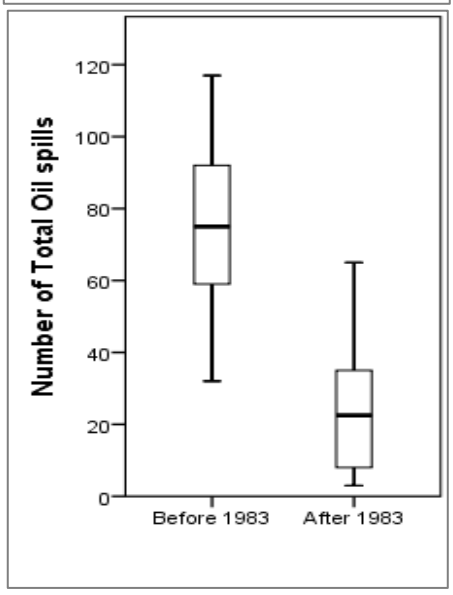


Table 6 - Number of Oil Spills, Source: IBM SPSS software

Hypothesis 1

H0 – There is no significant different between Number of oil spills before 1983 and after 1983

Vs

H1 – There is a significant different between Number of oil spills before 1983 and after 1983

Group Statistics

	class	N	Mean	Std. Deviation	Std. Error Mean
oilspills7to700	Before 1983	13	53.38	25.487	7.069
	After 1983	38	18.11	12.814	2.079
oilspillsover700	Before 1983	13	20.77	9.248	2.565
	After 1983	38	5.21	3.967	.644
Totaloilspills	Before 1983	13	74.15	26.876	7.454
	After 1983	38	23.32	16.361	2.654

Table 7 – Group Statistics: IBM SPSS software

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
oilspills7to700	Equal variances assumed	6.181	.016	6.526	49	.000	35.279	5.406	24.416	46.143
	Equal variances not assumed			4.788	14.131	.000	35.279	7.368	19.490	51.069
oilspillsover700	Equal variances assumed	23.583	.000	8.451	49	.000	15.559	1.841	11.859	19.258
	Equal variances not assumed			5.884	13.541	.000	15.559	2.644	9.869	21.249
Totaloilspills	Equal variances assumed	5.902	.019	8.127	49	.000	50.838	6.255	38.267	63.409
	Equal variances not assumed			6.425	15.157	.000	50.838	7.912	33.988	67.688

Table 8 – Independent Samples test: IBM SPSS software

Levene's Test for Equality of Variances:

The p-values of Levene's test is less than 0.05 in all 3 cases, therefore reject the null of Levene's test and conclude that the variance is significantly different before and after 1983.

T-test for Equality of Means:
The p-values of t-test is less than 0.05 in all 3 cases, therefore reject the null of t-test and conclude that the variance is significantly different before and after 1983.
Since $p < 0.05$ is less than the significance level $\alpha = 0.05$, therefore null hypothesis is rejected, and conclude that, There is a significant different between implementation of Marpol regulations Annex 1 and Number of oil spills events.

With evaluation data it is evident that there is significant difference of Number of oil spills after implementation of Marpol Annex 1. Number of Oil spills showing a downward trend with effects of Marpol regulations.

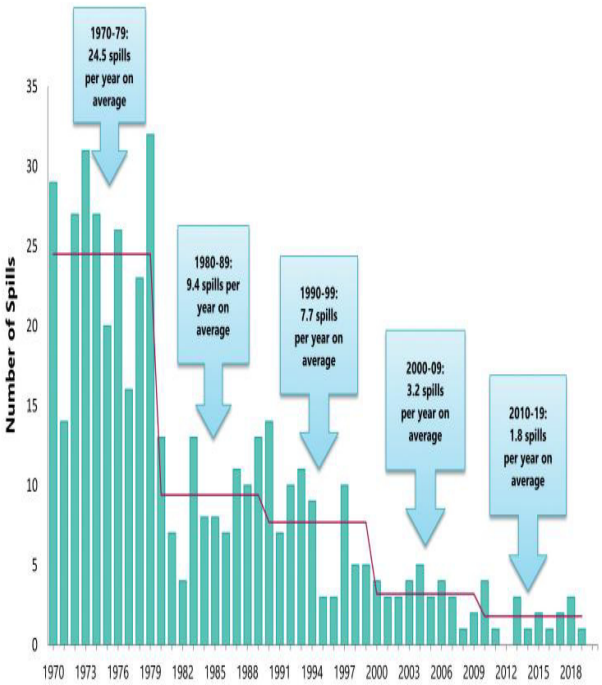


Figure 3 – Number of Oil spills, Source: ITOPF

Hypothesis 2
H0 – There is no significant different between quantity of oil spills before 1983 and after 1983
Vs
H1 – There is a significant different between quantity of oil spills before 1983 and after 1983

Group Statistics

	class	N	Mean	Std. Deviation	Std. Error Mean
quantity	Before 1983	13	265846.15	167507.137	46458.121
	After 1983	38	66842.11	99474.980	16136.973

Table 9- Group Statistics: IBM SPSS software

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
quantity	Equal variances assumed	6.105	.017	5.171	49	.000	199004.049	38481.176	121673.23	276334.86
	Equal variances not assumed			4.046	14.999	.001	199004.049	49180.879	94177.13	303830.96

Table 10- Independent Samples test: IBM SPSS software

Levene's Test for Equality of Variances:
The p-values of Levene's test is less than 0.05, therefore reject the null of Levene's test and conclude that the variance is significantly different before and after 1983.

T-test for Equality of Means:
The p-values of t-test test is less than 0.05, therefore reject the null of t-test and conclude that the variance is significantly different before and after 1983.

Since $p < 0.05$ is less than the significance level $\alpha = 0.05$, therefore null hypothesis is rejected, and conclude that, There is a significant different between There is a significant different between implementation of Marpol regulations Annex 1 and oil spill volume.

With evaluation data it is evident that there is significant difference of quantity of oil spills after implementation of Marpol Annex 1. Quantity of Oil spills showing a downward inclination with effects of Marpol regulations.

Conclusion

As identified, the safe transportation of liquid petroleum shows a track record that has been improving. The shipping industry, IMO, port

states and other organizations have taken many actions to decrease these undesirable events. With MARPOL Annex 1 new industrial programs underway not only to prevent oil spills but continue to improve safety and emergency preparedness onboard. The time may come when oil will be replaced by other energy sources, but in today's demanding world, where approximately 198300 tons of fuel, of all various types, are moved each day. [11]

There is an overall downward trend in the number of oil spills and the volume of oil split during last 4 decades. It has been found that large quantities of oil split can result from just few incidents, the cause of which is typically collisions, groundings or hull failure. But it should be noted that the frequency of these incident is declining.

After careful analysis of the data the paper shows that there is a clear downward trend of spills, spilt volume as well as number of spill incidents of Tankers. This has achieved with contribution to implementation and enforcement of conventions and regulations, as the study analyses implementation of Marpol Annex 1 shows significant difference in oil spills before and after implementation of above legislative developments.

This paper argues that there is a potential decrease of oil spill volume and number of spills after analyzing spill data with implementation of Marpol developments from 1970 to 2020. World’s tanker oil spill reduction in volume as well as number of spills depends on various facts. This is a gradual process which takes time, training, adoption, technology and good seamanship practice with good safety behavior onboard to achieve the goal of safer environment and Cleaner Ocean.

Suggestions and Recommendations

Shipping industry and coastal states need to continue efforts in spill reduction, prevention and cleanup. The Marine Environment Protection Committee (MEPC) needs to become a reality to provide additional safety to the environment. Constant research in oil spill cleanup and prevention needs to be continued. The tanker designs and safety arrangements should ensure the least amount of oil is spilled when an accident occurs. Assessments on current training practices need to be continually reviewed and enhanced when necessary. Safety practices in all oil operations must be continually stressed and reviewed to make sure safe vessel passage. In addition, future waterway structures need to be surveyed and examined to provide the least accident-prone environment.

Emphasis in this all important aspect of petroleum movement must never take a back seat position. It has been assessed that the reduction of oil pollution to zero was impossible if oil was to continue to be transported by sea. Accordingly, efforts must continue in this decisive aspect of petroleum management to ensure the highest potential caliber of petroleum movement safety, to provide the maximum possible protection to the environment. This should result in a continuous reduction in oil spills, and their impacts, in years to come.

Several international standards are recommended for certification of management policies and programs. Navigational watch practices to include recommendations covering standards for navigation duties, anchor watches, engineering watches and security rounds for tanker vessels. There should be recommended written emergency procedures by the shipping companies to cover all probable emergency

conditions and appropriate actions under such conditions. Regarding personnel policies, recommended that the tanker and tank barge crew members required to participate in a comprehensive personnel training program which covers vessel orientation, detailed requirements for each position, regular refresher training and frequent safety and response drills. Also crew members to be monitored for fitness and receive yearly performance evaluations.

The person in charge of oil transfers to be proficient in English and multinational crew should use a common language understood and spoken by ships' crew. Proper communication has to be established prior to transfer petroleum products one tanker to another, to a barge or to a shore facility.

Strict rules to be employed by the tanker owner/operator ensure that no crew member is under the influence of alcohol or illicit drugs while performing their duties.

It is recommended by IMO to have marine oil spill kits onboard tankers. Marine oil spill kits are designed as a marine oil spill response measure to be deployed easily and effectively.

Suggestions for Further Research

This study mainly focuses on MARPOL environmental legislative developments and oil spills related to tankers carrying oil as cargo.

Study oil pollution trend with non-tanker vessel bunker oil which is used for engine consumption, Study economy impact of tankers and non-tankers oil spills, Analysis of safety legislative developments on tanker safety and A review of new designed tanker's oil spill prevention procedures are some of future research opportunities with regard to oil spills.

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Original Article

Analysis on the Road Traffic Congestion in Colombo Metropolitan Area

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Abstract

The main focus of this study is aimed at understanding the factors causing traffic congestion in Colombo Metropolitan Area. Therefore, the study was carried out to address major research questions as, what factors affecting the current vehicle traffic flow, followed by what are the impacts of traffic congestion and what is the opportunity cost of time and fuel wastage cost of congestion. The main objective of the research was to identify the factors affecting the current vehicle traffic flow in Colombo, while the specific objectives of the research are to identify the impacts of traffic congestion, to estimate the opportunity cost of time and fuel wastage cost and to identify whether the commuters are satisfied with the strategies implemented by the government to mitigate traffic congestion. Accordingly, from the survey conducted for the commuters, the researcher identified factors such as **"Growth of population and vehicles"**, **"Unforeseen circumstances", "Events and incidents"** has an individual effect on the current vehicle traffic flow. In addition to that the researcher identified the main impacts of traffic congestion as **"Time", "Fuel", "Earnings**" and **"Productivity".** And also the esearcher identified that majority of the commuters are satisfied with the Bus Priority Lane and Park and Ride, while majority of the commuters neither satisfied nor dissatisfied with the Ferry Service as a strategy implemented to mitigate traffic congestion.

Keywords: Traffic Congestion, Vehicle Traffic Flow, Opportunity Cost, Fuel Wastage

Introduction

Traffic congestion remains a significant problem in most cities around the world, especially in developing countries, resulting in huge delays, increased fuel wastage and monetary losses. Due to inadequately planned road networks, the common outcome in several developing countries is the existence of small critical areas which are common hotspots for congestion. Inadequate traffic management around such hotspots is likely to result in extended traffic congestion. (Jain, Sharma, & Subramanian, 2012)

However, traffic congestion is much more a result of the basic mobility problem, which is that several people want to move at the same time every day. For example, the efficient functioning of the whole society system requires people to go to work, go to school, and even walk around at the same time and interact with each other.

A. Significance of the Research

The study identifies the factors causing traffic congestion in Colombo Metropolitan Area and its impact. This study will increase the awareness of motorists and the public about the importance of knowing the impact of traffic congestion. This is of significance to the transport planners of the Colombo city in assisting their future transport projects within the city and for the government and regulated authorities to implement policies. For future researchers, this research will serve as a basis and a source of perspective leading to their exploration for the improvements of this study. They can also come up with questions that did not answered by this study. And also they can use this to expand the scope of the study to investigate about the country's traffic congestion.

B. Research Problem and Objectives

Transport demand has increased significantly over the last few decades, especially in the Colombo Metropolitan Area. As demand for traffic increased, traffic congestion increased resulting in many negative consequences. This causes economic losses, travel time costs and increased operating costs for vehicles, such as fuel consumption. Taking into consideration that it has a negative impact on economic and environmental aspect of the society, it is crucial for social well-being to address this issue

Although many actions were taken to mitigate traffic congestion in the city of Colombo, most of them have not been successful. This suggests that this problem is growing exponentially and should be addressed persistently in order to avoid the negative consequences

Main Research Objective

1) To identify the factors causing traffic congestion in Colombo Metropolitan Area.

Specific Research Objectives

1) To identify the relationship between factors causing traffic congestion and the current vehicle traffic flow.
2) To identify the impacts of traffic congestion on selected demographic variables.
3) To calculate the opportunity cost of time and fuel wastage cost of traffic congestion.
4) To identify whether the commuters are satisfied with the strategies implemented
5) By the government to mitigate the traffic congestion.

Literature Review

According to the European Conference of Ministers of Transport (ECMT), there is no specific definition of traffic congestion and it can be defined in different ways (Managing urban traffic congestion, 2007). The most common definition of congestion in the state of traffic flow is when travel demand exceeds the capacity of the road. (Aftabuzzaman, 2007). From the viewpoint of delay travel time, congestion occurs when the usual flow of traffic is interrupted by a high density of vehicles resulting in excess travel time.

Table 1: Factors causing traffic congestion

Factor	Reference
Excessive Number Of Vehicles	(Report on the Study of Road Traffic Congestion in Hong Kong, 2014)
Population Growth	(Raheem, Olawoore, Olagunju, & Adeokun, 2015)
Inefficient Public Transport Services	(Harriet, Nkrumah, & Anin, 2013)
Inefficient Road Traffic Management	(Jain, Sharma, & Subramanian, 2012) (Nadeeshan & Mudunkotuwa, 2018)
Poor Roadway Condition	(Reddy & Tilak, 2016)
Unforeseen Circumstances	(Schwietering & Feldges, 2016)
Illegal parking	(Mahmud , Gope, & Chowdhury, 2012)
Improper planning of city and urban development	(Mahmud , Gope, & Chowdhury, 2012)
Economic Development and Urbanization	(Reddy & Tilak, 2016)
Higher purchasing power of public	(Mahmud , Gope, & Chowdhury, 2012)
Improper lane management	(Mahmud , Gope, & Chowdhury, 2012)

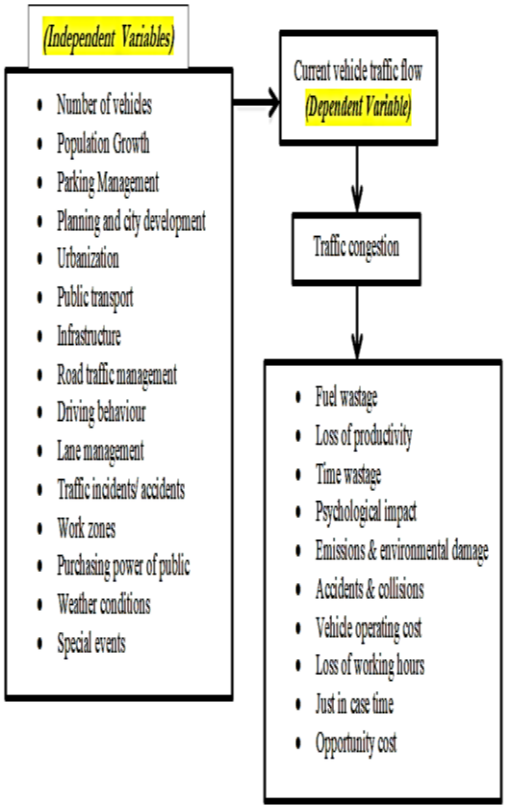
The impacts of traffic congestion could be classified into four main groups of environmental, economic, social and health. The nature, extent and severity of the consequences differs between one city to another, depending among many other things, on city size, road capacity and street layout, land use spatial distribution, travel patterns and public and private modes of transport. (Mahmud , Gope, & Chowdhury, 2012)

Research Methodology

A. Research Design

The research design falls in to the category of casual research where the main objective is to verify the extent and nature of cause-and-effect relationship between variables.

Figure 1: Conceptual Framework



B. Sample and Sampling Technique

Among the entire population of Colombo, data from more than 250 commuters were collected within the Colombo Metropolitan Area on the basis that each commuter encountered traffic congestion in Colombo. The researcher has used convenience sampling technique as the sampling method for this study.

C. Data Collection

A questionnaire was prepared to collect the primary data required for the study.

D. Data Analysis

The statistical tool being used in this research is SPSS version 16.0. Analysis of the data consists of Descriptive Analysis, Factor Analysis, Correlation Analysis, Regression Analysis and Chi Square Test.

Results and Discussion

A. Identification of the factors causing traffic congestion

The Cronbach's Alpha is a widely spread convenient statistical technique or tool to measure the internal consistency (reliability) of a psychometric test. If the value of Cronbach's Alpha is higher than 0.7, it is in an acceptable level.

Table 2: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.835	.840	15

The reliability of the overall data set exceeding the Cronbach's Alpha value of 0.7 and ultimately resulting 0.835, allowing the conclusion that reliability of the data set is at its acceptable level. The calculated KMO statistic value is 0.847 suggests that there is a proportion of variance in the data set that might be caused by underlying factors. Since the statistic is mor than 0.6 indicated that a factor analysis will be useful with the data set (Gamachchige & Mudunkotuwa, 2017)

To identify factors, Rotated Component Matrix has been drawn using Varimax Method. 15 Factors were reduced to 4 factors.

Factor 1 - Infrastructure and Development
Factor 2 - Growth of population and vehicles
Factor 3 – Unforeseen circumstances
Factor 4 – Events and incidents

B. Correlation Analysis

The association between the current vehicle traffic flow and the identified four factors are tested by using the Pearson Correlation Analysis.

The hypothesis used in Correlation Analysis is as follows;

H0: There is no association between current vehicle traffic flow and i^{th} factor

H1: There is an association between current vehicle traffic flow and i^{th} factor

(ith factor = Infrastructure and Development, Growth of population and vehicles, Unforeseen circumstances, Events and incidents)

According to the Correlation Analysis, Probability values for the factors, "Growth of population and vehicles" and "Unforeseen circumstances" are 0.003 and 0.005 respectively. Hence it is significant ($p<0.05$), null hypothesis can be rejected. Therefore it can be concluded that, there is an association between the current vehicle traffic flow and the factors "Growth of population and vehicles" and "Unforeseen circumstances."

C. Model Development for Current vehicle traffic flow

To development of the model, Regression Analysis has been carried out.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.269[a]	.072	.058	.403	2.136

According to the Model Summary, multiple correlation or the joint association is given by R. That is 0.269. This indicates that, independent variables are having a weak association jointly with dependent variable, current vehicle traffic flow. Proportion of the dependent variable covered by regression model is explained by R square. If the R square value is equal or more than 0.6, the particular model is nicely fitted. The R square value is 0.072. But still the model is valid as the probability of F test statistics is 0.000 and significant ($P \leq 0.05$) as per the Regression ANOVA. It indicates that, the model is jointly significant.

Following equation is constructed by illustrating the effect of independent components on the current vehicle traffic flow.

$$Y= 2.349 + 0.154X1 + 0.139X2 - 0.181X3$$

Y = Current vehicle traffic flow
X1 = Growth of population and vehicles
X2 = Unforeseen circumstances
X3 = Events and incidents

Table 4: Coefficient Matrix

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	T	Sig.	Tolerance	VIF
1	(Constant)	2.349	.331		7.094	.000		
	Infrastructure and Development	-.027	.079	-.027	-.347	.729	.554	1.805
	Growth of population and vehicles	.154	.056	.178	2.725	.007	.813	1.229
	Unforeseen circumstances	.139	.051	.193	2.695	.007	.679	1.474
	Events and incidents	-.181	.076	-.164	-2.386	.018	.737	1.357

The hypothesis used in Regression Analysis is as follows**;**

H0: There is no individual effect of ith factor on Current vehicle traffic flow

H1: There is an individual effect of ith factor on Current vehicle traffic flow

(i^{th} factor = Infrastructure and Development, Growth of population and vehicles, Unforeseen circumstances, Events and incidents)

According to the Coefficient Matrix, probability values for the factors, "Growth of population and vehicles", "Unforeseen circumstances", "Events and incidents" are 0.007, 0.007 and 0.018 respectively. Hence it is significant ($p<0.05$) and null hypothesis can be rejected. Therefore, it can be concluded that "Growth of population and vehicles", "Unforeseen circumstances" and "Events and incidents" have an individual effect on the current vehicle traffic flow.

D. Relationship between the impacts of traffic congestion and selected demographic variables

In order to check the relationship between the impacts of traffic congestion with some selected demographic variables, a chi-square test was conducted using the responses obtained for various items such as fuel wastage, loss of productivity, time wastage, etc.

The hypothesis used in chi-square test is as follows:

H0: i^{th} impact is not depend on j^{th} variable

H1: i^{th} impact is depend on j^{th} variable

(i = Fuel wastage, Loss of productivity, Time wastage, Psychological impact, Emissions and environmental damage, Accidents and collisions, Vehicle operating cost, Loss of working hours, Opportunity cost)

(j = Occupation, Mode of travel)

Relationship between the impacts and occupation

P values of Loss of productivity and Just in case time are respectively 0.020, 0.027, which are less than 0.05 and significant. Therefore H0 is rejected, which suggests that impact of loss of productivity and the impact of just in case time depends on the occupation.

Relationship between the impacts and mode of travel

P value of Fuel wastage is 0.046, which is less than 0.05 and significant. Therefore H0 is rejected, which suggests that impact of fuel wastage depend on Mode of travel.

E. Cost Calculation of Traffic Congestion

By using the data collected from the sample population, the opportunity cost and the fuel wastage cost of traffic congestion has been calculated.

Opportunity cost of time means the commuters' foregone value of the time that spent on road due to traffic congestion. The Total Average Opportunity Cost per day of the sample population can be calculated as Rs. 148,750. The Total Average cost of fuel wastage per day of the sample population can be calculated as Rs. 83,400.

F. Commuter's satisfaction on the current strategies implemented by the government to mitigate traffic congestion in Colombo

When the respondents were asked to respond whether they are satisfied or dissatisfied with the strategies implemented to mitigate the traffic congestion, following distribution of responses were obtained.

Figure 2: Satisfaction on BPL

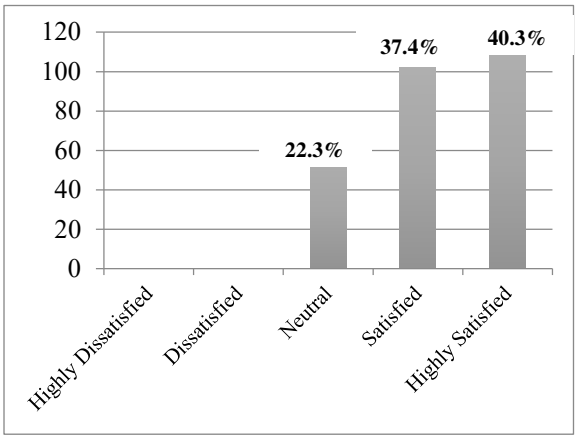


Figure 3: Satisfaction on Park and Ride

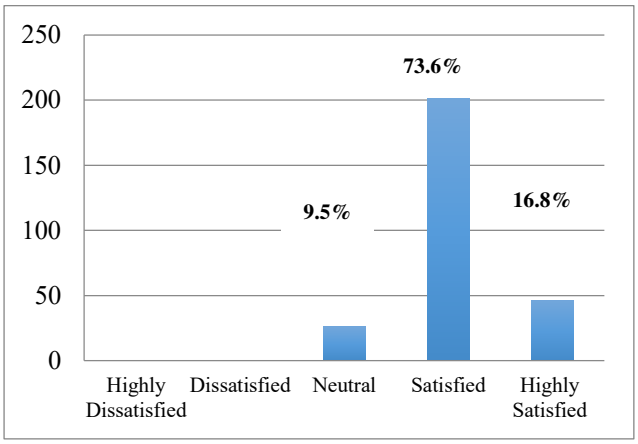
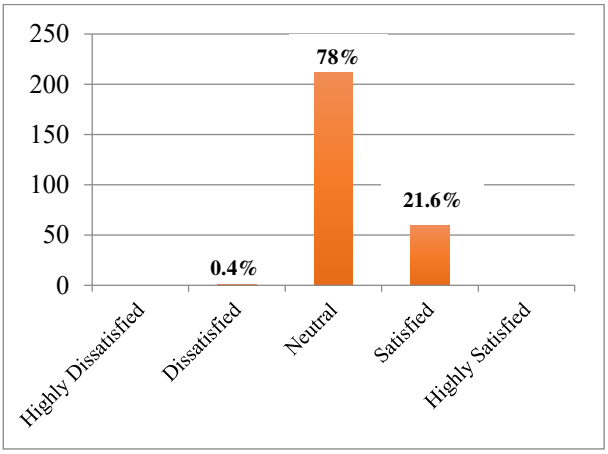


Figure 4: Satisfaction on Ferry Service



Conclusion

The primary objective of this research is to identify the factors causing road traffic congestion in Colombo Metropolitan Area. Factors were identified through factor analysis. There are 15 factors in this research study and they are reduced to 4 components by factor analysis. Through the Correlation Analysis it was confirmed that there is an association between the current vehicle traffic flow and the factors "Growth of population and vehicles", "Unforeseen circumstances" while there is no enough evidence from the sample responses to identify the association between "Infrastructure and Development" and "Events and incidents" with the current vehicle traffic flow. Through the Regression Analysis it was found that "Growth of population and vehicles", "Unforeseen circumstances", "Events and incidents" have an individual effect on the current vehicle traffic flow, while the "Infrastructure and Development" does not have an individual effect on the current vehicle traffic flow.

Through the Chi Square Test, the relationship between the impact of traffic congestion and some demographic variables has been identified. It was found that only the impact of loss of productivity and the impact of just in case time depends on the occupation. Other impacts do not depend on the occupation. Only the impact of fuel wastage is depending on the mode of travel while all other impacts do not depend on mode of travel.

According to the cost calculation of traffic congestion, each person who travels to Colombo has to bear an unproductive cost due to this traffic congestion.

Apart from the ferry service majority of the respondents are satisfied with the BPL and Park and Ride that has been implemented by the

government with the aim of mitigating traffic congestion in Colombo.

Recommendations

In order to mitigate the traffic congestion in Colombo the researcher would recommend the following remedies.

- In order to discourage the use of private vehicles, government intervention is highly recommended to improve the quality of public transport so that many people will use public transport.
- BPL and City Bus Service must be further implemented to other routes, addition to the routes in which those strategies are already implemented.
- Traffic management and road network plans should be updated on a periodic basis as required.
- The construction and repair of road works should be carried out during the night, otherwise they should be avoided during peak hours.

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Original Article

Cadastral Survey Plans Management System: A Deliberative Report on Possibility of Utilizing Innovative Technologies on Managing Cadastral Survey Plans and Mapping in Sri Lanka

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Abstract

This report discusses the review of the Cadastral Survey Plans Management System in the context of the research project that is aimed at improving the management and security of the system. The research efforts of the project are aimed at facilitating the Cadastral Survey Plans Management System by justifying the possibility of utilizing innovative technologies on managing cadastral survey plans and mapping in Sri Lanka. In order to overcome and avoid complexity of problems and issues, various techniques and tools will be used. While the research section of the project is bounded with the human interaction of the society, building a mutual relationship with the employees of the Survey Department and the clients will be one of the primary focus of the proposed project and it will lead to understand the structural aspects of the department as well. Thus, the project was focussed on decision procedures, data security and information sharing. When considering the data security and information sharing in the software artefact, responsibilities will be divided according to the decision procedures of the organization or department. The goal of implementing Cadastral Survey Plans Management System is to induce the manpower and paperwork into minimum level and empower the security of the department.

Keywords*: *Cadastral Survey, Encroachment Survey, Mapping, Tenement Lists

Introduction

As the oldest Government Department of Sri Lanka, established on 2nd August 1800, the Sri Lanka Survey Department is responsible for national surveying and mapping. By the end of the 19th century, Survey Department engaged on a wider range of surveying functions including Block Surveys for land settlement, Topography Surveys for mapping, Application/Miscellaneous Surveys including Irrigation Surveys, Road/Railway Surveys, and Forest Surveys etc. [1]. However, being one of the oldest departments in Sri Lanka and having a massive database of survey plans, tenement lists, and mapping information, it has been difficult to maintain various survey information properly for a long period of time.

by researching the Possibility of Utilizing Innovative Technologies on Managing Cadastral Survey Plans and Mapping in Sri Lanka.

Literature Review

According to the Chang, Young Ku Kang, Dong Hyun Kang and In Joon [2], in the current conventional computerization management of the cadastral system in South Korea is operated with raster map data. However, that data was difficult to use along with the National Geographic Information System in South Korea. Therefore, they decided that, for a more accurate map management, the cadastral map management system must be operated with vector data. Cadastral map computerization was built on related geographic information system. This system was used "Gauss Double Projection" for the length of lands and accurate division of area. Even users decided the length and area, it will be difficult to manage the whole cadastral map due to the discord of map connection. When considering the time before the Cadastral map computerization, the people who provided the land utilization confirmation document to the offices, spent almost over 30 minutes from application to acquirement. Also, cadastral mapping was directly related to private properties and government needed a way to gather necessary information from civilians.

The importance of Cadastral Map Computerization was to reduce the level of inefficiency in the Korean Cadastral Survey Corporation management system. The main affair of the Cadastral Map Management System in South Korea was the acquirement of land utilization confirmation document and merge-divide work of cadastral. The implementation of this project will have been a positive effect as it sought to solve management problems in the Corporation. When comparing with the former cadastral system, it spent more than 40 - 50 minutes for cadastral map acquirement and after the implementation of the Cadastral Map Computerization, computations processed within 10 minutes and efficiency of affair rose.

According to the Byong-Nam Choe, Mi-Jeong Kim, Kwon-Han Lee and Yoon-Hee Jeong [3], information on various maps and land documents, which are managed by the land administration in South Korea was inaccurate and discordant. Furthermore, people had to travel far to visit a city hall, country office or district office to obtain information on land use regulations. However, the process is taken several months for the information produced by municipalities. Considering the present status of the land data on digital topographical maps have an enormous amount of information and it includes a lot of superfluous information which interferes with the construction and maintenance of a spatial database. One of the other identified drawbacks in managing land information more accurately was a lack of attribute data on topography due to land data was originated and relied on the paper maps.

To solve the identified problems in land administration in South Korea, the Ministry of Construction and Transportation (MOCT) implemented the project of Land Management Information System (LMIS) in 1997. The LMIS has tripartite objectives such as to provide land information to people upon request, to enhance the productivity of public land administration and establish rational land policies.

When considering worldwide similar solutions, a Singaporean company has developed a Cadastral System that supports digital cadaster. According to the Kean Huat Soon, Derick Tan and Victor Khoo [4] who developed the Singaporean Cadastral System, this digital cadaster encodes cadastral information in

digital format which allows for automation and returns high productivity. This System based on the Intergovernmental Committee on Surveying and Mapping's ePlan model, which already has been implemented in Australia and New Zealand. However, registered surveyors can check all the information through the web portal before the authority's inspection and approval. By using this product, engineers expected to reduce turnaround times and speed up the overall approval process. Considering its key features,

▪ Adding the vertical dimension and time.
▪ Adopting an open standard for automation and data interoperability.
▪ Providing a proactive communication platform with registered surveyors.

The current cadastral system was not capable of representing complex and much newer information that involve the developments in Singapore.

By implementing the proposed Cadastral Survey Management System in Land Survey Division of Singapore Land Authority, it helped to achieve automation and data interoperability, 3D and provenance and built a proactive communication platform for registered surveyors.

All the major countries throughout the world since the last decades have been establishing digitalized cadastral systems. Throughout the world, it is recognized as an important facility which helps to make the economic and sustainable development stable. Cadastral Management Systems should be able to adjust for the multi-purposes and meet the modern IT environment.

Current cadastral maps are based on hand-drawn property maps and mostly these maps could be damaged due to the prolonged time of storage. Plans details could be faded or destroyed by several reasons and due to the analog maps and the accuracy of the cadastral maps could be different from few centimetres in some urban and rural areas.

As a solution to the above-identified issues, Prof. Stig Enemark and Prof. Hans Sevatdal [5] have published an opinion by researching "Is Land Information System and Planning decentralization is a significant key to sustainable development in Denmark?" Proposed cadastral infrastructure was empowered on land administration and land management systems.

▪ The proposed cadastral project assisted in valuation, taxation, land management, planning and administration.
▪ Enabled sustainable development and environmental improvement.
▪ Professionals in the IT world have already argued that within the next decade, such land information systems will perform an integral part of the model of a man-made environment.
▪ Provided land information to the financial and business sectors, land administration, environmental management, urban systems, and community information systems.
▪ Accuracy of the digital cadastral maps, the effectiveness of the sectors will be improving day by day.

According to the Tan Liat Choon, Dr. Khadijah Binti Hussin and Sr. Ernest Khoo Hock Oon [6], the urban population of Asia is

expected to increase to 1286 million people by the year 2020 and considering the population growth of Malaysia, it is also expected to reach

31 million people by 2020. Due to the rapid increases for development processes and technical purposes, the existing Malaysian

Cadastral System is unsuitable for representing the current situations.

The existing Malaysian Cadastral System is insufficient to meet the expected productivity of the high-density developments in urban areas. Due to the legal changes in the land registry has not been made in accordance with the complexity of the developments, some of the buildings have been built illegally or crossing boundary edges. There are difficulties to register the ownership of land and properties and existing legal registration process for 3D property in Malaysia is time-consuming. Experience in land registration and legislation shows there is insufficient property legislation. The utilization of lands in Malaysia has not followed the process of the proper Malaysian Cadastral System.

The land register considered one of the most critical documents in Malaysian Registration System. However, with the implementation of the new Cadastral Management System, the hard copy of the registry replaced by a computerized land registry that enabled the proprietor to transfer, change the land, or grant rights of easements.

Methodology

The success or the failure of the software is influenced by the quality of the requirements. Therefore, identification of the efficient software requirements is one of the key challenges to develop high quality software solutions. Requirement elicitation techniques can be divided into four categories according to their nature of communication. Such as traditional, contextual, collaborative, and cognitive.

A. Traditional

An Interview is a method of identifying the opinions of clients of the organizations by face-to-face conversations. With the guidance and support of Mr. N.R.L Mendis (Rtd. Superintendent of Surveys) and Mr Wikkramarachchi (Rtd. Add. Surveyor General), the interview process was conducted successfully and by selecting one of the three types of interviews such as Closed-Ended, Open-Ended, and Probing Questions, the Business Analyst was able to prepare and generate a report within 48 hours. Most importantly this interview process was intended to discover their expectations of the system, business aspects, critical thinking, and encourage the interviewee to open their personal thoughts on specific topics.

Questionnaires are a technique of eliciting requirements from many people within lesser cost and time. This technique is based on electronics and papers. Therefore, these questionnaires could be a set of written or typed questions on emails and printed sheets. The success of the questionnaire process is depending on how well the questionnaires are design and the skills of the interviewer who conduct the interview session. Considering the environmental facts, it could be suitable for remote locations. Therefore, the Questionnaire was distributed with the assistance of Surveyors and employees of the Divisional and District Survey Offices. Thus, Project objectives were identified in accordance with the suggestions and feedbacks expressed in the questionnaire.

B. Collaborative

Joint Application Development (JAD) is considered as one of the processes that expedite business solutions in the software development environment. After requesting a meetup from the Divisional Survey Office Gampaha, this was followed by a meeting with the Superintendent of Surveys, Assistant Superintendent of Surveys and Surveyors.

When considering the physical involvement of the JAD session, it encourages the teamwork of software architects, software developers, stakeholders, and others who related to the business and software processes to precisely depict the aspects of the business need where they can jointly develop a solution and the success of the session depends on the leadership among the participants who tries achieving group synergy during the JAD session. The JAD session was focused on business problems rather than the technical details. While the JAD offered a team-oriented approach in the software and business environment, it enabled the spirit of the partnership and effective than other traditional business meetups.

C. Cognitive

Document Analysis is a process of analysing the documents related to the problem and gather necessary information. It is considered as one of the best requirement elicitation techniques to gather information and the business analyst of the particular organization should be able to go through all the documents which are related to the software process and analyse the current system architecture as well. Furthermore, this technique helps business analysts to prepare questions for validating the correctness of information.

According to proper procedures and legal permissions obtained from the officers in charge of the relevant divisions of the Survey Department in Sri Lanka, it was possible to inquire into various official documents related to the proposed artefact such as Cadastral Survey Plans, Tenement Lists, Field Books, Amendments, Department Survey Regulations, Plans and Diagrams, Standing orders, Survey Acts, Temple Lands Registration Ordinance, Registration of Title Acts, Urban Development Authority Regulations for Subdivisions of Lands.

D. Feasibility Study

When it comes to the Feasibility Report, considering the project aspects and the context of the project, research studies were inclined more on Technical Feasibility and Economic Feasibility. According to the research facts, the familiarity with the applications of Survey Department was moderately low and it was impossible to connect Land Reform Commission (LRC), Road Development Authority (RDA), and Private Cadastral Survey Plan Information together. Also, Surveyors record all the survey information manually on field books. However, familiarity with the technology of the Survey Department was moderately high, both employees and senior officers had a good understanding of what the system should do. When considering the compatibility with the existing technology, it was also moderately high due to the advanced survey equipment used, computer labs, and knowledgeable individuals who could operate the proposed artefact.

Although the Survey Department was empowered with knowledgeable individuals and advanced technological equipment, there were still several shortcomings that make it impossible to implement the proposed artefact. Therefore, after a systematic, formal, and transparent Economic Feasibility investigation,

could fulfil the necessary resources and system needs through a properly designed budget plan.

Artefact

It is always debatable the possibility of utilizing innovative technologies on managing cadastral survey plans and mapping in Sri Lanka. Doubt and fear of failure leads to the edge of the bridge where the boundary lays between the 3rd world countries and the rest of the world. Now more than ever, the world needs cutting edge defensive techniques to face challenges, overcome drawbacks and prevent the threats before they occur. Therefore, throughout the application development, the research study aims to minimize the chances of having threats from intruders and secure the application and data responsibly. Thus, to obtain expected outcomes, the proposed artefact was designed and applied following innovative technological features.

1) Desktop Application:

- Microsoft Visual Studio 2019
- Microsoft C# Programming Language
- MySQL Database
- Bunifu Framework
- GMAP.NET
- IronOcr
- LiveCharts
- MessagingToolkit.QRCode
- Spire.Pdf
- Twilio

2) Features:

- Encode and Decode QR
- Encrypt and Decrypt Cadastral Survey Information
- OTP Message Service
- SSL Certification on Email
- Live Mapping – Latitude, Longitude, Routes, Add Points, Area by Polygon, Load Locations, Clear and Remove Points
- Screenshot Facility
- Live Charts and Report Generating – Revenue, Number of Lots, Extent and Topography
- Open and Extract PDF to Word Format | Search and Highlight Texts
- Indicating Error Messages and Password Reset Options
- Backup and Restore Database

Testing/ Results

A. *Bimsaviya | LRC | RDA*

According to the research facts, information, and alphanumeric data which were gathered from various requirement elicitation techniques, helped designing a platform that could manage imperative and crucial cadastral survey information in Bimsaviya Project, Land Reform Commission, and Road Development Authority.

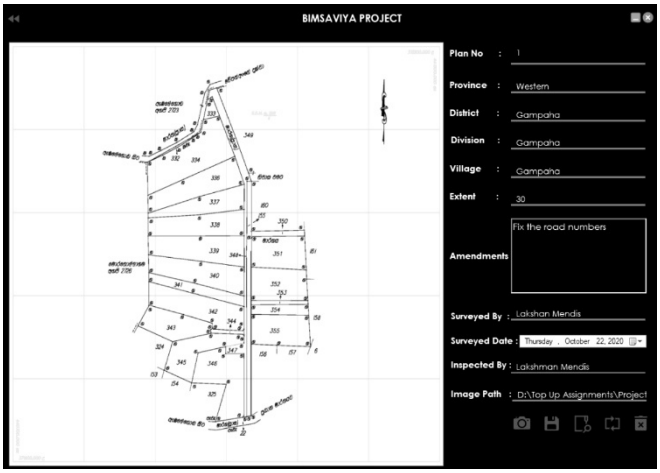


Fig. 1 Managing Bimsaviya Project Survey Information

B. Mapping

The Mapping can be considered as the [35] simplest way to find the details before log into the various types of investment projects on lands. The aim of publishing geospatial information in Google Map is, to fast track searching lands free of restrictions for better management of lands.

When developing the mapping feature which is empowered with the Live Mapping, Latitude, Longitude, Routes, Add Points, Area by Polygon, Load Locations, Clear and Remove Points features, allow permission to Surveyors and Superintendent of Surveyors to search locations based on specific criteria.

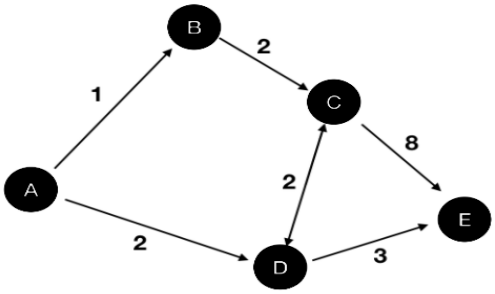
Fig. 2 Search Locations and Calculate Distance According to given Latitude and Longitude Values

When considering the types of various algorithms, Bellman Ford, A*, Floyd Warshall, Depth-First-Search (DFS), Breadth-First-Search (BFS), and Dijkstra are considered the most popular algorithms in finding shortest path.

Bellman Ford Algorithm (BFA) is used to find the shortest path from the source vertex to all other vertices in a graph [26]. This algorithm depends on the relaxation principle where the shortest distance for all vertices is gradually replaced by more accurate values until eventually reaching the optimum solution. However, BFA does not use a priority queue [27]. Instead, it repeatedly loops over all edges and updating the distances to the start node. BFA considered as a Dynamic Algorithm and it can calculate the negative directed edges [21], can minimize the cost when network was built by not building lot of router paths as it can find the shortest path from one node to another. Besides that, when used in Routing Information Protocol (RIP) a slow response to changes in network topology resulting from slow updates passed from the RIP device to the next device. These flaws lead to an attempt to use idle tracks that waste time and network resources.

```
Data: Given a directed graph G(V, E) , the starting vertex S, and
      the weight W of each edge
Result: Shortest path from S to all other vertices in G
D[S] = 0;
R = V - S;
C = cardinality(V);
for each vertex k ∈ R do
 | D[k] = ∞;
end
for each vertex i = 1 to (C - 1) do
  for each edge (e1, e2) ∈ E do
   | Relax(e1, e2);
  end
end
for each edge (e1, e2) ∈ E do
  if D[e2] > D[e1] + W[e1, e2] then
   | Print("Graph contains negative weight cycle");
  end
end
Procedure Relax (e1, e2)
for each edge (e1, e2) in E do
  if D[e2] > D[e1] + W[e1, e2] then
   | D[e2] = D[e1] + W[e1, e2];
  end
end
```

Fig. 3 Pseudocode: Bellman Ford Algorithm



node	shortest cost from A
A	0
B	1
C	3
D	2
E	5

Fig. 4 Nodes based on Bellman Ford Algorithm

Another algorithm to consider in finding the shortest path is A* Algorithm. A* is based on using heuristic methods and widely recognised as an optimal and complete algorithm. According to the Akash Jain [30], the optimal algorithm finds the least cost path from the source location to the destination while complete algorithm finds all the paths that are available from the source location to the destination. Considering the disadvantages of the A* algorithm, it is said that it is a bit slower than the other competitive algorithms.

f (n) = Total estimated cost of path through node n
g (n) = Cost to reach node n
h (n) = Estimated cost from n to destination

$$f(n) = g(n) + h(n)$$

The Floyd-Warshall Algorithm (FWA) is a classic dynamic algorithm which compute the length of all shortest paths between any two vertices in a graph [32].

for k = 1 ... n do
for i = 1 ... n do
for j = 1 ... n do
m [i, j] = min (m [i, j], m [i, k] + m [k, j])

m = Matrix
k = Iteration 1 to n
i = First Point v_i
j = First Point v_j

The aim of the algorithm is to compare each route variation with the distance from each source to the destination and accumulates the distance between the nodes that are passed [32]. When searching the shortest path, all iterations (k) will be used to make n matrix. Therefore, the process used is slower than some of the competitive algorithms. Apart from that FWA can only find the shortest path when there are no negative cycles, and it does not return the details of the paths.

According to Google, Dijkstra's Algorithm (DA) finds the [25] shortest path between two places and it picks the unvisited vertex with the lowest distance, calculates the distance through it to each unvisited neighbour and updates the neighbour's distance if smaller.

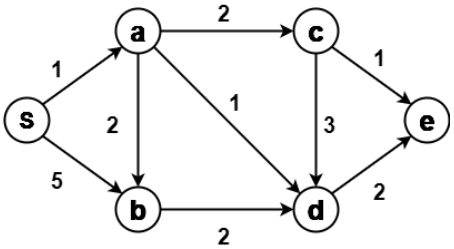


Fig. 5 Nodes based on Dijkstra Algorithm

DA is an iterative algorithm that provides the shortest path from one particular source node to all other nodes in the graph and also considered as the greedy algorithm that relies on an optimum solution at each iteration until the destination node visited [33]. Considering the behaviour of the DA, it should be directed-weighted graph and the edges should be non-negative. However, if the edges are negative, the actual shortest path cannot be obtained [34].

Input: An edge weighted connected graph G (V, E, w) where w: E → R + and two vertices s, t.
Output: A path from s to t with minimum total cost (shortest path)

```
S = ∅.
Initialize empty priority queue.
foreach v ∈ V do
    p[v] = NIL
    d[v] = ∞
    enqueue(v)
end for
d[s] = 0
Update queue order of s
while queue is not empty do
    v = dequeue element with min priority d[]
    if p[v]! = NIL then
        S = S ∪ {(p[v], v)}
    end if
    foreach edge (u, v) do
        if u is in the queue and d[v] + w(v, u) < d[u] then
            p[u] = v
            d[u] = d[v] + w(v, u)
            Update queue order of u
        end if
    end for
end while
return S
```

Fig. 6 Dijkstra's Shortest Path Algorithm

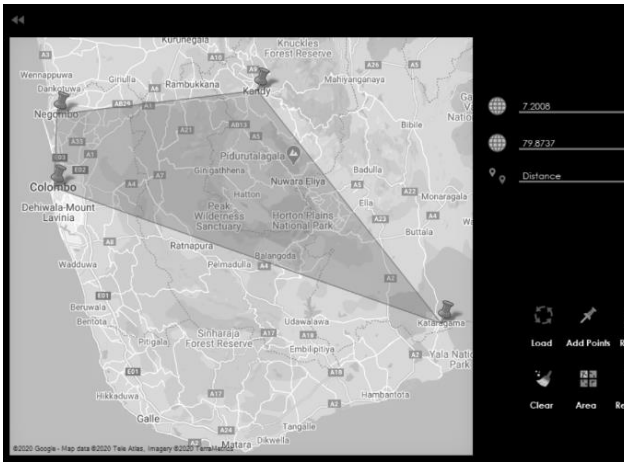


Fig. 7 Generate a Polygon Area on Specific Geo-Locations

Considering all the above-mentioned algorithms and their processes, in order to provide more accurate geo-locations, calculate distance, find routes, and generate polygon areas, the proposed artefact was applied one of the most complex algorithms named "Dijkstra's Algorithm" (DA).

TABLE I
GEO-LOCATION COORDINATES

Locations	Latitude	Longitude
Colombo	6.9271 N	79.8612 E
Negombo	7.2008 N	79.8737 E
Kandy	7.2906 N	80.6337 E
Kataragama	6.4135 N	81.3326 E

C. *Encryption and Decryption*

According to the ethical policies on confidentiality, almost every organizations or companies in the today world responsible for guaranteeing of confidentiality of information. In order to use for different marketing purposes, most of the organizations around the world, misuse personal and sensitive information of customers. Misuse of personal and private information is widely recognized as invasion of privacy. Therefore, when gathering private and sensitive information about people from the government of Sri Lanka, people may need to make sure that their private information will not be used in ways which they do not approve.

There was a time during the civil war in Sri Lanka, latitudes, longitudes, and coordinates were priceless information for both government and terrorists. Whoever has the accurate coordinates in the battlefield, they always won the advantage of the field. Therefore, when using above-mentioned sensitive information, we are bound legally and ethically to prevent the security breaches and protect secured information, the research applied "Base64" encrypting and decrypting methodology.

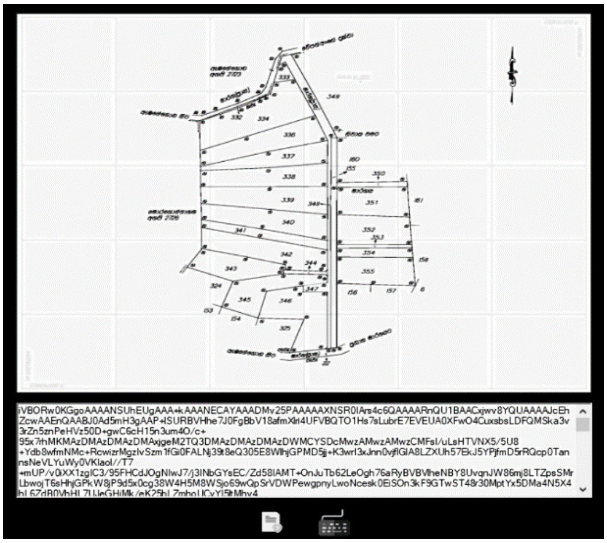


Fig. 8 Encrypting and Decrypting Cadastral Survey Plan Information

D. Tenement List

TABLE 2
SAMPLE TENEMENT LIST DATABASE

Plan No	Lot No	Extent	Requisition No	Unique No
3652	5	34	6814	2234
1538	23	5	3256	6342
768	11	83	413	325
850	2	15	3674	2571

When it comes to the Tenement List, it is used to identify the owner of a particular land and authenticate the ownership of the land. Thus, a platform was designed where Surveyors and Superintendent of Surveyors can manage imperative information such as Plan No, Lot No, Requisition No, Unique No, Extent, Name of the Land, Description, North, East, South, West, Remarks, Village, Minor Division, Divisional Secretariat Division, District, Province, Surveyed Date, Surveyed By, and the Designation.

Recommendations for Future Considerations

Technology has advanced in many ways within a period of years and it has changed, and impacted human interaction with community, communication, thinking, and interaction with the surrounding environment. Higher expectations and desires of human needs have led to a consistent advancement in technology and consequently, human lives depend on technology today. Based on the recommendations for further considerations and the measurement of the effectiveness of the artefact, facial recognition and speech recognition services could be proposed. In the end, it will be a platform, where everyone can voice their commands.

Conclusion

This report was aimed to gain experience about issues that surveyors and the government have been facing throughout the surveying process.

The proposed system was creatively designed and enforced for managing Bimsaviya, LRC, RDA and Private Cadastral Plans and Tenement List Information, Encoding and Decoding QR Codes, Encrypting and Decrypting Cadastral Survey Information, OTP Message Service, SSL Certification on Email, Live Mapping including Latitude, Longitude, Routes, Add Points, Area by Polygon, Load Locations, Clear and Remove Points, Live Charts and Report Generating by Revenue, Number of Lots, Extent and Topography, Open and Extract PDF to Word Format, Search and Highlight Texts, Screenshot Feature, Backup and Restore Database, Indicating Error Messages, Password Reset Options and System Validations such as Login Validation and Email Validation.

To put the matter in a nutshell, the research consisted of and nurtured by descriptive statistics, survey acts, survey regulations, standing orders and many more ordinances and statutes prepared by the Survey Department of Sri Lanka.

Furthermore, the research was conducted according to an exploratory process to increase the efficiency of services, increase the overall satisfaction rate of customers and employees of the Survey Department of Sri Lanka.

Acknowledgement

I would like to express my gratitude to everyone who supported me throughout the research. I owe my deep gratitude to the Head of the Department of IT, Ms. Suranji Nadeeshani and Mr. Thilak De Silva for their guidance and motivation. The research could not have been possible without the kind support and guidance of Ms. Sachini Vindya Gunasekara who helped me with the proper guidance and sharing knowledge. I am thankful to everyone in the Survey Department and Mr. N.R.L Mendis (Rtd. Superintendent of Surveyors) who provided me with the facilities and knowledge being required for the research.

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Original Article

Commuters Perception Towards The Bus Base Park and Ride Implementation in Colombo City Limit

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Abstract

This study was conducted to identify the commuter's perception towards the bus base Park and Ride implementation in Colombo city limit. This study analyses the factors that commuters would consider when selecting park and ride system for their travel purpose. For the researcher to achieve the aforementioned objectives, the conceptual framework was structured based on secondary data which congregated by existing publications and articles. The research questionnaire was developed in order to gather primary data through google forms. Simple random sampling technique was used to distribute the questionnaire among the commuters who use seven corridors to enter Colombo city limit. Three hundred fifty-two responses were taken into consideration and analysis was done by taking them into one data base. The reliability of the collected data was analysed using Cronbach's alpha. The KMO test statistic for sample adequacy. Moreover, factor analysis was created based on the Principal Component Analysis by extracting 3 factors from the 22 Variables, the total amount of variance accounted, redistributed over the three extracted factors, renamed using Component Score Coefficient Matrix. Kruskal-Wallis Test was conducted for hypothesis testing and binary logistics analysis was conducted to identify the association of factors and for create a model. As per the Kruskal-Wallis test, author has found that most of the demographic variables were impacted to the commuter's perception toward the bus base PnR system. Mean values of the 22 variables were concluded that bus frequency, travel time and safety and security of PnR system were mostly influenced for selection of PnR system. Out of the extracted factors, service attribute and travel influences were having positive association toward the commuters' perception on PnR choice while comfortability factor was insignificant. As per the research findings, the overall commuters' perception on PnR can be concluded as strong positive perception.

Key words: Park and ride, Commuters Perception, Transportation, Congestion, Traffic mitigation

Introduction

Transport system development is embedded in the scale and context in which it takes place, from a local to a global perspective and from an environmental, historical, technological and economic perspective. Modern cities all over the world have been suffering from the traffic congestion that was created by the influx of private cars on the road network. Another reason for congestion is limited capacity of infrastructure and lack of innovative transport methods. Transportation is considered as the most powerful contributor to the economy and competitive strength in businesses (Zhao, 2019).

As a developing country, Sri Lanka has been achieving expeditious growth in different sectors such as financial and trades, telecommunication, construction and tourism. There for transportation play major role in the country's economy in order to accomplish the commuting demand requirement of the public citizens. Colombo Metropolitan Area is largest metropolitan area in Sri Lanka which was populated 6.13 MN as at 2019.Total personal trip demand would increase 1.75 times and the trip demand made by private own vehicles would increase vividly due to lack of public transport. Colombo city is divided to 15 sub areas and are named from Colombo 1 to 15. Those seven transport corridors were identified as major radial corridors connecting Colombo's city centre.

Research Problem

When compared with the available capacity of these roads in Colombo city limit, the average index of volume to capacity (V/C ratio) is over 0.6. The ability to handle the traffic flow in roads of Colombo city has reached to the critical proportion. In Sri Lanka many people would consider possession of motor vehicle high on their list of priorities. There for people seek private transport day by day and this lead s to congestion due to lack of road capacity and parking availability. Sri Lanka is the developing country and with compare to other transport solutions bus base park and ride can be taken as a good solution for mitigate traffic congestion in Colombo city limit .By considering the world scenario there are number of examples where this system did not provide successful result. (Karunadasa, 2017).There for it is detail investigation is required to identify the commuter's perception toward this kind of implementation.

Question 1

What are the factors effect for commuter's perception towards the bus Base Park and ride system implementation in Colombo city limit?

Question 2

What will be the impact of identified factors on commuter's perception on bus based Park and Ride implementation in Colombo city limit?

Research Objective

1. To identify the factors effecting the commuter's perception toward the bus Base Park and ride implementation in Colombo city limit.
2. To measure the impact of identified factors on commuter's perception on bus base park and ride implementation in Colombo city limit.

Significance of the Study

According to world ranks, park and ride was ranked fifth out of 18 local transport measures for both effectiveness in reducing car use and public acceptability. (Parkhurst, 2000). In early stage of development of public transport system, Park and ride enhances the modal shift to a public transport mode.

When it comes to the significance of research, it can be seen in a major perspective of importance of "Commuters perception on park and ride implementation" as a public transport method for mitigate the traffic congestion.

From the seven corridors, there is considerable amount of vehicle inflow move daily to Colombo. By implementing PnR system, it encourages to transfer commuters from private mode to public mode. According to previous findings, Park and ride is successful transport system in most developed countries. Still Colombo doesn't have efficient and developed public transport system like PnR. Even though this was not new initiative for the Sri Lanka, it's compulsory to identify the passenger's behaviour and perception toward new transport method. As per the knowledge of researcher there was no researches which conducted to identify commuters demand and perception on PnR in Colombo city limit. Understanding of the commuters' perception is important to policy decision makers for the development of transport solutions such as bus base PnR. Also it is influential for the private and public bus services and for development of the Colombo transportation system in sustainable manner. This study is important to conduct because satisfying passenger expectation is obligatory to create demand for the travel mode.

Literature Review

Introduction

Rapid development of the cities all around the world and rapid increase of vehicular flow has become major issue for environment pollution and traffic safety. Expansion of the network capacity by new road construction has never been a viable solution to traffic congestion due to the restricted land Room, especially in urban areas, and because new or widened roads attract more traffic demand, creating undesirable congestion on the unchanged roads (Meng, 2012)

Park and Ride's basic procedure involves persuading commuters to move part of their journey to public transport by providing a monitory discount or time savings towards driving the entire journey. (Rachel Katoshevski -Cavaria, 2018).Park and ride system can be fragmented into its three main components (Karunadasa, 2017), (Stephen Ison, 2016)

1. Private transport mode

Private transport mode is necessary for the park and ride scheme for proper operations. As per the Bo's (2004) in some cases which passengers are moved by private transport to public transport cannot be categorized as Park and Ride. For example: conventional public transport use. Country development and economy is highly influenced to the incensement of the private own vehicles (Seik, 1997)For example: Poland park and ride system is popular as a result of charging less amount for the parking facility. (Kurek, 2020)The versatile advantages of private transport mean that riders from diverse backgrounds, such as low-density suburban areas, can use Park and Ride. (Karunadasa, 2017)

2. Public transport access

Park and ride stations are mostly located in the city limit boundaries. The public transit network is not very attractive to suburban and metropolitan commuters because of the difficulties of public transport. Spatial productivity in public transport is in higher level and emission rate and fuel consumption has been lower than one tenth of road traffic. (Shahi Taphsir Islam, 2015). Key element for attractive public transport in PnR is nonstop and accurate bus service between park and ride station to city centre. (Cairns, 1998). As per the (Dickins, 1991)proper public transport access and strategic park and ride system has advantage to promote public transportation.

3. Planned services

Park and ride system is combination of private transportation and public transportation. Proper bus operation, Better Park and ride station facility and lower fares should be offered for maintain accurate park and ride system. (Cairns, 1998)The Park and Ride scheme can be developed on a range of forms, varying from the use of limited shared-use locations to the intent-built of several thousand sites. (Karunadasa, 2017). Baohong (2012) Commented that layout preparation and formal assessment criteria have been developed to guide practice in Park and Ride system. Hollevoet (2011) Identified that passenger's modal choice is mainly depend on, spatial determinants, socio-demographic determinants, travel mode and journey determinants and psychological determinants.

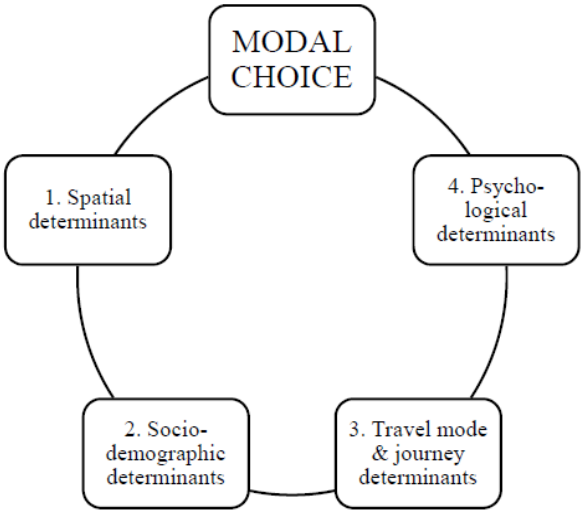

Figure 1.2: Model choice determents
Source:: (J. Hollevoet, 2011)

In empirical studies, discrete choice model have been established by (Hui Ying, 2009) to identify the influencing factors for travel behaviour. Several researches have been conducted base on this model and (Avishai Ceder n, 2013) analysed that Transit users favoured out-of-vehicle times with reduced volatility when making transfers. By analysing 11 PnR stations Qin and Guan (2012) analysed about PnR behaviour (Shahi Taphsir Islam, 2015) and they were used binary logit model for analyse the behaviour. Time and the cost were the mostly effected factors for PnR and traveller's income, occupation and origin and destination of the trip have been effected when choose the PnR system. Islam (2015) analysed the factors for park and ride behaviour and results were represented that travel time of public transportation, total travel time in PnR system, means of public transportation and parking fee to the destination were influencing factors for PnR modal choice. Based on the survey results researcher analysed travellers who earned higher monthly income and longer duration of license of drivers were not interested in use of

PnR. (Kurek, 2020).H.G Quin (2012) analysed that relationship between choices of PnR with intention to use parking, based on structural equation model.

Methodology

Research design

The main objective of this paper is to analyse the commuter's perception on bus base PnR implementation and identify factors affecting the choice of PnR in Colombo city limit. This study describes the relationship between the independent variable and the dependent variables and is the most common primary approach for data collection of studies.

Variable identification

Author has identified several attributes that define the perception and choice of PnR as viewed by commuters. Commuters willingness for choose bus base PnR is dependent on many factors that are evaluated as dependent variables in this analysis. Question has been developed as "Yes" and "No" pre-set responses to analyse the dependent variable of willingness to choose PnR system.

22 variables are identified as independent variables which are obtained from the empirical findings, literature and information from industry experts. As state in figure3.1, those variables categorized under 9 main factors. These variables are known to be influencing factors of commuter's perception on bus base PnR implementation in Colombo city. As per the empirical findings, Demographic variables in determinants of modal choice play vital role for the commuter's perceptions in social and psychological perspectives.

Questionnaire design

Primary data collection process was accomplished from internet base google forms. The questionnaire consisted 22 main questions and it segregated into 3 main parts. Which consists about the demographic and travel characteristics question, Likert scale questions of independent variables and dependent variable by using dichotomous question.

Analysis

In summarizing the analysis chapter researcher can conclude that two major goals of the study. First goal is to identify the factors affecting to commuters' perception on bus base PnR system implementation and the second one is to identify the level of acceptance of PnR implementation to in Colombo city limit. Researcher has analysed demographic variables, cross tabulation, independent variable frequency analysis, KMO and Bartlett test, factor analysis, Kruskal Wallis test, hypothesis testing and finally the binary logistics regression model.

Conclusion and Recommendations

According to Chi square value and cross tabulation were determined that gender, age, education, monthly income and present journey time have an association with the acceptance of the PnR system. Males have disagreed to use PnR rather than the females and respondents who were in matured ages (46-55) tend to disagree in using the PnR system while bachelor degree holders from the sample are more likely to agree to use PnR system. Researcher has identified the respondents who earn higher income levels have mostly disagreed to use PnR for their travel purposes. This was also indicated in the cross tabulation analysis as 16.4% of

respondents earning above LKR100, 000 per month were not willing to use PnR. In the cross tabulation test conducted on the average journey time factor, it was identified that there is an association between PnR acceptance decision and category of respondents' journey time This indicates that 13.6% of the respondents who take time less than 30 minutes to complete their journey has disagreed. As per the responses provide by the sample, Malabe corridor was the most utilized road out of the seven corridors. High-level corridor and Galle corridor was the second and third most utilized corridors in the sample population. However, there is no significant association between PnR acceptance and the routes used by the respondents. KMO and Bartlett test result identified that the sample size is adequate in order to perform exploratory factor analysis. Kruskal Wallis test was done to analyse the relationship between demographic variables and extracted three main factors. It discovered that occupation, route and distance are dependent from the service attribute factor while gender, age, income, transport expense, travel mode and vehicle ownership are dependent from comfortability factor. Influences factor is dependent on age, occupation, income, transport expense, route, travel mode, average journey time and average journey distance. Researcher has identified the considerable impact from the demographic and travel characteristics variables toward the three main factors.

Pearson correlation and hypothesis testing was performed to determine the relationship between acceptance of PnR and extracted three factors. Service attribute and Influences factors were significant while Comfortability factor have identified as insignificant factor for the willingness to choose PnR system. Binary logistics model was constructed to identify the probability and predictors of the three main factors. According to omnibus test, it was demonstrating that adding Components 1, 2 and 3 explains and contributes to the model apart from being intercepted. Hence, it can be concluded, that there is a relationship between commuters' perception on bus base PnR implementation and the combination of determinants of commuters' perception on bus base PnR implementation in Colombo city limit. Also it showed two positive relationships, first with willingness to use PnR and service attributes and secondly with commuters' willingness to use PnR and influences.

Recommendation

In order to implement effective PnR system for the Colombo city limit, foremost consideration is to educate and inform the general public about the park and ride system and its benefits for the reliability and environmental aspect. Commuters place more importance on travel influences and service attributes, there for it can also be recommend to develop infrastructure facilities for the main corridors. According to research data, the researcher would recommend bus frequency, system efficiency and safety reliability must be promoted among the passengers to create a positive attitude toward the PnR system. Respondents have recognized PnR as good method to travel without difficulties and they have identified: it as a prominent way to reduce traffic, save the time, as a good initiative to future generation. Policy makers' involvement is highly impact to enhance the PnR system for transport efficiency in Colombo city limit and it can be concluded that it is mandatory to develop PnR system for demolish private vehicle dominant transportation system in Colombo.

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Original Article

Development and Evaluation of a Novel Herbal Emulgel for Potential Anti-Inflammatory and Antioxidant Activities *in Vitro*

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Abstract

Emulgel is a novel topical drug delivery system which can overcome the major limitation of gel; limited delivery of hydrophobic drugs. Leea indica (Burm.f.) Merr. (Burulla) is a medicinal plant used in Sri Lankan Ayurvedic medicine for many therapeutic purposes. The present study was aimed to develop a novel herbal emulgel using Leea indica leaf extract and evaluate in vitro anti-inflammatory and antioxidant activities. Different formulations (Fg1-Fg5) were prepared by incorporating freeze dried powder of 70% aqueous acetone leaf extract. All formulations (Fg1-Fg5) were tested for their physicochemical stability parameters such as pH, appearance, odor, homogeneity, spread ability, phase separation and washability for 60 days and they were subjected for in vitro anti-inflammatory activity by Human Red Blood Cell membrane stabilization assay and in vitro antioxidant activity by 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assay respectively. Two commercially available gels were used as the positive control. Among the formulated herbal emulgels, Fg5 showed the significantly high values of in vitro anti-inflammatory and antioxidant activities compared to the tested positive controls. At the concentration of 12.5 mg/mL, Fg5 showed percentage inhibition of 93.73 ± 0.90% of heat induced hemolysis of erythrocytes and in vitro antioxidant activity of Fg5 was 3.39 ± 0.01 mmol Trolox per 100 g of emulgel. All formulated emulgels were found to be semi-solid, homogenous, and washable with water, having no phase separation and pH of the formulations were reported in the range of 6 to 7. There was no remarkable variation of stability parameters tested during 60 days. It is concluded that the formulated herbal emulgels have promising anti-inflammatory and antioxidant activities and formulation Fg5 can be recommended for further investigations using in vivo models.

Keywords: anti-inflammatory, antioxidant, emulgel, Leea indica

Introduction

Inflammation is an essential immune response which acts as a protective strategy during injury or infection in body. Body increases production of white blood cells, other immune cells and chemical mediators as a response to an inflammatory signal received by the immune system [1]. Inflammation can be either acute (a short term regulated form of inflammation) or chronic (a long-term dysregulated form of inflammation) [2] and can be harmful, if it lasts longer as a chronic inflammation or if the inflammatory response occurs in places where it is not needed [1].

Inflammatory conditions are treated mainly via orally administered Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) which block the

inflammatory pathways via inhibiting the mediators and factors involved in these pathways. Though these drugs are effective, they are relatively expensive and also can cause severe adverse drug reactions as well as risk of heart attack or strokes associated with NSAIDs [3].

There is a growing interest in the pharmaceutical industry for topical drug delivery systems over the other conventional routes due to its various advantages including reduced risk of systemic adverse reactions, avoidance of first pass metabolism and gastro-intestinal tract variability, direct administration to desired site of action, non- invasiveness and prevention of drug-drug interactions [4]. Topical formulations of anti-inflammatory drugs are widely used in day-to-day life for pain and symptomatic relief of various acute and chronic conditions such as acute sprains, strains, overuse injuries, arthritis, neuropathic pain etc. Topical NSAID formulations are the widely prescribed group for such patients to get both analgesic and anti-inflammatory effects. Topical anti-inflammatory formulations are available in many dosage forms in the market such as gels, creams, ointments, sprays, balms and topical patches etc. [5]. Among the topical formulations, gels have been more demanded with increased patient compliance in both pharmaceutical and cosmeceutical preparations [6]. Gelling agents or gel forming polymers such as Hydroxypropyl methylcellulose (HPMC), Carbopol and Sodium carboxymethylcellulose (Sodium CMC) are essential for preparation of gels [7]. Gel formulations have many advantages over other dosage forms and the major limitation of gels is delivery of hydrophobic drugs. The new concept of topical drug delivery system known as emulgel, can successively overcome this limitation.

Emulgel is an emulsion which is gelled by mixing it with suitable gelling agent/s in accordance with the active ingredients used as Oil in Water (O/W) for lipophilic materials and Water in Oil (W/O) for hydrophilic materials [8]. It is reported as a promising drug delivery method for hydrophobic drugs. Emulgels are favorable to use as they are greaseless, easily spreadable, easily removable, non-staining, better stable, emollient and pleasing in appearance [9].

Leea indica (Burm.f.) Merr. (In Sinhala: Burulla/Gurulla) is an evergreen perennial shrub or a small tree grown in Sri Lanka. Almost all the parts of the plant including leaves, roots, fruits, stem bark and flowers are used for therapeutic purposes in certain formulations. This plant is reported to have wide range of pharmacological properties including anticancer, antioxidant, analgesic, anxiolytic potential, antiviral, thrombolytic and phosphodiesterase inhibitory activities [10], [11]. Therefore, this research aimed to develop more efficacious, cost-effective and safer anti-inflammatory herbal emulgel using *Leea indica* (Burm.f.) Merr. Leaf extract.

Materials and Methods

Plant materials and chemicals

Leaves of *Leea indica* (Burm.f.) Merr. Were collected from Gampaha district (Western province, in Sri Lanka) in 2020 and were authenticated at the National Herbarium, Peradeniya**,** Sri Lanka. 2-2-diphenyl-1-picrylhydrazyl (DPPH), trolox, carbopol-940, triethanolamine, tween 80, tween 20, ethanol, methanol, acetone and hexane were purchased from Sigma Aldrich local agencies in Sri Lanka.

Preparation of the plant extracts

The crude extract of 70% aqueous acetone was prepared according to a published method [12] with slight modifications. Briefly, ground powder of oven dried leaves was steeped in the solvent (300 mL) separately in Scott Duran bottles with occasional shaking (GEMMYCO shaker, Lab shaking incubator, model:IN-666) for 24 hours in the dark conditions at room temperature. After 24 hours, these extracts were filtered using four layers of muslin cloth and were concentrated under the vacuum using the rotary evaporator (HAHN HS-2005S-N) below 65 °C. Partitioning with hexane was carried out to obtain the defatted crude extracts and they were then subjected to freeze drying (freeze dryer-BIOBASE BK-FD10PT) until a constant weight was gained.

Formulation of herbal emulgel

The emulgel was formulated according to the compositions given in the **Table 1** by following the methods described by Singh et al. and Sultana et al. with slight modifications [13], [14].

Stability testing of physicochemical parameters

Final formulations were evaluated for their physicochemical stability parameters such as pH, appearance, odor, homogeneity, spread ability, phase separation and washability for 60 days at room temperature.

Table 1: Composition of formulated herbal emulgels

Ingredient	Formulations (g)					
	Base	**Fg1**	**Fg2**	**Fg3**	**Fg4**	**Fg5**
Freeze dried leaf extract	-	-	0.200	0.400	0.200	0.400
Carbopol-940	0.125	0.125	0.125	0.125	0.125	0.125
Triethanolamine	0.100	0.100	0.100	0.100	0.100	0.100
Castor oil	0.300	0.300	0.300	0.300	0.300	0.300
Menthol	1.000	1.000	1.000	1.000	1.000	1.000
Eucalyptus oil	-	0.400	-	-	0.400	0.400
Methyl salicylate	-	0.700	-	-	0.700	0.700
Camphor	-	0.400	-	-	0.400	0.400
Tween 80	0.080	0.080	0.080	0.080	0.080	0.080
Tween 20	0.200	0.200	0.200	0.200	0.200	0.200
Distilled water up to	Qs	Qs	Qs	Qs	Qs	Qs

Qs: Quantity sufficient

Evaluation of *in vitro* anti-inflammatory activity of the formulations

In vitro anti-inflammatory activity of formulations prepared was tested by Human Red Blood Cell (HRBC) membrane stabilization method (Heat induced Red Blood Cell hemolysis method) as described [15] with minor modifications. Briefly, the reaction

mixture was prepared by mixing 400 µL of 10% RBC suspension and 4.00 mL of emulgel sample in centrifuge tubes. The reaction mixture was incubated at 56 ºC in water bath for 30 minutes. After the incubation period, the centrifuge tubes containing reaction mixtures were centrifuged at 2500 rpm for 5 minutes. Absorbance of the supernatants was taken at 560 nm using UV visible spectrophotometer (Shimatdzu UV- 1800). Commercially available two gel formulations were used as the positive controls. Negative control was prepared by adding normal saline instead of test sample. The experiment was carried out in triplicates and the percent inhibition of hemolysis was calculated by the equation given (Equation 01).

Equation 01: Calculation of percent inhibition of hemolysis [15]

Percentage inhibition of hemolysis = (Vc – Vt) X 100/Vc

Where, Vc is the absorbance of the negative control and Vt is the absorbance of the test sample.

Evaluation of *in vitro* radical scavenging activity of the formulations

In vitro radical scavenging activity of the final formulations was determined using the 2, 2, -diphenyl-1-picrylhydrazyl (DPPH) assay according to a published method [12]. The antioxidant activity was calculated using the standard calibration curve of Trolox and expressed as mmol Trolox equivalents to 100 g emulgel. Commercially available two gel formulations were used as the positive controls.

Statistical analysis

All experimental measurements were carried out in triplicates and the results were expressed as the mean ± Standard Deviation. The results were analysed using the SPSS software version 25.0. At ($p < 0.05$), the values were considered significantly different at 95% level of confidence

Results

Evaluation of physicochemical stability parameters of final formulations

All formulated herbal emulgels were found to be semi-solid, homogenous, and pleasant in odor, good in appearance with no phase separation **(Fig. 1.)** and pH of the formulations were found in the range of 6 to 7. Physicochemical stability parameters of all formulated emulgels showed no remarkable variation during the period of 60 days tested.

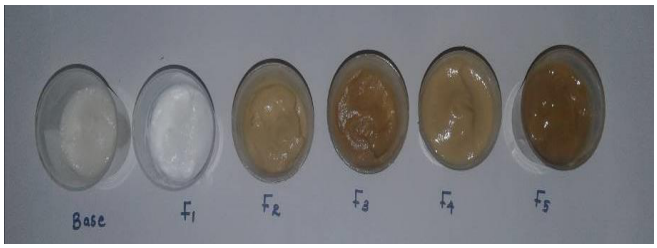

Fig. 1. Physical appearance of formulated herbal emulgels

Results of *in vitro* anti-inflammatory activity of the final formulations

The results of percentage inhibition of hemolysis were obtained at 12.50 mg/mL concentration of each emulgel formulation. All herbal emulgels (Fg2-Fg5) which contained 70% aq. acetone leaf extracts exhibited remarkable *in vitro* anti-inflammatory activity compared to the positive controls. Fg5 showed the highest percentage inhibition effect on hemolysis.

Results of *in vitro* antioxidant activity of the final formulations by DPPH assay

The *in vitro* antioxidant activity of the formulated herbal emulgels were evaluated by using (2, 2 diphenyl-1-picrylhydrazyl) DPPH assay compared to commercial emulgels at 50 mg/mL concentration of samples, with reference to the standard curve equation: y = 0.2635x, r^2 = 0.9966. The results were expressed as mmol Trolox equivalents/100 g of formulation Fg2, Fg3, Fg4 and Fg5 herbal emulgel formulations which contained 70% acetone crude extract exhibited better antioxidant activity compared to other emulgel formulations **(Table 2).**

Table 2: In vitro anti-inflammatory and antioxidant activities of formulated herbal emulgels

Formulation	% Inhibition ± SD	Radical Scavenging activity (mmol Trolox/100 g formulation)
Base	31.59 ± 0.22	0.048 ± 0.00
Fg1	68.16 ± 0.46	0.327 ± 0.00
Fg2	77.79 ± 0.48	1.779 ± 0.01
Fg3	81.97 ± 0.13	2.941 ± 0.01
Fg4	90.96 ± 0.39	2.934 ± 0.01
Fg5	93.73 ± 0.90	3.386 ± 0.01
Commercial gel 1	62.58 ± 0.64	0.364 ± 0.00
Commercial gel 2	58.06 ± 0.59	0.169 ± 0.01

SD: Standard Deviation; mmol: mili moles

Discussion

All the formulated emulgels showed remarkable *in vitro* anti-inflammatory and radical scavenging antioxidant activities in the formulations developed. Formulations; Fg2 - Fg5 which contained 70% aq. acetone leaf extracts as an ingredient exhibited significantly high values of *in vitro* anti-inflammatory and antioxidant activities compared to the positive controls (Commercial gels) tested. Among them, Fg5 which contained the highest concentration of plant extract (4% of crude extract) showed the highest activities. Using ingredients such as eucalyptus oil, castor oil, methyl salicylate, camphor and menthol with known anti-inflammatory activity of the formulations developed, would have improved the efficacy of the anti-inflammatory activity. All the formulations showed no variation in the stability testing for the given period. However, further stability studies should be carried out for a considerable time period under approved conditions to confirm the stability and efficacy of the formulations which will be useful to determine its shelf life. It is recommended to evaluate a wider range of physicochemical parameters of final formulations in these stability studies. *L. indica* is known to possess a wide range of pharmacological activities such as antioxidant, analgesic, antimicrobial, cytotoxic, wound healing, anti-hyperglycemic, hypolipidemic, thrombolytic, sedative, anxiolytic activities etc. Srinivasan et al. revealed the presence of 23 known chemical compounds in the leaves of *L. indica* including eleven hydrocarbons, gallic acid, phthalic acid, three phthalic acid esters, palmitic acid, ursolic acid, solanesol, farnesol, 1-eicosanol, lupeol and β-sitosterol in their study using GC-MS analysis, spectroscopic analysis and co-TLC techniques [16]. Ethanolic extract of *L. indica*

leaves had been tested for its phytochemical, antioxidant, antimicrobial and cytotoxic effects. Antioxidant activity was estimated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay, $FeCl_3$ reducing power assay, alkaline DMSO method and iron chelating assay. Cytotoxic, antibacterial and antifungal activities were tested by brine shrimp bioassay, disc diffusion technique and food poison technique respectively. Phytochemical screening revealed the presence of alkaloids, glycosides, cardiac glycosides, terpenoids, flavonoids, steroids and tannins and significant values of total phenolic and flavonoid contents in the extract. Leaf extract also showed significant antioxidant, antibacterial, antifungal activities and prominent cytotoxic activity during this study [17]. Another study also had been conducted to determine the antioxidant, cytotoxic and phytochemical properties of ethanolic extract of *L. indica* leaves and the results had shown significant values in DPPH assay in a dose dependent manner and a promising cytotoxic activity for the brine shrimp lethality bioassay [18].

The research reported by Saha and the team stated that crude methanolic extract obtained from whole plant of *L. indica* possesses strong antioxidant and nitric oxide (NO) inhibitory activities by using scavenging activity on DPPH, Ferric thiocyanate (FTC), Thiobarbituricacid (TBA) methods and Griess assay [19]. Emran et al. evaluated the central and peripheral analgesic potential of *L. indica* plant using two experimental mice models. Ethanolic extract of *L. indica* at dose level of 200 mg/kg showed a significant reduction of writhing response for acetic acid- induced writhing test and the response were dose dependent [20]. Azizi et al. in their study investigated the wound healing effect of ethanolic extract of *L. indica* in mouse fibroblast cells and mouse macrophage cells by scratch assay and MTT (3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide) assay and the study results had proven the efficacy of *L. indica* in wound heling [21]. The study done by Dalu et al. had evaluated the anti-hyperglycemic and hypolipidemic activities of alcoholic and hydro-alcoholic extracts of *L. indica* leaves. The activities were tested with rats using glucose tolerance test and alloxan induced model compared to standard drug, glibenclamide. It was found that higher doses of hydro-alcoholic extracts more effective than alcoholic extracts in reducing blood glucose and lipid levels. Besides, acute toxicity studies performed in this research have shown that both hydro-alcoholic and alcoholic extracts are safe up to the dose level of 3000 mg/kg [22].

Conclusion

The aim of this study was to develop more efficacious, cost-effective and safer anti-inflammatory herbal emulgel using *L. indica* (Burm.f.) Merr. Leaf extract. All herbal emulgels, which included 70% aqueous acetone leaf extract of *L. indica* as an ingredient, showed significantly greater *in vitro* anti-inflammatory and antioxidant activities compared to the reference commercial formulations. Among them, Fg5 emulgel was found to be the most stable and active formulation with the highest *in vitro* anti-inflammatory and antioxidant activities and therefore it can be recommended for further investigations in animal models.

Acknowledgement

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Conflict of Interests

The authors declare that there is no conflict of interest.

Ethical Approval

This study was conducted after obtaining the ethical approval from the Ethics Review Committee of Faculty of Allied Health Sciences, University of Ruhuna under the reference no: 31.12.2019:2.8.

Informed Consent

For the blood withdrawal procedure in this research study, healthy human volunteers were selected among the students who were between ages 20-30 years, from the Faculty of Allied Health Sciences, University of Ruhuna, who had not taken any anti-inflammatory drug for 2 weeks prior to the blood withdrawal and the purpose and the participant's involvement were clearly explained to each and every volunteer before obtaining the consent. Written informed consent was obtained from all volunteers.

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Original Article

Development of Herbal Green Tea Bags with *Osbeckia octandra* L. (DC.) (Heen bovitiya) and Evaluation of the Effect of Infusion Time and Temperature on Extracted Phytochemicals

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Abstract

Herbal tea or a tisane is a mixture of dried plant parts used for medicinal purposes. Present study was aimed to develop herbal green tea bags with *Osbeckia octandra* (*Heen bovitiya*) leaves predominantly and evaluate the effect of infusion time and temperature on their total phenolic (TP), total flavonoid (TF) contents and *in vitro* antioxidant activity. Six different tea bags (T_1 to T_6) were prepared by incorporating dried *O. octandra* (leaves), *Camellia sinensis* (leaves), *Zingiber officinale* (rhizomes), *Vanilla planifolia* (pods) and *Allium sativum* (bulbs) in different proportions. Each herbal tea bag was infused at a constant infusion temperature of 100 ºC for 3, 5 and 7 minutes and for a constant infusion time of 7 minutes at different temperatures; 100, 90 and 80 ºC. TP, TF contents, *in vitro* radical scavenging activity and ferric reducing antioxidant power of all tea extracts were determined by spectroscopic analysis. Data were analyzed with one sample t-test. All infusions were rich in phytochemicals; phenols, flavonoids, tannins, terpenes, triterpenoids, phytosterols, saponins, alkaloids, amino acids and carbohydrates. TP, TF contents and *in vitro* antioxidant activity of the formulated tea bags were significantly higher after the addition of *O. octandra* leaves and the values were different at different infusion conditions ($p<0.05$). At constant infusion time of 7 minutes, TP, TF contents and antioxidant activity of *O. octandra* incorporated green tea bags were higher when infused at 80 ºC compared to 90 ºC and 100 ºC. At constant infusion temperature of 100 ºC, the values were higher for the formulated green tea bags when infused for 7 minutes compared to 3 and 5 minutes. Hence, it was concluded that the formulated tea bags with *O. octandra* leaves were rich with antioxidants and that they should be brewed for a long time period (7 minutes) at a low temperature (80 ºC).

Keywords: antioxidant activity, phytochemicals, total flavonoid, total phenolic, Osbeckia octandra

Introduction

Tea is the second most consumed drink worldwide which contains various types of phytochemicals such as; catechins, epicatechins, epigallocatechins, epigallocatechingallates, flavanol glycosides, saponins, phenolic acids, purine alkaloids, condensed tannins and proanthocyanidins [1]. It is rich with antioxidant and free radical scavenging properties [2]. *Camellia sinensis* (L.) Kuntze is a flowering plant which belongs to the family Theaceae, whose fresh leaves and leaf buds are used to produce tea. The green tea is prepared

by infusion of fresh tea leaves or unfermented fresh green shoots while black tea is prepared by the infusion of fermented tea leaves where tea leaves are oxidized with maceration and exposed to oxygen [3,4]. Green tea contains caffeine while black tea contains caffeine and theobromine [5]. There are many types of tea products such as; herbal tea, green tea, black tea, oolong tea and white tea. Herbal tea or a tisane is a mixture of dried leaves, flowers, fruits, nuts, seeds, barks, grasses, roots and other parts of a plant or other botanical elements which are used for medical purposes. Some herbal tea products are prepared by incorporating one or more herbal ingredients or extracts to tea leaves [6,7]. Chamomile tea, ginger tea, ginseng tea, cinnamon tea, peppermint tea, hibiscus tea are numerous types of herbal teas with their unique benefits. Herbal tea is brewed in the same way as normal tea (*Camellia sinensis*) [6].

There is a growing trend in the consumption of herbal tea due to their proven pharmacological properties such as; antioxidant, lipid lowering, anti-inflammatory, immune boosting activities. Antioxidants are the compounds that protect the cells from oxidative stress. There are many defense mechanisms in the body to limit the amount of available reactive oxidants and avoid the effects caused by them. In the presence of imbalance of oxidants and antioxidants of the body, there is a need of consumption of exogeneous antioxidants [8]. Natural antioxidants are more preferred than the synthetic antioxidants in which dietary antioxidants play a major role in the removal of free radicals formed in the body.

Osbeckia octandra L. (DC.) or *Melastoma octandra* belongs to the family Melastomataceae, is a rare, endemic plant which is widely used in Traditional and Ayurveda medicine systems due to the many pharmacological activities. It is commonly called as Ayurveda bush-tree, *Heen Bovitiya* in Sanskrit/ Sinhala, *Kathtoo mukhtohulai* in Tamil and Eight Stamen *Osbeckia* in English. Therefore, the present study was aimed to develop herbal tea bags enriched with antioxidants incorporating *Osbeckia octandra* (Heen bovitiya) leaves predominantly.

It has been reported that the composition of the tea infusion is affected by variety of tea and infusion time [3]. It had stated that green tea has a greater antioxidant capacity than black tea [4]. Since, the infusion conditions can change the composition and bioactivity of infusions; the effect of infusion time and temperature on total phenolic (TP), total flavonoid (TF) contents and *in vitro* antioxidant activity were evaluated in this study.

Materials and Method

Preparation of plant materials

Three batches of fresh leaves of mature *O. octandra* without any apparent insect or microbial attacks were collected from Galle District, Southern Province, Sri Lanka (geographical coordinates; latitude: 6.053519 and longitude: 80.220978) during the period from November 2019 to January 2020. Leaves were authenticated from National Herbarium, Royal Botanical Garden, Peradeniya, Sri Lanka. Dry powders of *Camellia sinensis* (green tea leaves), *Zingiber officinale* (rhizomes), *Vanilla planifolia* (pods) and *Allium sativum* (bulbs) were purchased from the local supermarket.

Chemicals

Folin-Ciocalteu phenol reagent, Catechin, Sodium carbonate, Sodium hydroxide, Sodium nitrite, Aluminium chloride, Gallic acid, 2-2-diphenyl-1-picrylhydrazyl (DPPH), 2,4,6-tripyridyl-s-triazine (TPTZ), Trolox, Sulphuric

acid, Nitric acid, Sodium hydroxide, Ferric chloride, Lead acetate, Ammonia, Benzene, Copper acetate, Chloroform, Acetic anhydride, Sodium carbonate, Ethanol, Sodium nitrite, Ferrus sulphate, Sodium phosphate, Starch, n-Hexane of analytical grade were purchased from Sigma Aldrich via local agencies in Sri Lanka. Mayer's reagent, Wagner's reagent, Fehling's A, Fehling's B, Dragendroff's reagent, Ninhydrin reagent and Benedict's reagent were prepared by using the chemicals of routine laboratory work.

Preparation of herbal tea bags and extraction of biologically active compounds

Methodology published in Astill *et* al., 2001 and Niwat, 2019 was followed with modifications. Six different herbal green tea bags were prepared by incorporating dry powders of *O. octandra* (leaves), *C. sinensis* (green tea leaves), *Vanilla planifolia* (pods), *Z. officinale* (rhizomes) and *A. sativum* (bulbs) according to the compositions given in the **Table 1** to a constant total weight of 1.50 g. Tea bags were infused in a constant volume of distilled water (150.0 mL) at two different conditions; at a constant infusion temperature of 100 ºC for infusion times; 3, 5 and 7 minutes and for a constant time of 7 minutes at different temperatures; 100, 90 and 80 ºC [3,6].

Table 1: Composition of formulated herbal green tea bags

Type of Tea bag	*O. octandra*	*C. sinensis*	*Z. officinale*	*A. sativum*	*V. planifolia*
T_1	67%	20%	6.5%	-	6.5%
T_2	-	87%	6.5%	-	6.5%
T_3	67%	20%	6.5%	6.5%	-
T_4	-	87%	6.5%	6.5%	-
T_5	67%	20%	-	6.5%	6.5%
T_6	-	87%	-	6.5%	6.5%

Qualitative analysis of phytochemical screening

Preliminary phytochemical screening was conducted to each tea infusion to screen for the available phytoconstituents; alkaloids, phenolic compounds, tannins, flavonoids, steroids, phytosterols, terpenoids, triterpenes, glycosides, saponins, carbohydrates, reducing sugars, proteins and amino acids following the published methodology in Keo *et al*., 2017 and Visweswari *et al*., 2013 [9,10].

Total phenolic and flavonoid contents

The Folin-Ciocalteu assay and aluminum chloride colorimetric methods of each tea infusion were performed to estimate the total phenol (TP), total flavonoid (TF) contents of extracts respectively as per the methodology published in Hettihewa, 2014 [11].

Radical Scavenging Activity (DPPH assay)

Radical scavenging activity of each extract was determined using DPPH assay according to the method described in Hettihewa, 2014 and the

results were expressed in mmol Trolox equivalents/ 100 g DW of the tea bag [11].

Ferric-reducing antioxidant power activity (FRAP assay)

The FRAP assay was used to determine the ferric reducing power of the extracts based on the assay described in Hettihewa, 2014 and the results were expressed in mmol Fe(II) equivalents/ 100 g DW of the tea bag [11].

Statistical Analysis

All experimental measurements were carried out in triplicate and the results were expressed as average ± standard deviation. Data was analyzed using SPSS software 25.0 version and one sample t-test was followed to determine the effect of infusion conditions on TP, TF contents and *in vitro* antioxidant activity. One-way ANOVA with Tukey post-hoc tests were conducted to compare the parameters of tea products analyzed. Multiple comparisons were conducted pair-wise and at p=0.05, the values were considered significantly different at 95 % level of confidence.

Results

Qualitative phytochemical analysis revealed that the phytoconstituents including; phenolic compounds, flavonoids, tannins, triterpenes, phytosterols, saponins, alkaloids, amino acids and carbohydrates were present in all tea infusions. The values of total phenolic, total flavonoid contents and antioxidant activities were higher for the developed herbal green tea bags when infused at 80 ºC than at 100 ºC and 90 ºC for a constant time of 7 minutes. The values were higher for the developed herbal green tea bags when infused for 7 minutes than for 3 and 5 minutes at a constant temperature of 100 ºC. TP, TF contents and *in vitro* antioxidant activity of tea products were significantly higher at p=0.05 in the developed green tea bags with *O. octandra* than green tea bags without *O. octandra* at all infusion temperatures and times (**Table 2 & 3**).

Table 2: TP, TF contents, DPPH and FRAP values at different infusion temperatures for constant infusion time (7 minutes)

Tea Bag with the composition %	Infusion Temperature (ºC)	TPC±SD[p] (mg CAE/100 g DW)	TFC±SD[q] (mg CAE/100 g DW)	DPPH±SD[r] (mmol TE/100 g DW)	FRAP±SD[s] (mmol Fe^{2+}E/100 g DW)
Sample T_1	100	1650.58±5.63[a]	371.14±4.03[a]	7.00±0.00[a]	20.63±0.01[a]
HB:GT:ZO:AS:VP	90	1710.24±5.63[b]	395.08±14.06	7.35±0.02[b]	20.84±0.02[b]
(67:20:6.5:0:6.5)	80	1929.00±5.63[c]	[b]	7.42±0.00[c]	21.20±0.06[c]
			406.57±3.13[c]		
Sample T_2	100	1612.32±2.36[d]	360.19±3.65[d]	7.38±0.19[d]	20.43±0.02[d]
HB:GT:ZO:AS:VP	90	1700.89±3.59[e]	378.96±9.81[e]	7.47±0.01[e]	20.65±0.04[e]
(0:87:6.5:0:6.5)	80	1899.25±4.61[f]	401.12±7.20[f]	7.51±0.00[f]	21.36±0.01[f]
Sample T_3	100	1960.28±23.79[g]	412.17±15.32[g]	7.41±0.00[g]	20.48±0.00[g]
HB:GT:ZO:AS:VP	90	1989.65±4.22[h]	423.14±10.94[h]	7.49±0.00[h]	20.74±0.03[h]
(67:20:6.5:6.5:0)	80	2032.41±5.63[i]	448.55±12.50[i]	7.52±0.00[i]	21.50±0.10[i]
Sample T_4	100	1888.56±26.11[j]	360.19±3.65[j]	7.38±0.19[j]	20.43±0.02[j]
HB:GT:ZO:AS:VP	90	1912.26±11.23[k]	378.96±9.81[k]	7.47±0.01[k]	20.65±0.04[k]
(0:87:6.5:6.5:0)	80	1979.61±12.26[l]	401.12±7.20[c]	7.51±0.00[l]	21.36±0.01[l]
Sample T_5	100	1762.10±3.69[m]	380.15±5.78[m]	7.04±2.15[m]	20.79±0.04[m]
HB:GT:ZO:AS:VP	90	1800.44±0.11[n]	398.33±0.56[n]	7.44±1.01[n]	20.99±0.56[n]
(67:20:0:6.5:6.5)	80	1990.20±4.41[o]	411.33±2.40[o]	7.69±0.06[o]	21.25±1.11[o]
Sample T_6	100	1712.09±1.22[m]	369.87±1.70[m]	7.00±0.50[m]	20.44±1.22[m]
HB:GT:ZO:AS:VP	90	1796.23±0.56[n]	373.56±4.77[n]	7.25±1.25[n]	20.65±0.14[n]
(0:87:0:6.5:6.5)	80	1892.44±1.14[o]	401.23±5.12[o]	7.55±0.80[o]	21.06±0.04[o]

HB: Heen bovitiya, GT: Green tea, ZO: *Zingiber officinale*, AS: *Allium sativum*, VP: *Vanilla planifolia*

[p]*Total phenolic content is expressed as mg GAE/100 g DW*
[q]*Total flavonoid content is expressed as mg CAE/100 g DW*
[r]*Radical scavenging activityis expressed as mmol TE/100 g DW*
[s]*Ferric reducing activityis expressed as mmolFe^{2+}E/100 g DW*
Results are expressed as mean ± standard error. Means followed by the same letter with in the tea type in a column are not significantly different at p= 0.05

Table 3: TP, TF contents, DPPH and FRAP values at different infusion time for a constant infusion temperature (100 ºC)

Tea Bag with the composition %	Infusion Time (minutes)	TPC±SD[p] (mg CAE/100 g DW)	TFC±SD[q] (mg CAE/100 g DW)	DPPH±SD[r] (mmol TE/100 g DW)	FRAP±SD[s] (mmol Fe^{2+}E/100 g DW)
Sample T_1	3	1463.65±12.36[g]	367.46±7.19[a]	6.66±0.17[g]	20.28±0.01[a]
HB:GT:ZO:AS:VP	5	1580.98±8.44[h]	370.11±4.69[b]	6.48±0.26[h]	20.38±0.01[b]
(67:20:6.5:0:6.5)	7	1650.58±5.63[i]	373.32±2.03[c]	7.00±0.00[i]	20.48±0.00[c]
Sample T_2	3	1598.74±6.35[d]	359.65±5.97[d]	7.20±0.00[d]	20.22±0.04[d]
HB:GT:ZO:AS:VP	5	1795.49±9.31[e]	362.45±3.69[e]	7.31±0.01[e]	20.29±0.02[e]
(0:87:6.5:0:6.5)	7	1843.12±6.69[f]	369.87±5.78[f]	7.35±0.01[f]	20.42±0.03[f]
Sample T_3	3	1672.46±2.81[a]	338.29±1.56[g]	7.35±0.15[a]	20.31±0.01[g]
HB:GT:ZO:AS:VP	5	1843.22±25.83[b]	374.09±0.31[h]	7.39±0.00[b]	20.53±0.05[h]
(67:20:6.5:6.5:0)	7	1960.28±23.79[c]	384.03±1.56[i]	7.41±0.00[c]	20.63±0.01[i]
Sample T_4	3	1412.55±8.39[j]	329.65±8.74[j]	6.41±0.01[j]	20.23±0.03[j]
HB:GT:ZO:AS:VP	5	1501.28±3.96[k]	356.89±7.14[k]	6.48±0.00[k]	20.40±0.03[k]
(0:87:6.5:6.5:0)	7	1599.12±3.69[l]	379.25±4.71[c]	6.91±0.02[l]	20.53±0.07[l]
Sample T_5	3	1489.23±1.09[m]	321.06±1.69[m]	7.06±0.17[m]	20.29±0.17[m]
HB:GT:ZO:AS:VP	5	1591.23±0.08[n]	372.12±0.03[n]	7.28±1.11[n]	20.49±0.04[n]
(67:20:0:6.5:6.5)	7	1888.32±1.42[o]	379.81±2.44[o]	7.22±1.04[o]	20.52±1.00[o]
Sample T_6	3	1399.29±0.17[p]	319.89±1.04[p]	6.99±0.17[p]	20.10±0.11[p]
HB:GT:ZO:AS:VP	5	1546.12±0.07[q]	365.84±0.11[q]	7.02±1.26[q]	20.28±1.11[q]
(0:87:0:6.5:6.5)	7	1720.02±0.40[r]	371.00±1.08[r]	7.14±0.06[r]	20.45±0.44[r]

HB: Heen bovitiya, GT: Green tea, ZO: Zingiber officinale, AS: Allium sativum, VP: Vanilla planifolia

[p]*Total phenolic content is expressed as mg GAE/100 g DW*
[q]*Total flavonoid content is expressed as mg CAE/100 g DW*
[r]*Radical scavenging activityis expressed as mmol TE/100 g DW*
[s]*Ferric reducing activityis expressed as mmolFe^{2+}E/100 g DW*

Results are expressed as mean±standard error. Means followed by the same letter with in the tea type in a column are not significantly different at p= 0.05

Discussion

Plants contain a variety of biologically active compounds called phytochemicals which can act as antioxidants by scavenging the free radicals, thus have a therapeutic potential

against free radical associated disorders [12]. Medicinal plants are commonly rich in phenolic compounds; such as flavonoids, phenolic acids, stilbenes, tannins, coumarins, lignans and lignins which show antioxidant potential [13]. The formulated herbal green tea bags were rich with many phytoconstituents including; phenolic compounds, flavonoids, tannins, triterpenes, phytosterols, saponins, alkaloids, amino acids and carbohydrates. Tea is the most widely consumed beverage worldwide containing a variety of polyphenols [1] and therapeutic potential of tea can be enhanced by incorporating herbal ingredients [7]. All tea bags with the addition of *O. octandra* leaves (T_1, T_3, T_5) obtained higher values for TP, TF contents and *in vitro* antioxidant activity than that of the tea bags without *O. octandra* (T_2, T_4, T_6) at all infusion temperatures and times. The TP, TF contents and *in vitro* antioxidant activity were higher for all green tea bags when infused at 80 ºC than at 90 ºC and 100 ºC (**Table 1**). The TP, TF contents and *in vitro* antioxidant activity were higher for all green tea bags when infused for 7 minutes than for 3 and 5 minutes at a constant temperature of 100 ºC (**Table 2**). Green tea is prepared by infusing soaked dried green tea leaves in hot water (80-90 ºC) for 3-4 minutes. Catechins in tea act as antioxidants. It has been found that brewing of green tea at a temperature of 85 ºC for 3 minutes gives the maximum amount of catechins [14]. The precise infusion temperature is on par with the present study findings. TPC and antioxidant activity were found to be high when herbal tea was infused at 100 ºC for 5 minutes and 80 ºC for 10 minutes which is similar to the present study findings [15]. It had found that the highest antioxidant potential was obtained with prolonged cold steeping for green tea which is similar to the current study [16]. However, another study reported that the maximum antioxidant activity was obtained at 100 ºC for 9.5 minutes which is different from finding of the present study [17,18]. In addition, it has been found that *in vitro* antioxidant activity was correlated with the TPC and significantly high antioxidant activity was obtained at 80 ºC in par with the findings of the current study [19].

Conclusions

The green tea bags formulated with *O. octandra* leaves are rich with antioxidants and that they should be brewed for a long time period (7 minutes) at a low temperature (80 ºC) to achieve the maximum antioxidant activity.

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Conflict of Interests

No any potential conflict of interest exists in this publication.

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Original Article

Empirical Study Assessing the Factors that Influence Consumer Purchase Intentions for Eco-friendly Vehicles in the Colombo District of Sri Lanka

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Abstract

This study explores the factors influencing consumer purchase intentions for eco-friendly vehicles in the Colombo district of Sri Lanka. The conceptual framework was structured primarily based on the Theory of Planned Behavior and 28 potential influential factors were explored in this study. This study mainly focuses on determining the influence of attitudes, subjective norms, perceived behavioral control, personal moral norms and also demographics of the consumers in purchasing eco-friendly vehicles. 262 responses were taken by using snowball sampling by distribution of the questionnaire survey and 210 useable responses were considered in the research. The author has found that personal moral norm and supplementary factors influence the intention to adopt eco-friendly vehicles while attitudinal, perceived behavioral control and subjective norms have become insignificant.

Keywords: Consumer Buying Behavior, Eco-Friendly Vehicles, Green Consumerism, Purchase Intention, Theory of Planned Behavior

Introduction

This study explores the factors influencing consumer purchase intentions for eco-friendly vehicles in the Colombo district of Sri Lanka. The conceptual framework was structured primarily based on the Theory of Planned

Behavior and 28 potential influential factors were explored in this study. This study mainly focuses on determining the influence of attitudes, subjective norms, perceived behavioral control, personal moral norms and also demographics of the consumers in purchasing eco-friendly vehicles. 262 responses were taken by using snowball sampling by distribution of the questionnaire survey and 210 useable responses were considered in the research. The author has found that personal moral norm and supplementary factors influence the intention to adopt eco-friendly vehicles while attitudinal, perceived behavioral control and subjective norms have become insignificant.

One of the most common ways of fulfilling the generation of energy which is required for these vehicles is by burning fossil fuels. This emits enormous amount of gases to the environment. Carbon dioxide, which is one of the major contributors to the Green House Effect, is emitted extensively during this combustion. Thiel, et al., (2012) states that the emission of CO2 from road transportation has increased significantly during the recent past. As of 2016, global transport sector had contributed 7,866.0 million of tonnes of CO2 of which 5,852.6 million of tonnes is by road transportation (IEA,

2018). Sri Lanka had contributed 9.4 million of tonnes in 2016 of which 9.0 million of tonnes is by road transportation (IEA, 2018).

According to (International Energy Agency , 2021) CO2 emissions from transport in Sri Lanka in 2018 was 8258 metric tons which is higher than 8078 metric tons in 2017. According to statistics of Department of Motor Traffic, (2018) one fifth of vehicles were unable to successfully pass the Gas Emission test in 2016. Passing rate of the Gas Emission test has increased during 2012 to 2015 period, but in 2016 there is a significant drop.

According to IEA, (2018) transportation sector has contributed 7.866 billion tonnes of CO2 into the environment in 2016 of which 5.8526 billion tonnes is by road transportation at a global scale. Bekker, (2019) in his studies found that Car and Light Commercial Vehicle (LCV) sales in top 54 markets contracted by 0.5% in a global scale in 2018 compared to 2017. However, also found that there is a 3.3% increase in the sales of such mentioned vehicles in Asia-Pacific region in 2018 compared to 2017. It is evident that the CO2 emissions also rises with the increase of vehicle population as fuel consumptions go up. Figure 1 shows the increase of vehicle population in Sri Lanka by year 2012 to 2018 and there is a significant increase in vehicle population. So the fuel consumption also goes up dramatically.

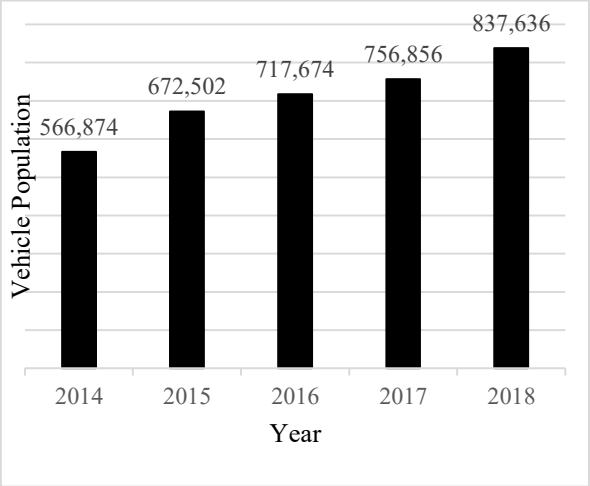


Fig. 1 Vehicle Population in Sri Lanka by Year (2012-2018)

Source - (Department of Motor Traffic, 2018)

It is very important to take actions in order to reduce pollution caused by emission of CO2 from transportation and conserve the environmental systems in a sustainable manner. Sustainable environmental planning and management are few of the strategic challenges to overcome in the current circumstances. Today's world is going forward in terms of initiating green concepts and sustainability measures in transportation sector to reduce the amount of emission of CO2 into the environment and minimize carbon footprint while Sri Lanka is yet to thrive. Yusof, et al., (2013) states that there is an increased awareness and concern of environmental issues throughout the population. It has initially begun with the concern on decrease of scarce natural resources and then it moved towards a concept called green consumerism where people started to consume environmentally friendly products. Laroche, et al., (2001) mentioned that consumers are willing to pay a higher price or premium for such green products.

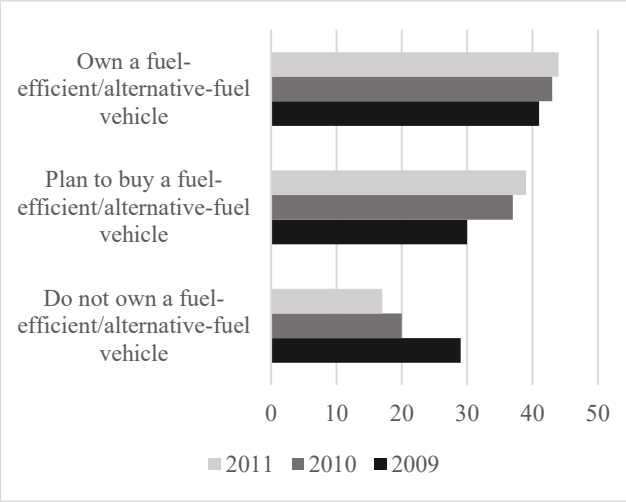


Fig. 2 Percentage increase in interest in Green Vehicles

Source - (Capgemini, 2011)

Environmentally friendly vehicles are said to be a solution to minimize the environmental impact in the current context. According to findings of Van Mierlo, et al., (2003), Electric vehicles causes the lowest environmental damage and the hybrid vehicles can be considered as 'clean'. Countries have taken measures to promote eco-friendly vehicles such as hybrid and electric vehicles for the consumers to reduce the emissions by road vehicles. There are different types of eco-friendly vehicles such as Hybrid cars, Electric cars, Bio diesel cars, Ethanol cars, Hydrogen powered cars. Hybrid cars can be categorised as Hybrid Electric Vehicles (HEVs) and Plug-In Hybrid Electric Vehicles (PHEVs) while Electric cars can be categorised as Battery Electric Vehicles (BEVs) and Fuel Cell Electric Vehicles (FCEVs).

Dijk, et al., (2013) uncovered that Toyota and Honda were the first to mass-produce low carbon emission vehicles with hybrid technology during 1997-2005 period. The success story was not smooth according to his studies. The Prius I with relatively lesser acceleration was launched to Japan market in 1997 and after capturing the market Prius II with increased acceleration was introduced to California in 2000. With the rapid consumerism of the new technology in American market, Toyota started to roll out worldwide in 2004. Toyota and Honda launched their hybrid products as Prius and Insight in 1997 and 1998 respectively. Other car manufactures were reluctant to go for such technology at first, but after 2005 they started to invest for hybrid technology.

Bekker, (2019) states that the BEV sales increased drastically by a huge 74% in 2018 to 1.26 million of BEVs compared to 0.73 million of BEVs in 2017.

Karunanayake & Wanninayake, (2015) mentions that Sri Lankan vehicle market is introducing different varieties of eco-friendly vehicles ranging from mid-range Toyota hybrids to top-end luxuries like Porsche hybrids. Also states that Sri Lankans are "Risk Avers" people and are hesitating to embrace innovative technological products. But for vehicles with eco-friendly technology it was totally different and purchasers with high purchasing power as well as cost conscious purchasers lean towards purchasing eco-friendly vehicles.

In this regard, it is timely convenient to explore the factors influencing the intension of purchasing eco-friendly vehicles. These vehicles can be a significant solution for the increasing environmental impact due to conventional internal combustion vehicles. These vehicles emit zero or minimal amount of CO2 to the environment and so that they play an important role in reducing the harmful emissions. As this sustainable, environmentally friendly technology can be very important to developing countries like Sri Lanka, the focus of this research is on understanding the factors influencing the consumer intention for

purchasing an eco-friendly vehicles among Sri Lankan consumers.

Colombo is the commercial capital and major economic centre in Sri Lanka. As most of the key activities take place around Colombo, it contributes a significantly high level of emissions to the atmosphere. So, it is timely convenient to study relating the solutions to mitigate this issue. Therefore, this study mainly concerns on the research problem of "what are the factors influencing consumer purchase intention for eco-friendly vehicles in Colombo district of Sri Lanka".

As consumers always try to maximize their utility, there is a significant question whether they are more sensitive to cost or availability or any other attributes. Especially when it comes to Sri Lankan context, as there is only one publication in Sri Lanka regarding the same discipline as this study, there is not much empirical evidences to understand such determinants in Sri Lanka.

As mentioned by Karunanayake & Wanninayake, (2015) most of the previous researches were focused on environmental aspect and only itself is not sufficient enough to understand the behaviour of consumers towards purchasing eco-friendly vehicles. This study is realistic in nature as such area of knowledge is concerned when it comes to making a decision in purchasing a vehicle. Accordingly, this study is the only publication in Sri Lanka related to similar discipline and it has been done partly based on Theory of Reasoned Action (TRA). As the researcher has found that Theory of Planned Behaviour (TPB) was shown to be superior to the TRA for the prediction of target behaviour and TPB explains more variation in behavioural intention than the TRA regardless of the level of control (Madden, et al., 1992).

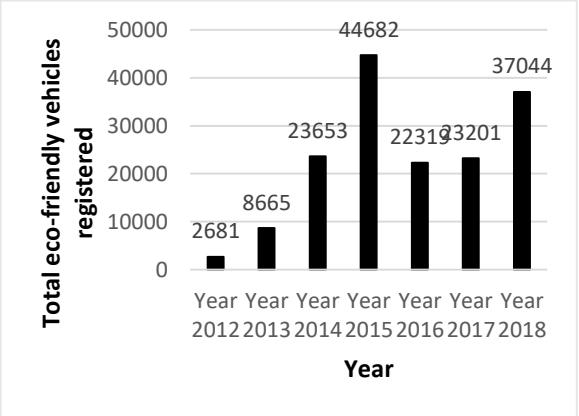


Fig. 3 Registration of Eco-Friendly Vehicles by Year (2012-2018)

Source - (Liyanage, 2019)

Fig. 3 shows the registration of eco-friendly vehicles in past seven years. The highest number of eco-friendly vehicle registrations can be seen in year 2015. Even though there is a massive growth between year 2012 and year 2015, an enormous decrease in registration of eco-friendly vehicles can be observed in year 2016. However, a significant increase in year 2018 is visible and so that there is an immense variation in the registration of eco-friendly vehicles. So that, it can be said that there is an empirical gap as well as a practical gap in the study area and researcher find it worthy to investigate.

This study endeavour to assess the factors influencing such discipline in the Sri Lankan context. This can be useful in encouraging people towards purchasing environmentally friendly vehicles replacing the conventional internal combustion vehicles. Consequently, these outcomes can be used in policy decision process towards the favour for the consumers such as tax concessions, dedicated parking and lane priorities etc. Understanding the consumer intention is important to policy decision makers as they are the responsible parties for long-term development of transportation sector as well as infrastructure. Also, it is influential for the car manufacturers to direct the industry towards a

more sustainable future. This study is significant to companies who market eco-friendly vehicles as well as the government and also it helps to encourage academics to further investigate on the same discipline.

The primary objectives of this paper is assessing the factors influencing the consumer purchase intention towards eco-friendly vehicles in Colombo district. Secondary Objectives are:

- Identifying how attitudes, influence the consumer purchase intention towards eco-friendly vehicles in Colombo district.
- Identifying how subjective norms, influence the consumer purchase intention towards eco-friendly vehicles in Colombo district.
- Identifying how perceived behavioural control, influence the consumer purchase intention towards eco-friendly vehicles in Colombo district.
- Identifying how personal moral norms, influence the consumer purchase intention towards eco-friendly vehicles in Colombo district.
- Identifying how demographics, influence the consumer purchase intention towards eco-friendly vehicles in Colombo district.

The following research questions are formulated to be answered through the study as means of achieving aforementioned objectives.
Question 01: What are the waste clearance approaches available for pharmaceutical industry in Sri Lanka?
Question 02: What are the positively and negatively correlated factors those will be affected to the waste disposal cost in pharmaceutical industry?

Explaining human behaviour is a complex and difficult task. As Kotler, (2000) mentioned, “Understanding consumer behaviour is never simple, because customers may say one thing but do another”. Consumer Purchasing Behaviour is considered to be a highly important research area. Many researches have been conducted to identify the factors influencing the consumer purchasing behaviour. Understanding such behaviour can be beneficial for successful marketers to study customers and uncover clues for developing new products, product features, prices, channels, messages and other marketing mix elements (Kotler, 2000). As described in stimulus response model, consumer’s buying behaviour is influenced by cultural (culture, subculture, and social class), social (reference groups, family, and social roles and statuses), personal (age, stage in the life cycle, occupation, economic circumstances, lifestyle, personality, and self-concept), and psychological (motivation, perception, learning, beliefs, and attitudes) factors.

As per the writings of Kotler & Armstrong, (2014), buying behaviour differs greatly from product to product or service to service. There are types of Buying Decision Behaviour such as Complex buying behaviour, Dissonance-Reducing buying behaviour, Habitual buying behaviour, Variety seeking buying behaviour etc.

Prasad & Jha, (2014) has mentioned 10 models to help the marketers to understand various steps in the whole process of consumer decision making for final purchase of the products of their choices. Few of them are Andreason model, Nicosia model, Howard-Sheth model, Industrial buyer decision model etc and also has found that price, quality etc and attitude, perception, self-concept etc are taken into consideration during the processes.

The Theory of Reasoned Action (TRA) is a model which has been used extensively to predict the behavioural intentions and/or

behaviour (Madden, et al., 1992). The conceptual framework of research of Karunanayake & Wanninayake, (2015) has been developed partly based on this theoretical model.

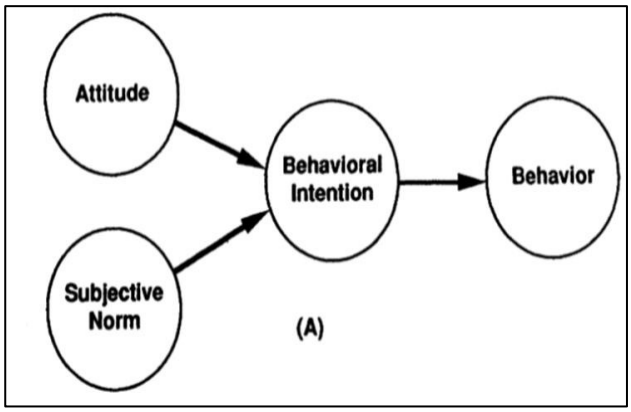


Fig. 4 Path model for Theory of Reasoned Action

Source - (Madden, et al., 1992)

Theory of Planned Behaviour (TPB) is one of the most commonly used theory in identifying the factors affecting purchase intention of the consumers. It is an extension of the "Theory of Reasoned Action" (TRA). According to TPB, it is a collective function of both intention and perceived behavioural control (Ajzen, 1991). Madden, et al., (1992) have concluded that TPB was shown to be superior to the TRA for the prediction of target behaviour and TPB explains more variation in behavioural intention than the TRA regardless of the level of control.

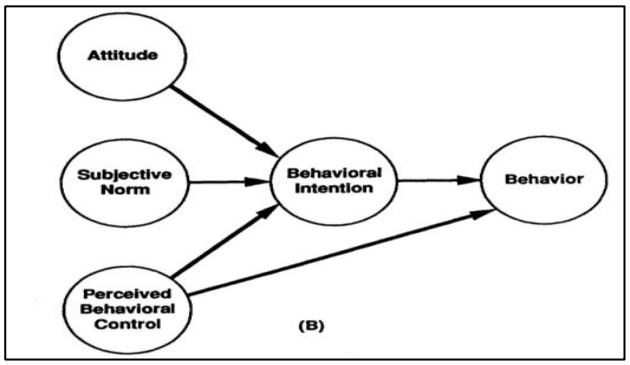


Fig. 5 Path model for Theory of Planned Behaviour

Source - (Madden, et al., 1992)

Selecting a vehicle is often a complex task with a high involvement process within it. TPB is a good model to understand the factors influencing the consumer purchase intention towards eco-friendly vehicles. Hong, et al., (2013) used decomposed TPB as a basis for investigating the factors influencing the adoption of eco-friendly vehicles. According to the study, the decomposed theory of planned behaviour acts as a good means of understanding factors influencing intention of a person to adopt innovative products such as attitude, subjective norm, and perceived behavioural control.

- Attitude - Attitude refers to the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question (Ajzen, 1991). As of Henning & Karlsson, (2011), attitude generally describes ones like or dislike of a certain thing.

- Subjective norm - Ajzen, (1991) refers this as the perceived social pressure to perform or not to perform the behaviour. Hong, et al., (2013) states it is the "person's perceptions that is people who are important to him think that he/she should or should not perform the behaviour in question".

- Perceived Behavioural Control - Hong, et al., (2013) states this as factors that may impede the performance of the behaviour. It further describes that there are two aspects to this. The first one is individual's self-confidence in his or her ability to perform a behaviour and the second one is facilitating conditions and it reflects the availability of resources needed to engage in the behaviour.

- Personal moral norm - Kaiser & Scheuthle, (2003) stated that the explanatory power, when determining intention of

individual to perform certain environmental-friendly behaviours, can be enhanced by personal feeling of moral responsibility or personal moral norm and also found that an individual's moral norm plays a significant role in predicting behavioural intention. In addition to the three primary elements in the TPB model, Wang, et al., (2016) has incorporated personal moral norm in order to develop and extended TPB model to predict the behavioural intention.

- Demographics and Intention to Adopt - Wu, et al., (2010) states that higher education, higher income and young consumers have a higher tendency to purchase hydrogen powered cars and Sanitthangkul, et al., (2012) mentions age, occupation and income significantly influence on decision to purchase eco-friendly cars

Karunanayake & Wanninayake, (2015) has conducted the first research on purchase intentions of Hybrid Vehicles in Sri Lanka and has considered variables such as consumers' environmental attitudes, price perception such as price of product and comparison of prices, perceived risks, social influence or subjective norms, and product knowledge.

Hong, et al., (2013) has used compatibility, pro-environmental, perceived behavioural control, demographics such as gender, income, education level, and age, attitudes and subjective norms in the study. Gupta, (2013) has found that influence of friends, family and relatives has a significant impact on the vehicle purchasing behaviour and also price of vehicle, fuel efficiency, powerful engines, brand image, re-sale value, after sales services also impacts the said behaviour. Performance, after sales services, safety are taken into consideration in the study of Aghdaie & Yousefi, (2011) for Iran market. Dongyan & Xuan, (2008) has taken performance, brand image, fuel consumption, safety, re-sale value into consideration in the study for purchase behaviour in Beijing.

Knez, (2017) has considered that price of vehicle, maintenance/repair cost, warranty, fuel type, load space as factors affecting vehicle purchasing behaviour. Neizari, et al., (2017) and Krupa, et al., (2014) has also considered price of vehicle as a factor influencing the purchasing behaviour. Thiel, et al., (2012) state factors such as price of vehicle, safety features, performance, environmental considerations, automobile trends, recharge mileage and recharge time etc. influence the purchase behaviour. Wang, et al., (2017) has found that personal morals such as moral principle and responsibility towards environment are influenced in eco-vehicle purchasing behaviour.

Karunanayake & Wanninayake, (2015), Gupta, (2013), and Krupa, et al., (2014) have taken subjective norms such as influence of family, friends and colleagues as for the factors affecting the consumer purchase intention. Perceived behavioural factors such as tax incentives, sales incentives, and government fuel policies are taken into their studies by Hong, et al., (2013). And also factors such as automobile trends and tax incentives are taken by Thiel, et al., (2012) and Jayaraman, et al., (2015) respectively. Lai, et al., (2015) has taken variables such as cheap electricity and infrastructure readiness and Wang, et al., (2017) the cruising range for identifying purchase behaviour.

TABLE I
Summary of Supporting literatures

Factor	Supporting Literature Review
Price of vehicle	Karunanayake & Wanninayake (2015), Neizari, et al. (2017), Krupa, et al. (2014), Thiel, et al. (2012), Gupta (2013), Knez (2017)
Fuel Efficiency	Hong, et al. (2013), Krupa, et al. (2014), Gupta (2013), Hamamoto (2019)
After-Sales Services	Dongyan & Xuan (2008), Gupta (2013), Aghdaie & Yousefi (2011)
Maintenance/repair cost	Knez (2017)
Re-Sale Value	Hong, et al. (2013), Dongyan & Xuan (2008), Gupta (2013)
Brand Image	Karunanayake & Wanninayake (2015), Gupta (2013)
Safety Features	Thiel, et al. (2012), Dongyan & Xuan (2008), Knez (2017), Gupta (2013), Aghdaie & Yousefi (2011)
Design	Hamamoto (2019), Gupta (2013)
Performance	Krupa, et al. (2014), Thiel, et al. (2012), Gupta (2013), Knez (2017), Hamamoto (2019), Aghdaie & Yousefi (2011)
Environmental considerations	Karunanayake & Wanninayake (2015), Krupa, et al. (2014), Thiel, et al. (2012), Jayaraman, et al. (2015), Knez (2017)
Influence of family	Karunanayake & Wanninayake (2015), Krupa, et al. (2014), Gupta (2013)
Influence of friends	Karunanayake & Wanninayake (2015), Krupa, et al. (2014), Gupta (2013)
Influence of colleagues	Karunanayake & Wanninayake (2015), Krupa, et al. (2014), Gupta (2013)
Automobile trends	Thiel, et al. (2012)
Tax incentives	Hong, et al. (2013) Jayaraman, et al. (2015)
Sales incentives	Hong, et al. (2013)
Government Fuel Policies	Hong, et al. (2013)
Cheap electricity	Lai , et al. (2015)
Infrastructure readiness	Lai , et al. (2015)
Cruising range	Wang, et al. (2017)
Recharge mileage	Thiel, et al. (2012)
Recharge time	Thiel, et al. (2012)
Fuel type	Knez (2017)
Load space/Passenger capacity	Knez (2017)

Availability of Spare parts	Hong, et al. (2013)
Warranty	Knez (2017)
My moral principle	Wang, et al. (2016)
My responsibility towards environment	Wang, et al. (2016)

Research Methodology

This research takes the nature of a causal design which is also known as exploratory research. According to Dudovskiy, (2018) causal research is conducted in order to recognize the extent and nature of the cause-and-effect relationships. Causal researches are used for explanatory purposes and for prediction and testing of hypotheses which enables the researcher to forecast probable scenarios that would take place.

The main objective of the study is to assess the factors influencing consumer intention towards purchasing eco-friendly vehicles in Colombo district of Sri Lanka. Dependent variable of this research is the intention to adopt eco-friendly vehicles while factors influencing the consumer intention towards purchasing such vehicles are considered as the independent variables of the study. Those independent variables are supported by research articles as mentioned above in table 1

The conceptual framework is developed based on the theory of planned behaviour as described by Ajzen, (1991). Further extensions are included according to the decomposed theory of planned behaviour of Hong, et al., (2013) and personal moral norm incorporated model of Wang, et al., (2016). The conceptual framework of is study is as shown in the Fig. 6 below

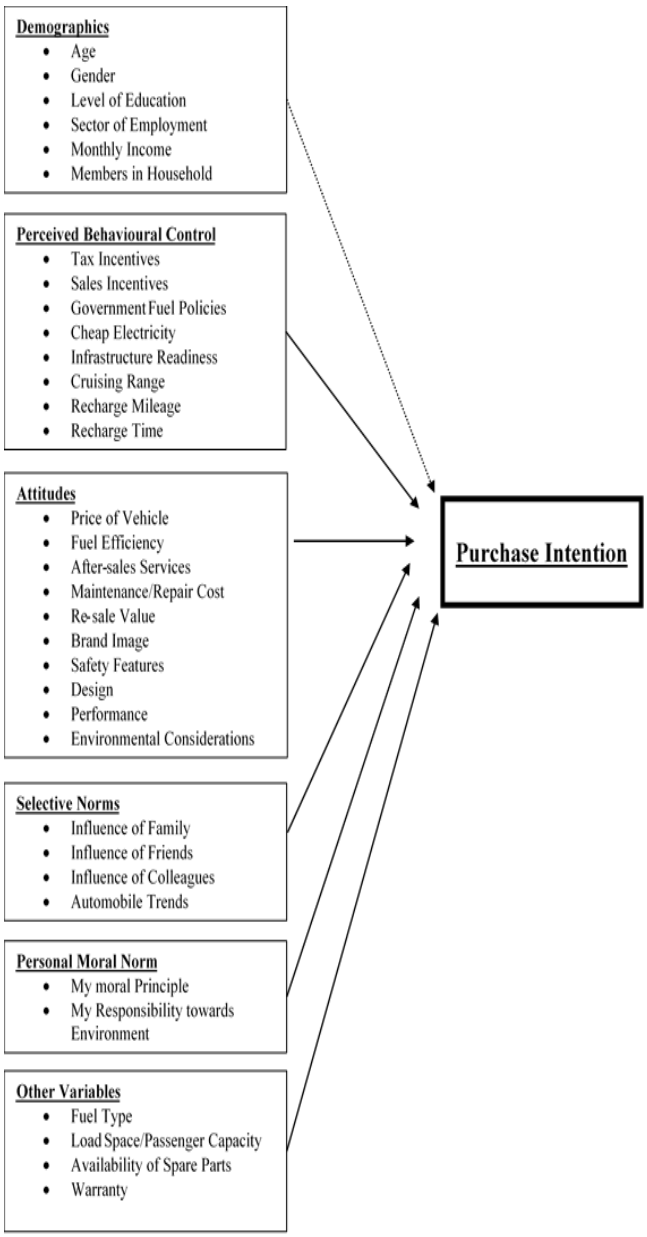


Fig. 6 Conceptual Framework

The primary data was collected through distribution of an online questionnaire. Questionnaire was distributed through Google Forms and hard copies were given out among random car purchasers. In order to test the validity and reliability, a pilot survey was conducted by distribution of the questionnaire survey to 100 respondents. The Cronbach's Alpha was calculated for find the reliability of data collected from the pilot survey to statistically verify the validity and reliability of the questionnaire and the alpha coefficient was in the excellently acceptable range which permitted the questionnaire to be used in the main survey.

Primary Data Set

The research is based on primary data collected through the questionnaire survey which was distributed among 262 respondents. Once the pilot survey confirmed the validation of the questionnaire, the final survey was initiated.

Secondary Data

Secondary data was mostly used for the conceptualization of the study and they were

gathered from sources such as journals, scholarly articles, peer reviewed various articles, credible publications, reports and web pages etc. These secondary data were also supportive in determining sample size, sampling methods, development of conceptual framework and questionnaire, scaling and analysing data as well.

Validity and Reliability

Cronbach's Alpha is used in statistics to measure the internal consistency/ reliability which is utmost commonly used to verify the reliability of the scale in a multiple Likert-Scale questionnaire. Higher rate of Alpha coefficient is measured as questionnaire being further reliable to collect the primary data related to the survey. Conventionally, it is recognized that Cronbach's alpha coefficient requires 0.70 or higher to be reliable. Following (01) is the equation for calculating total Cronbach's Alpha coefficient. The reliability test using Cronbach's Alpha coefficient has been carried out in this study to check the reliability of the pilot and main surveys.

$$\alpha = \frac{N * \bar{C}}{\bar{V} + (N-1) * \bar{C}} \ldots\ldots\ldots\ldots (01)$$

α = Cronbach's Alpha value

N = Number of items

$\bar{C}$ = Average inter-item covariance between the items

$\bar{V}$ = Equal to average variance

Statistical Methods of Data Analysis

Data collected through the questionnaire survey were fed into SPSS 16.0 (a statistical software tool) in order to generate a broad analysis of the dissertation which is discussed below in next section. Following statistical data analysis methods were used in analysing the data set obtained.

Descriptive Analysis

Descriptive statistics are used in order to describe the fundamental features of the data in the study while providing summaries about the considered sample and the measures which were taken for the study and also it summarizes the distribution of the responses. Level or the nature of the collected data has been identified by using the descriptive statistics. This can be categorized into two parts as measures of central tendency such as mean, median, and mode and measures of variability such as standard deviation, variance, the minimum and maximum variables, and the kurtosis and skewness.

Cross Tabulation

Cross Tabulation is used to understand the patterns in different categorical variables in the study. It is also used to analyse the relationships within data which may not be readily evident. The Chi-Square is used to evaluate Tests of Independence when using a cross tabulation.

Factor Analysis

Factor analysis is a technique which is used to reduce the large number of variables in the study into lesser number of factors. It enables to group variables with similar characteristics together. This analysis is used to group the variables which is taken additionally to the theoretical model.

Correlation Analysis

Correlation analysis is a statistical evaluation method used to study the strength of relationship between two or more variables. The variables are said to be associated with each other when the movement of one variable is co-occur with the movement of another.

Regression Analysis

Regression analysis is done to describe the relationship between the independent variables

and the dependent variable. It produces a regression model where the coefficients represent the relationship between each variable and the dependent variable and also the predictions can be made using this model. Multiple Linear Regression Analysis is carried since there are more than one independent variable.

Results and Discussion

Cross Tabulation Analysis

According to the results of the Cross-Tabulation analysis gender biasness is not clearly visible towards intention to adopt eco-friendly vehicles while similar proportions from each age category have agreed to have the intention to adopt them. Respondents who are with bachelors and master's degree have high tendency towards adopting eco-friendly vehicles.

Independent Sample t-test and One-Way ANOVA for Demographics

The level of education has found to be having an influence on the intention to adopt eco-friendly vehicles with ANOVA. According to the probabilities, A/L, degree, masters and doctorate qualifications are having insignificant P values. Therefore, they do not have any difference with regard to intention to adopt eco-friendly vehicles. Other educational qualifications, diploma and undergraduate are having significant differences. Descriptive statistics are applied to identify these differences. Wang, et al., (2016) also has discovered that the ones whose education level is high are more likely to adopt Hybrid Electric Vehicles and it supports the finding of the author. According to descriptive statistics, ones who hold bachelor's and masters are having higher mean values for intention to adopt eco-friendly vehicles. Therefore, those who are having such educational qualifications have higher intention to adopt eco-friendly vehicles

Factor Analysis

This study is based on a theoretical model and the author has taken few other variables into consideration. The factor analysis is done in order to group these additional variables into meaningful factors.

TABLE II
KMO and Bartlett's Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.876
Bartlett's Test of Sphericity	Approx. Chi-Square	936.156
	df	6
	Sig.	.000

According to the Table 4.2, KMO value is 0.876 which is higher than the acceptable adequacy rate of 0.5. It indicates that the factor analysis can be useful with the data

The Bartlett's test shows a highly significant value of 0.000 which is significant at alpha=0.001. Therefore, null hypothesis (H0)can be rejected. Correlation metrics is not an identity matrix and it can be concluded that there is a significant correlation between variables which has been used in factor analysis.

TABLE III
Communalities Test Results

	Initial	Extraction
Availability of Spare parts	1.000	.897
Fuel type	1.000	.865
Load space/passenger capacity	1.000	.904
Warranty period	1.000	.894

Extraction Method: Principal Component Analysis.

The output of the communalities test shows the proportion of variance in each variable that can be explained by the factors. All the variables have an extraction value above 50% and the highest extraction value is in the "load space/passenger capacity" which is 90.4%.nalysis.

TABLE IV
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.559	88.978	88.978	3.559	88.978	88.978
2	.182	4.546	93.524			
3	.137	3.422	96.946			
4	.122	3.054	100.000			

Extraction Method: Principal Component Analysis

The total variance table shows the eigenvalues, percentage of variance, and cumulative percentage of variance of each factor or component that can be extracted from the analysis. The analysis has extracted one component that explain 88.978% of the total variance.

TABLE V
Component Score Coefficient Matrix

	Component
	1
Availability of Spare parts	.266
Fuel type	.261
Load space/passenger capacity	.267
Warranty period	.266

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization
Component Scores.

Factor A (Supplementary)=(0.266×Availability of Spare parts)+(0.261×Fuel Type)+(0.267×Load space or passenger capacity)+(0.266×Warranty Period)

Reliability Analysis

TABLE III
Summary of results of Reliability Analysis

Factor	Cronbach's Alpha	No. of Items
Attitudes	.980	10
Perceived Behavioural Control	.980	09
Subjective Norm	.911	04
Personal Moral Norm	.943	02
Supplementary	.958	04

There is an excellent internal consistency as the Cronbach's Alpha values of all factors are more than 0.9. According to the reliability analysis, all the variables are having Cronbach's Alpha values more than 0.6 and it indicates that there is an internal consistency between the items. Therefore, variables can be created with respect to the corresponding items included in the questionnaire.

Descriptive Analysis

Using Mahalanobis Distance statistics researcher removed 11 outliers. According to CDF Chi-Square outliers have been detected and they have been removed. Mahalanobis probability less than 0.001 have been identified. After that objectives have been addressed.

TABLEVII Descriptive Statistics

	Attitude	Perceived Behavioural Control	Subjective Norms	Personal Moral Norm	Supplementary	Intension to adopt eco-friendly vehicle
N Valid	210	210	210	210	210	210
Missing	0	0	0	0	0	0
Mean	3.9360	3.8352	3.1536	3.7296	3.8568	4.07
Std. Deviation	1.15695	1.16899	1.00622	1.21981	1.18742	.883
Skewness	-1.855	-1.511	-.515	-1.204	-1.545	-1.435
Std. Error of Skewness	.168	.168	.168	.168	.168	.168
Kurtosis	2.041	1.261	-.437	.485	1.225	3.057
Std. Error of Kurtosis	.334	.334	.334	.334	.334	.334

According to descriptive Statistics, all the independent factors are in agree level. This is because mean values are closer to 4 in the Likert Scale and it indicates that these variables are in the agree level in the organization. Highest standard deviation belongs to Personal Moral Norm as the highest standard deviation is 1.21981. Minimum variance belongs to Subjective Norms as the minimum standard deviation is 1.00622. All the coefficients of skewness are between -3 and +3. This says that data are normally distributed **Invalid source specified.**.

Correlation Analysis

The association between the dependent variable and the identified five factors is tested by the Pearson Correlation Analysis and the below hypotheses are tested.

H0: There is no association between intention to adopt EFV and ith factor

H1: There is an association between intention to adopt EFV and ith factor

i = {Attitudes, Perceived Behavioural Control, Subjective Norms, Personal Moral Norm, Supplementary variables}

TABLE VIII
Correlation Analysis Results

		Intension to adopt eco-friendly vehicle
Attitude	Pearson Correlation	.152*
	Sig. (2-tailed)	.027
	N	210
Perceived Behavioural Control	Pearson Correlation	.162*
	Sig. (2-tailed)	.019
	N	210
Subjective Norms	Pearson Correlation	.099
	Sig. (2-tailed)	.154
	N	210
Personal Moral Norm	Pearson Correlation	.186**
	Sig. (2-tailed)	.007
	N	210
Supplementary	Pearson Correlation	.103
	Sig. (2-tailed)	.137
	N	210

According to the correlation analysis, probability of the association between intention to adopt eco-friendly vehicles and Attitude factor is 0.027. Therefore, the result is highly significant at 5% and hence the null hypothesis (H0) is rejected. Coefficient of correlation is) is rejected. Coefficient of correlation is 0.152 and as the value is positive and between 0 and 0.5, it can be said that there is a significant weak positive association between intention to adopt eco-friendly vehicles and Attitude

Furthermore, probability of the association between intention to adopt eco-friendly vehicles and Perceived Behavioural Control factor is 0.019. Therefore, the result is highly significant at 5% and hence the null hypothesis (H0) is rejected. Coefficient of correlation is 0.162 and as the value is positive and between 0 and 0.5, it can be said that there is a significant weak positive association between intention to adopt eco-friendly vehicles and Perceived Behavioural Control.

However, probability of the association between intention to adopt eco-friendly vehicles and Subjective Norms factor is 0.154. Therefore, the result is insignificant and hence the null hypothesis (H0) can be retained. There is no significant association between intention to adopt eco-friendly vehicles and Subjective Norms.

Same time, probability of the association between intention to adopt eco-friendly vehicles and Personal Moral Norm factor is 0.007. Therefore, the result is highly significant at 1% and hence the null hypothesis (H0) is rejected. Coefficient of correlation is 0.186 and as the value is positive and between 0 and 0.5, it can be said that there is a significant weak positive association between intention to adopt eco-friendly vehicles and Personal Moral Norm.

Finally, probability of the association between intention to adopt eco-friendly vehicles and Supplementary factor is 0.137. Therefore, the result is insignificant and hence the null

hypothesis (H0) can be retained. There is no significant association between intention to adopt eco-friendly vehicles and Supplementary factor.

Regression Analysis

TABLE IX
MODEL SUMMARY

According to the model summary multiple correlation is 0.268. This means that individual factors are having weak association jointly with intention to adopt eco-friendly vehicles. Durbin-Watson test statistics is 1.782 and it is between the expected standard values of 1.5 to 2.5 and therefore residuals are independent, and model is appropriate. Jointly effect of individual factors has been analysed by Regression ANOVA result is provided by Table 4.29 below.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.268a	.072	.049	.861	1.782

a. Predictors: (Constant), Supplementary, Subjective Norms, Personal Moral Norm, Perceived Behavioural Control, Attitude

b. Dependent Variable: Intension to adopt eco-friendly vehicle

Proportion of dependent variable is covered by regression model is explained by the R Square value. If the R Square value is equal or more than 0.6, that model is nicely fitted. According to Table 4.28, the R Square value is 0.072. Even though this value is less than that of the required value, the regression model is valid as the ANOVA result is significant.

TABLE X
Regression ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.673	5	2.335	3.146	.009a
	Residual	151.394	204	.742		
	Total	163.067	209			

a. Predictors: (Constant), Supplementary, Subjective Norms, Personal Moral Norm, Perceived Behavioural Control, Attitude

b. Dependent Variable: Intension to adopt eco-friendly vehicle

In the regression ANOVA, probability of F-test statistics is 0.009. This is highly significant at 1% and it deems that individual factors jointly influence on intention to adopt eco-friendly vehicles. Individual effect has been analysed by individual Coefficient and result are given by Table 4.30.

Probability of F-test statistics of the regression ANOVA is highly significant, and it means that the model is jointly significant. Therefore independent factors jointly on intention to adopt eco-friendly vehicles.

TABLE XI

Table of Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.582	.222		16.136	.000		
	Attitude	.124	.139	.162	.889	.375	.136	7.329
	Perceived Behavioural Control	.190	.122	.252	1.555	.121	.174	5.760
	Subjective Norms	-.012	.087	-.013	-.135	.893	.460	2.175
	Personal Moral Norm	.262	.111	.362	2.359	.019	.193	5.185
	Supplementary	-.434	.158	-.584	-2.741	.007	.100	9.957

a. Dependent Variable: Intension to adopt eco-friendly vehicle

Probabilities of personal moral norm factor and supplementary factor are highly significant with positive beta value and negative beta value respectively. This says that the personal moral norm influences positively, and supplementary factor influence negatively on intention to adopt eco-friendly vehicles. Attitude factor, perceived behavioural control factor and subjective norms are individually insignificant as the P values are more than 5%. Hence, it can be deemed that they influence individually, but they influence jointly.

Following Linear Regression Model can be built based on the above table.

$$Y = 3.582 + 0.124X_1 + 0.190X_2 - 0.012X_3 + 0.262X_4 - 0.434X_5$$

Y = Intention to adopt eco-friendly vehicles
X1 = Attitude Factor
X2 = Perceived Behavioural Control Factor
X3 = Subjective Norms Factor
X4 = Personal Moral Norm Factor
X5 = Supplementary Factor

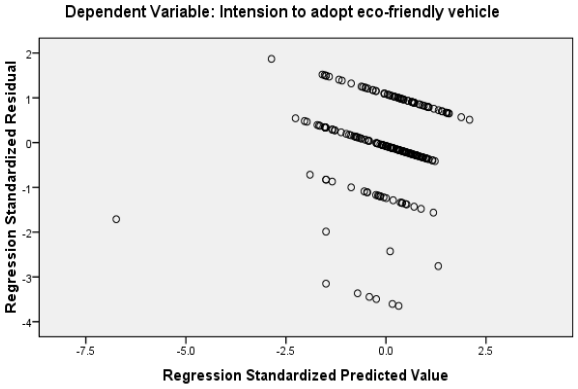
Researcher concludes that intention to adopt eco-friendly vehicles is expected to increase by 0.124, if the attitude increase by 1. Intention to adopt eco-friendly vehicles is expected to increase by 0.190, if the perceived behavioural control increase by 1. Intention to adopt eco-friendly vehicles is expected to decrease by 0.012, if the subjective norms increase by 1.

Intention to adopt eco-friendly vehicles is moral norm increase by 1. Intention to adopt eco-friendly vehicles is expected to decrease by 0.434, if the supplementary factor increase by 1.

Diagnostic tests for regression results

Residuals are tested as diagnostic test to decide the validity of regression results. In the model summary, Durbin-Watson test statistic is 1.782 and it is very close to 2 and in between 1.5 to 2.5. Therefore, residuals are independent, and model is valid. As all the Variation Inflation Factors (VIF) are less than 10, it indicates that independent factors are not highly correlated. Therefore, there is no multicollinearity problem in the regression model. Also, the Tolerance values in each factor are more than 0.1, it can be said that there is no multicollinearity problem in the model. So, it can be concluded that the regression model is highly valid.

TABLE IV
Scatterplot



In the scatterplot, standardized residuals are plotted against standardized predicted values. Residuals are distributed in a systematic pattern. This indicates that there is a pattern between the residuals and the dependent variable. That means there is a heteroscedasticity problem. So, the author has concluded that there are expected to increase by 0.262, if the personal additional variables that has not been considered in the study.

Hypothesis Testing

Hypothesis testing is done for the five factors in order to check how the independent variables effect on the dependent variable of "intention to adopt eco-friendly vehicles".

H0: There is no significant impact by ith factor on intention to adopt eco-friendly vehicles

H1: There is a significant impact by ith factor on intention to adopt eco-friendly vehicles

- Attitude

According to the table of coefficients of regression analysis, the significant value of attitudes is 0.375 which is higher than 0.05 (P>0.05). Then the null hypothesis (H0) is not rejected. That means the attitude has no influence on the intention to adopt eco-friendly vehicles.

- Perceived Behavioural Control

According to the table of coefficients of regression analysis, the significant value of perceived behavioural control is 0.121 which is higher than 0.05 (P>0.05). Then the null hypothesis (H0) is not rejected. That means the perceived behavioural control has no influence on the intention to adopt eco-friendly vehicles.

- Subjective Norms

According to the table of coefficients of regression analysis, the significant value of subjective norms is 0.460 which is higher than 0.05 (P>0.05). Then the null hypothesis (H0) is not rejected. That means the subjective norms has no influence on the intention to adopt eco-friendly vehicles.

- Personal Moral Norms

According to the table of coefficients of regression analysis, the significant value of personal moral norms is 0.019 which is higher the table of coefficients of regression analysis, ththan 0.05 (P<0.05). Then the alternative hypothesis (H1) is accepted and null hypothesis is rejected. That means the personal moral norm has an influence on the intention to adopt eco-friendly vehicles.

- Supplementary Factor

According to the table of coefficients of regression analysis, the significant value of supplementary factor is 0.007 which is higher than 0.05 (P<0.05). Then the alternative hypothesis (H1) is accepted and null hypothesis is rejected. That means the supplementary factor has an influence on the intention to adopt eco-friendly vehicles.

Discussion and Conclusions

The researcher concludes that attitude, perceived behavioural control and subjective norms has no influence individually on the intention to adopt eco-friendly vehicles while personal moral norm and supplementary factor influences on the intention to adopt eco-friendly vehicles. It indicates that intention to adopt eco-friendly vehicles does not get influenced by attitude, perceived behavioural control and subjective norms.

TABLE V
Summary of Findings of the study

	P Value	Acceptance or Rejection
Attitude	0.375	Rejected
Perceived Behavioural Control	0.121	Rejected
Subjective Norms	0.460	Rejected
Personal Moral Norm	0.019	Accepted
Supplementary	0.007	Accepted

54% of the useable responses represents the male category while 46% represents female category. 18-25 age group represents 51% of the sample while the age category of 26-35 represents 45% of the sample. These age groups are very important for a more accurate result as the research also focuses on the ones who has the intention to adopt eco-friendly vehicles in near future. The other age group of 36-45 accounts for only 5% of the sample.

Furthermore, one of the key findings of this study is that Toyota, BMW and Honda are in the topmost preferred brand of vehicle in the Sri Lankan vehicle market. 63% of the sample use vehicle for the purpose of personal travel 36% of the considered sample use vehicle for both personal travel as well as for business purposes. Most of the people are price conscious rather than quality as Sri Lanka is still in the developing phase. 80.5% of the useable responses mentioned that price is either important or very important factor which

influence the consumer intention towards purchasing of eco-friendly vehicles.

The outcome of the study can be used as a basis to suggest ways to promote eco-friendly vehicles and to provide recommendations. The foremost recommendation is to reduce the taxes imposed or provide tax incentives on eco-friendly vehicle importation to Sri Lanka. The prices of these vehicles should be comparatively very low in order to encourage the people in purchasing such vehicles. So, with respect to that, the taxes should be reduced to maximum extent possible. Also, life cycle cost of these vehicles is very high due to high maintenance/repair cost which people consider that as a pessimistic factor to reject purchasing eco-friendly vehicles. Reduction of taxes can be identified as a solution for this also.

Current trend is for either necessities or luxuries irrespective of ecology. The awareness of importance among the people about the eco-concepts should be highly considered and they should be encouraged to use eco-friendly products like these eco-friendly vehicles. Also, the potential purchasers should be encouraged to purchase this kind of vehicles. Low interest vehicle loans, easy payment plans for eco-friendly vehicles can also be recommended. Benefits like priorities in parking, parking free of charge can also be provided to encourage eco-friendly vehicles.

The infrastructure support should be provided in order to increase the usage of eco-friendly vehicles. Increasing and improvements in charging infrastructure can be recommended. The number of charging stations in urban areas and especially in outstations should be expanded. Also, the maintenance facilities should be enhanced. Availability of spare parts is also another factor that influences the eco-friendly vehicles. So, the availability of them should be increased and the parts should be readily available at affordable prices. Safety features should be increased, enhanced and improved.

Few modifications in the vehicle is also can be recommended. The efficiency of the vehicles has to be enhanced in order to attract more purchasers. Charging times of these vehicles are significantly high. Increasing battery capacity and embedding fast charging technologies can be identified as recommendations for this issue. The PHEVs should be improved further, and also eco-technologies can also be developed for heavy vehicles.

However, even though it is considered that the eco-friendly vehicles as a sustainable solution for the environmental crisis, there are few major concerns that should be taken care of. One of the major sources of generating electricity is by combustion of coal which is another a major environmental crisis. And also, the disposal of batteries is another major concerning area. Electricity generation and the disposal of batteries should be eco-friendly and properly managed. Usage of eco-friendly fuel can be taken as an alternative for power generation.

Declarations

Study Limitations

Data from a simple random sampling method will help to obtain a more accurate model. Lack of a proper database of the eco-friendly vehicle purchasers, restricted the researcher using random sampling techniques to collect primary data. As there is a limitation, researcher has chosen snowball sampling technique to gather data. There is a tendency to have more outliers in snowball sampling technique due to the nature of it. Also, the time frame for the data collection is inadequate as the sampling technique is snowball sampling. Dudovskiy,

(2018) has also mentioned that, oversampling a particular network of peers in snowball sampling, can lead to biasness. Hence, the data collection has been a difficult task and a proper and more accurate model is not constructed due to these limitations.

The study initially used 28 variables that might influence the consumer intention towards purchasing of eco-friendly vehicles with the support of literatures. However, there might be numerous more other factors which are not considered in the study, especially the factors which are more specific in Sri Lankan context. Future research can also focus on those particular factors.

Also, there is a pattern between the residuals and the dependent variable. That means there is a heteroscedastic problem. The author has concluded that there are additional variables that has not been considered in the study. That is a limitation to this study and the future research can take these additional variables into consideration and expand the study further.

Furthermore, the area of scope considered under the study is the Colombo district of Sri Lanka. However, the people resided in other districts might possess different factors that influence the consumer intention towards purchasing of eco-friendly vehicles. Hence, the future research can address and overcome these limitations in order to get more holistic picture of the study.

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Original Article

Evaluating Risk Management Readiness of Organizations towards COVID-19: A Case of the Small-scale Boutique Hotels

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Abstract

COVID-19 is a pandemic that has disrupted the tourism industry worldwide. This study identifies the risk-response strategies of small-scale boutique hotels to analyse business readiness in the face of COVID-19. A similar study has not been previously conducted in the Sri Lankan context. The research was conducted on small-scale boutique hotels in Sri Lanka using the convenience sampling method whereby four boutique hotels were selected from the Southern province. The gathered data were analysed using thematic analysis and the key variables identified were the managers' perception and resource availability. The study found that 1) the boutique hotels were mainly dependent on foreign customers and thus faced heavy losses and 2) the strategy for continuing their business operations was based on downsizing, pay cuts, and targeting local customers through promotional offers on social media. The findings also revealed that efforts to attract local tourism were not successful. The lack of a contingency plan in the case of disruption of foreign tourism was evident. Based on the analysis, the risk-response strategies used for recurring shocks (e.g. floods, fire, etc.) are inadequate to face a crisis that has a long and unpredictable impact in nature. It was further evident that the hotel owners did not understand how to evaluate the risks of their business apart from what they have been facing continuously over the years.

Keywords: COVID-19, Tourism, Risk Management, Small-Scale Boutique Hotels

Introduction

An organization is an interconnected system of internal and external parties comprised of customers, suppliers, and employees. A shock wave causes this system to disrupt, misaligning the supply and demand [1] which could result in downsizing and even threatening the survival of the organization [2],[3]. A crisis can impact multiple levels – e.g. global, country, economy, industry, company etc. [4].

The COVID-19 pandemic has produced significant local and global impacts [5]. The tourism industry is an important sector in the global economy with an annual average GDP growth of 8% and 10% employment [6]. Due to the drop in tourist arrival in 2020 compared to 2019, a loss between 290 million to 440 million resulted in a single year [7]. COVID-19 is the worst crisis the tourism industry has faced over the years [7].

The spontaneous nature of these external shockwaves makes it difficult to predict and

anticipate such events [8]. Organizations need to be prepared for such external crises [9].

A. *Background of Study*

Sri Lanka is a country that depends heavily on the service sector, where the tourism industry plays a major role in the country's development [10]. Tourism is the third-largest Sri Lankan industry based on foreign exchange earnings [11]. The Sri Lankan government banned inbound passenger flights to the island during the pandemic. The room occupancy rate of Sri Lanka Tourism Development Authority (SLTDA) registered classified and unclassified accommodation declined from 76.4% to 52.0% in the first quarter of 2020, compared to the first quarter of 2019 [10]. The generated gross value addition from the accommodation and F&B (food and beverage) sector declined by 6.2% in the first quarter of 2020, in comparison to 2019[10].

Past research identifies managers' perception and resource availability as two factors determining an organization's preparedness towards a crisis. Resource availability is focused on the human resource management and financial capabilities of an organization. During a crisis, the top management's focus shifts towards ensuring business continuity [12]. Crisis demands a greater involvement of top management [13] as they have the authority to easily deploy resources [12]. Active engagement of employees should be increased to effectively execute the decisions made by the top management [14]. While most organizations simultaneously focus on cutting costs through layoffs and pay cuts, the availability of adequate financial resources supports organizations to face a crisis [15]. Lack of knowledge regarding a crisis causes organizations to use uninformed, ineffective strategies to mitigate it.

A. *Problem Statement*

In a business cycle, the possibility of a crisis cannot be avoided [4]. Some enterprises can survive a crisis, while some cannot [16]. The Sri Lankan business sector has had no prior experience in facing a pandemic. Since this crisis was not initiated within an organization, most companies ranging from small-scale to industry giants were impacted. With the commercial acceptance of the work-from-home concept due to island-wide curfews, organizations could not resume their normal activities as soon as they hoped to. Lack of preparation has led businesses to lay off employees, impose salary cuts, and in worst cases halt operations due to disruptions in the supply chain [17].

COVID-19 affected industries such as apparel, tourism, retail, banking, and construction [18] while lack of organizational preparedness was demonstrated by the struggle for the survival of many [18]. A crisis may not be entirely preventable, however, prior preparedness may minimize the impact [19].

B. *Research Objectives*

This research aims to evaluate the risk management readiness of boutique hotels towards COVID-19. Accordingly, the following objectives were formulated.

Main objective:

- To evaluate crisis readiness of boutique hotels towards COVID-19

Sub-objective:

- To determine the influence of COVID-19 on boutique hotels in Sri Lanka
- To determine the drawbacks of existing crisis management activities followed by the organizations

- To determine the strategies followed to overcome the crisis faced by the boutique hotels in Sri Lanka.

C. *Significance of Study*

An organizations' survival during a crisis depends on how well it caters to its stakeholders' demands. The operations of an organization should be at a satisfactory level. Past research stresses the importance of crisis management and practices that should be adopted by an organization to thrive through catastrophes. Preparedness is the initial key step to be taken in crisis management. A crisis can be of many types such as war, natural disasters, man-made errors, and pandemics [20]. While there are many studies conducted on crisis management, little research is available related to COVID-19. Many theories and factors have not undergone empirical testing.

One aspect of the knowledge gap would be that most studies are carried out in western countries and limited studies are carried out in non-western countries. Most organizations struggled to survive through this pandemic due to a decline in demand. This research focuses on identifying the risk-response strategies in Sri Lanka to analyze organizational preparedness in the face of COVID-19.

Literature Review

A. *Crisis Management*

Crisis management involves making strategic decisions in a complex and unstable situation where the damage inflicted by the crisis can be mitigated [3], [21]. Crisis management can be divided into three stages 1) pre-crisis, 2) crisis response, 3) post-crisis. The pre-crisis phase includes steps taken for preparation and prevention. The crisis response stage is where the organization faces the catastrophe while the post-crisis focuses on learning from the previous experience and preparing for the next crisis [3]. Another model for crisis management phases consists of four stages 1) incubation 2) detection 3) crisis and 4) repair and learning. However, a crisis does not pass all these stages in theoretical models. A crisis continues from one phase to another based on many factors such as early detection, preparation, and decisions made by the management at each phase [22]. Preparedness is the initial key step to be taken in crisis management [20]. Preparation for handling a crisis involves creating a crisis management plan that is updated frequently, selecting a crisis management team, testing the plan, training the crisis management teams, and pre-draft crisis-related messages[22]. The crisis management plan is misunderstood as a guideline to be used in such situations although it only serves as a framework that can be used to make good decisions [3], [21].

A. Carmeli and J. Schaubroeck[21] have identified six reasons why organizations do not engage in proper crisis management. These reasons include denial, disavowal, grandiosity, idealization, intellectualization, and compartmentalization.

- Denial - organizations assume that they have no threats from a crisis.
- Disavowal - organizations are aware of the impact a crisis would have on the organization but the magnitude of the impact is diminished.
- Grandiosity - a crisis will not threaten organizations that are big and powerful.
- Idealization - organizations ignore crisis signals assuming the crisis does not have an impact on good organizations.
- Intellectualization - organizations take necessary actions to mitigate crisis occurrences.
- Compartmentalization - a crisis will not affect the entire organization but only one department.

B. Managers' Perception

Managers' key responsibility during a crisis is to analyse and minimize the negative impacts. High involvement of top management is needed to support the teams to ensure the firm does not fail [23]. Crisis preparedness starts with the top management's perception of the crisis and the immediate actions for survival as they have the authority to manage and allocate resources appropriately [12]. Proper leadership from managers at the strategic level play a crucial role to overcome business disruptions [13].

Some of the strategic actions taken by the top management during a crisis are, improving the quality of their products, training the employees, focusing on customer satisfaction, and allocating a budget for research and development [24].

C. Resource Availability

Resources play a crucial role in crisis management as the availability of resources facilitates rapid delivery and cost-effectiveness of a project while insufficient resources will lead the organization to collapse [25]. Readily available resources increase the readiness and allow organizations to continue by minimizing disturbances to disruptions [12], [26].

Organizations prone to crisis prepare for it by focusing on the ability to deploy resources hence organizations give employees and managers access to the organizational resources [14]. The organization's financial stability collapses if the company's management fails to acquire the right amount of financial resources during a crisis [27].

However, most organizations do not allocate a necessary amount of emergency funds, instead, they use their working capital to resolve crisis issues. There is a direct impact on the financial status of the organization during an unexpected crisis. Pay cuts, employee layoffs are used to overcome such impacts [15]. Proper budgeting helps to mitigate the risk for a certain amount in the absence of an insurance scheme [28].

Companies should shift their policies to hybrid working systems and should develop crisis management plans with the help of HR managers to face ongoing and future crises [29]. There is a deficiency in resource availability during a crisis regarding human resources [30]. Human resources are vital to continue business processes and to certify the balance in work life. Some companies went through a higher turnover due to COVID-19 which led to poor employee motivation. This impacts the organization in short and medium terms. The remaining employees face psychological insecurity which leads to poor performance [31].

Methodology

This study focuses on small-scale boutique hotels in Sri Lanka. Hotels were categorized based on their listing under the Sri Lanka Tourism Development Authority [32]. The research follows a qualitative approach where thematic analysis and pattern matching was used to elucidate the findings.

A. Data Collection

Primary data was collected to achieve the stated objectives of the research. Due to the COVID-19 pandemic, the data collection method was restricted to telephone interviews with the hotel owners via a structured questionnaire where 20 open-ended questions were designed to capture the organizational insights and behaviour on risk management to gather information.

B. Research Design

The population considered for the study were all the registered boutique hotels listed under the Sri Lanka Tourism Development Authority which were 36 boutique hotels [32].

The convenience sampling method was used to select the sample, which was restricted to four, small-scale boutique hotels located in the Southern province of Sri Lanka. The Southern Province recorded the highest occupancy rate in 2019, 59.68% in comparison to all the other regions in the given year [32].

All the organizations had the experience of operating in the industry for more than one and half years and had an average of 10 employees. The names of the owners and hotels are not disclosed due to confidentiality reasons.

Data Analysis

A. *Influence of COVID-19*

Based on the data analysis, COVID-19 severely impacted businesses because of its global reach and prolonged nature. Any crisis affects the rules and regulations in a country. Similarly, COVID-19 resulted in government policy changes for the Sri Lankan tourism industry, such as temperature readings of every individual, provision of sanitary kits, maintaining guest details, and maintaining a logbook of staff duties. Hotels had to temporarily shut down any activities that required direct human contact such as spa facilities.

For the smooth functioning of hotel operations, suppliers must cater to the requested services without any disruptions. Examples of supplier services include kitchen needs, chemicals, utensils, and laundry. These services were more severely impacted during the COVID-19 period. The main reasons for this were a) import regulations and b) island-wide lockdowns. To deal with the import regulations, a local supplier base was developed. Supplies were also delayed due to route changes.

B. *Existing Crisis Management Activities*

The findings suggest organizations operating in the tourism industry lack knowledge in crisis management. Only forms of crisis management used were limited to 1) a percentage allocation of financial resources and 2) investing in insurance policy schemes. It was observed that the organizations that had cash reserves as a part of their contingency plan could continue operations even during an unexpected event. On the other hand, organizations that did not plan for the unforeseen crises had to terminate their operations. It should be noted that despite owners allocating financial resources like a risk management measure, this method is not immune to impacts from long-lasting shocks such as COVID-19.

C. *Strategies Followed to Overcome Crisis*

Organizations that were unprepared for the crises took measures to lay off employees, reduce consumption of utilities, and temporarily cease operations. Hotels that had some degree of preparedness extended a smaller margin of pay cuts to employees, e.g. 20% instead of 50%.

Demand is the most critical factor for the survival of a business. A drop in demand cuts off the cash flow essential to maintain an organization. Most hotels were targeting foreign customers and had to shift to targeting local customers suddenly. This was done via social media platforms such as Facebook and Instagram through attractive offers (to target the local customer base). Travel websites such as Booking.com, Agoda, and Airbnb were also used for their promotional efforts.

These efforts were not successful due to the following reasons:

1. Increased marketing efforts were required to target locals as opposed to foreign clientele. The increased marketing efforts were required due to the large variety of options available to locals.

2. Boutique hotels could not compete with the rates offered by five-star hotels for locals.

Conclusion

The research focuses on evaluating the crisis readiness of small-scale boutique hotels towards COVID-19. This was evaluated based on three sub-objectives evaluating the influence of COVID-19 on boutique hotels, to determine the existing crisis management activities followed by the organizations, and strategies followed to overcome the crisis faced. A hotel risk management plan can be commonly addressed as either establishing an insurance policy or having capital reserved from the budget. Lack of knowledge on crisis management was evident among the owners of the hotels. It was identified that hotel owners were reluctant to invest in a crisis management plan due to their lack of knowledge in crisis management and due to the difficulty of allocating additional resources for a crisis management plan. Hence small-scale boutique hotels in Sri Lanka were less prepared to face a crisis.

A. Recommendations

To increase preparedness towards crises the following recommendations can be suggested:

1. To educate the upcoming and existing leaders on the importance and alternative methods of risk management. Moreover, the government can introduce an insurance scheme on unexpected risks to ensure the survival of small and medium-scale tourist organizations.
2. To diversify the supplier networks to ensure the supply chain does not get disrupted due to the incapability of one supplier. Having a supplier-balanced scorecard [33] to assess the performance and create a dynamic supplier base would avoid disruptions in the supply chain.
3. To have in place different strategies to target different customer segments.

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Original Article

Flood Early Warning and Prediction System for Tributary Streams

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Abstract

Flood Early Warning system development is relatively new and costly area for developing countries, though it has captured attention of the respective parties since such Early Warning System can avoid loss of lives and reduce property damages from floods. Rather than standalone early warning system, warning system with the ability to forecast or predict flood events is more useful for the relevant stake holders where it can be used to plan and act fast. Geological areas around tributary streams are more likely to flood without considerable warnings from the nature as it highly depends on the main river behavior. This system uses Internet of Things (IoT) devices for data capture and transfer. River Water level, Rain status and the Water flow rate (discharge rate) is measured using Sensors. An Artificial Neural Network (ANN) is trained with collected data and integrated with live data feed in order to predict the water level. By doing so forecasting flood events according to the current readings. Notifications are sent via pre-defined notification channels. Due to the higher number of data types considered, ANN predicts water level with considerable accuracy. This collective approach of using ANN and IoT devices has made the forecasting easier and more reliable while using more variables made the predictions more accurate. In addition, these collected data can be used in the future for disaster recovery and mitigation planning since they are kept in cloud environment where public can access.

Keywords: ***Internet of Things, Artificial Neural Network, Flood Prediction, Disaster Management***

Introduction

Flood early warning, detection and forecasting is not a typical or common area of studies when it comes to research work due to its complexity and lack of business value. Although lot of literature can be found on flood detection models, theoretical aspects of floods and flood avoidance etc., very less work can be found on practical approach to this topic. Io T is one of the key emerging technologies which helps to automate and integrate devices via internet regardless of the physical location. Usage of IoT technology and publicly available integration platforms can reduce the cost and the technological complexity while increasing the possibility of implementing Early warning systems in most required areas. In addition to the EWS, flood forecasting can be done with the integration of Artificial Neural Network (ANN) to the collected and stored date from IoT devices, which can be used by the relevant stake holders to plan and get necessary actions before the disaster (in this case, Flood) happens.

This research prototype is built on the hypothesis, which is that the river floods are directly connected with the water level of the

river, water flow of the river and the rain status of the tested area. This hypothesis is proved at the end evidently using the success rate of the prediction made by the system.

Several methods have been proposed and used in the literature found related to flood forecasting, in one such case, Samikawa [1] proposes an IoT based Flood Early Warning system running with the help of edge computing and Artificial Neural Networks (ANN). Water level and rainfall data are collected using Sensors and sent to an Arduino micro controller where the data is sent to a Raspberry PI which act as an edge computer via Bluetooth (BLE). This concept is commonly known as Wireless Sensor Network (WSN). Multiple sensor devices are connected to the Raspberry PI, while an active internet connection fetches the data into cloud based IoT data collection and integration platform, 'Thingspeak'. This platform is used to push early warning alerts into the public using configured channels. He has more focused on bringing the Analysis action into low power edge device rather than placing it in a centralized manner. ANN is trained and used to forecast flood events in timely ahead manner. Moreover, Sophia [2] has proposed a flood alerting system using water level meter where users are able to get the alert and monitor the water level using web-based GUI. Moreover, she has used a rain sensor to get the rain fall data. Using a NodeMCU (ESP8266) and Arduino microcontroller collected data is sent to Web GUI via Wi-Fi and users can get the relevant information. However, there it is not aimed adding the forecasting part, though similar sensors are used in data collection part.

Usage of rainfall-based flood prediction system has been discussed for Malaysia [3]. This system collects history and real time rain fall data and feed the data into a Nonlinear Autoregressive Exogenous (NARX) model which is developed using MATLAB. As per this research, this NARX Model is used to predict flooding 24 hours ahead of time. However, no IoT devices used since data was collected from existing devices used by the authorities. Since this research used large (from one year) amount of data to train the NARX which is a form of recurrent dynamic neural network with feedback connections encircling on several layers of the network, it has proven to provide predictions with lower error rate. Similar as [1], Using ANN based flood modeling and flood prediction. Acquiring the rainfall and water level data which then processed using ANN Radial Basis function which is a model of ANN architecture consisting of three layers naming Input, Hidden and output. From the research they [4] have concluded with finding the ideal hidden neuron count (30), maximum epoch (5000) and learning rate (0.2) for the ANN training. Several tests have been executed to identify the errors in the system and several error calculations functions also tested. It was used the Mean Absolute Percentage Error (MAPE) as the measuring information for the trained data set. An Average percentage of water level data was at 0.047%, which is considerably low, hence the prediction values have higher chance of success.

Furthermore, researchers [5] [6] have used ANN and IoT technology successfully to forecast flood events, which differs from this research from the collected variables and the IoT methodology used.

Research Problem

1. How to accurately forecast and issue flood early warnings for tributary streams?

a. What can be the variables used in forecasting model?

b. Can an artificial neural network be trained and used for accurate flood forecasting?

Research Methodology

This Flood early warning and prediction system involves with neural networks and have more than one integration points. Flood Early warning systems are mostly built for public benefit or for research, rather than going with a business perspective. Hence, it has less business value when considered as an isolated system. However, the outcome of these kind of system has a massive impact on businesses, since flooding can have impact on businesses and economy as well. According to a data collection survey done by JICA [7] on disaster risk reduction sector in Sri Lanka, it was found that the most frequent natural disaster in the Island is floods which is 37% from all-natural disasters. Total number of 18141 houses/buildings have been destroyed due to floods during the last decade (1996-2016) [7] With these facts and figures it is evident that Floods can have major impact on the economy. As per a case study carried out by UK Centre for ecology & hydrology, improved flood warning systems are saving up to £30 million per year [8].

A. Data collection and integrating.

It was identified that mainly 4 data parameters are needed to be collected. Water flow(discharge), Water level, Rainfall status will be collected Real-time using Sensors implemented in the main artifact which will then transfer to the data store via GSM Module. Currently in Sri Lanka precipitation is not available online (only available daily precipitation data, which updated with one day delay). Hence OpenWeatherMap online API can be used to get the hourly precipitation data for the selected geographical area.

B. Data storing, interfacing.

It is required to store the collected data for analysis and should be able to display real-time for monitoring purpose. Thingspeak platform can be used to store and interface data. It is chosen as it is supporting the MATLAB analysis which is used in prediction process

C. Data analyzing and reacting.

Gathered data needed to analyze and data is needed to train the ANN at first. After training the ANN, it will be used to predict the water level of the stream with other parameters. Reacting part is triggered when the water level is above predefined height. (This height differs with the selected geological location for implementation.)

Below Figure 1 showcase the main data flow diagram for the system which includes all the sensors and devices which is used during the system data flow

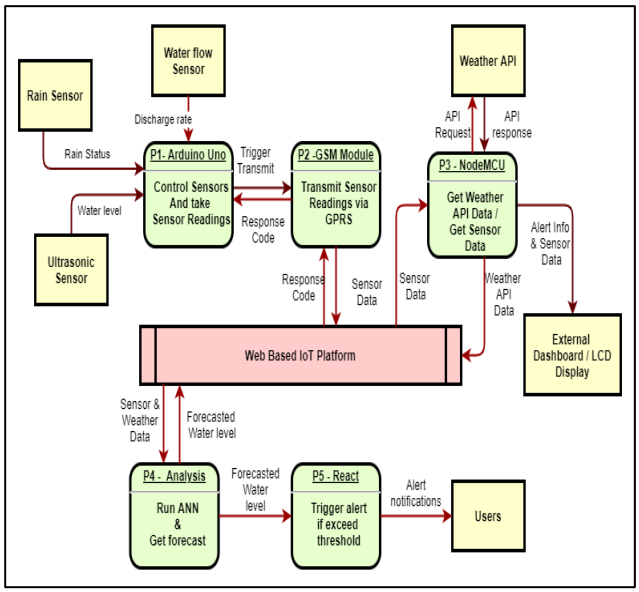

Figure 1 - Main Data flow with all components

- P1 - Arduino Uno: Main Integration point for the sensors (Ultrasonic, Water flow and Rain Sensor). Controls the sensors and take timely sensor readings (time configurable

from the code). Triggers the GSM module to establish connection with mobile network to send the collected sensor readings into web platform via GPRS. Main advantage of using controlling device is that it allows to use the sensors and communication devices in intelligent manner (only use when needed) to conserve power. Also helps to carryout primary filtering and calculations (i.e., calculate flow rate etc.) of sensor readings.

- P2 – GSM Module: Establish GPRS connection using available mobile network (depend on the SIM). Push sensor data to the IoT platform when triggered by the Microcontroller (Arduino Uno).
- P3 – NodeMCU: Used to get weather data from weather API, filter the required chunks and push them to the IoT platform. Also used as an integration module for external dashboard or LCD display (not implemented with this project). NodeMCU will pull sensor and weather data from IoT platform and send them to the external dashboard/Display using WIFI connection.
- P4-Analysis: This module is responsible for the analysis using the trained ANN and get forecasted water level for the tributary stream using the sensor and weather data. Locally trained ANN is uploaded into this module for this purpose. When an anomaly (predicted water level exceeding threshold value)detected this will trigger alert event for the React module.
- P5 – React: Main purpose of this module is to push notifications/alerts when it is triggered from Analysis module. Notifications can be pushed via email, Twitter message or other medium according to the requirement.

Sequence of the above data flow is illustrated in below Figure 2.

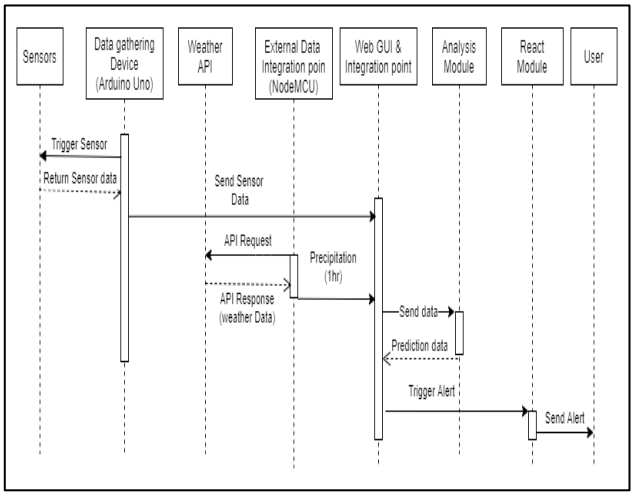

Figure 2 Flood alert sequences

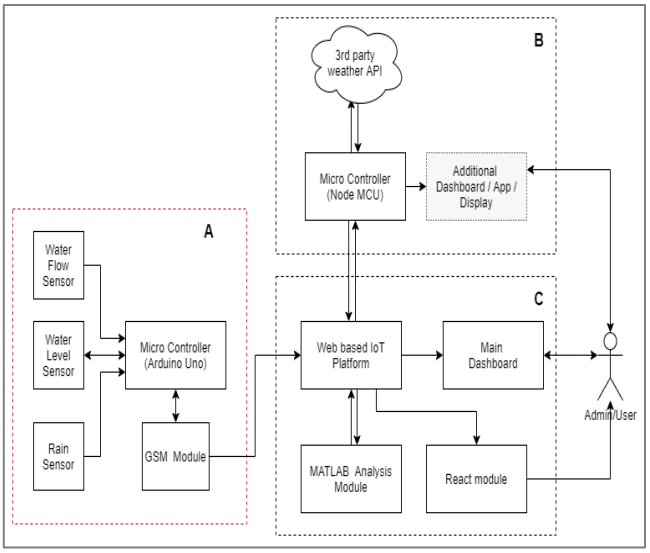

Figure 3 - System Architecture

All three above segments (Figure 3) have different tasks defined and functionality of all 3 is needed for effective working of the system.

A) Data Collection Segment - the main sensor data is collected, processed and sent to the Main Data processing unit is done by this. Consisting with 3 main sensors; Ultrasonic sensor to get current water level, Water flow sensor to get the water discharge and a Rain sensor to get rain status of the implemented location. These collected raw sensor data is processed into human readable values and pushed to the Web based Main data processing unit via a GSM module. Furthermore, this segment will directly alert the user/admin if the current water level is rising above a given (should be pre-configured) limit.

B) Data Integration Segment - It was required to communicate with a 3rd-Party Weather API in order to acquire some weather precipitation related forecasting for the geographical area of the Main River. Additionally, if a user/admin needs to include additional dashboard (customized web based), a mobile app or a physical display to monitor the Flood Early warning system Readings, This Data integration segment enables that feature using a NodeMCU unit. This unit not only pushes the 3rd Party API data into Main Data processing segment, but also pull-back the Sensor data, which then can be communicated to cater the additional desired monitoring requirements.

C) Data Processing and Reacting Segment - This is fully web-based platform and consists of all the collected or processed data, Analysis module which is responsible for analyzing and forecasting flood events and finally the reaction module to Send the necessary alerts accordingly. Thing-speak web based IOT platform is chosen for this task mainly due to it supports MATLAB integration which is vital for the Forecasting using ANN.

Aggregated Sensor and precipitation API data is stored in Thing Speak online data base and are separately displayed in the dashboard as line graphs. These data are processed using MATLAB analysis module and will use the locally trained ANN to get the forecasted water level. If a forecasted water level is above nominal value, react module is triggered, and Alerts is sent via defined method.

Artificial Neural Network

Neural Network used in this system consists of 3 inputs (Rain status, Water flow and precipitation), 1 output (Water level), two hidden layers and 12 neurons (Figure 4).

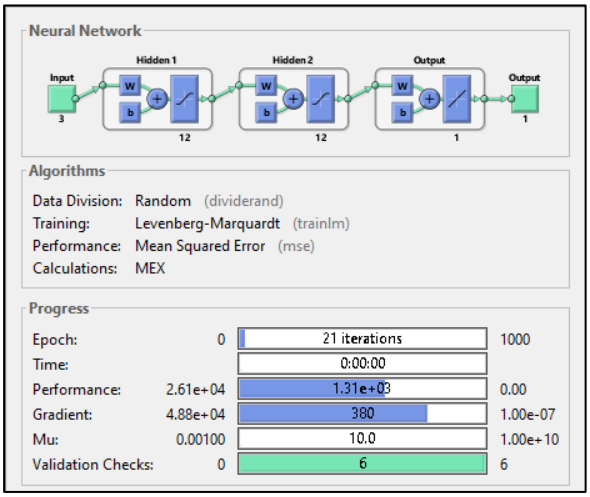

Figure 4 - ANN raining with MATLAB ANN train too (source: Author)

Optimum hidden layer count and the neuron count was picked by analyzing the different behaviors for different setups changing the variables. The performance of the ANN training and the related error histogram is illuminated in Figure 5 showing the error between training ,

test and validation data set is low and the output results can be successfully used.

Data Collection module implemented at 6°47'31.3"N 80°22'08.7"E Geolocation (figure 5and 6) and required data set for ANN training and validation were captured.

Figure 5 -Implemented location of Data Collectio n module

Source: Google Maps satellite view [https://www.google.com/maps/@6.7920723,80.368748,178m/data=!3m1!1e3]

Figure 6 - Implemented Data collection module prototype. (Source: author)

Results and Discussion

Acquired test data set was used to train and validate ANN. With the validation set, ANN showed no abnormality and ANN had a fine performance (which indicates validity of the variables used.

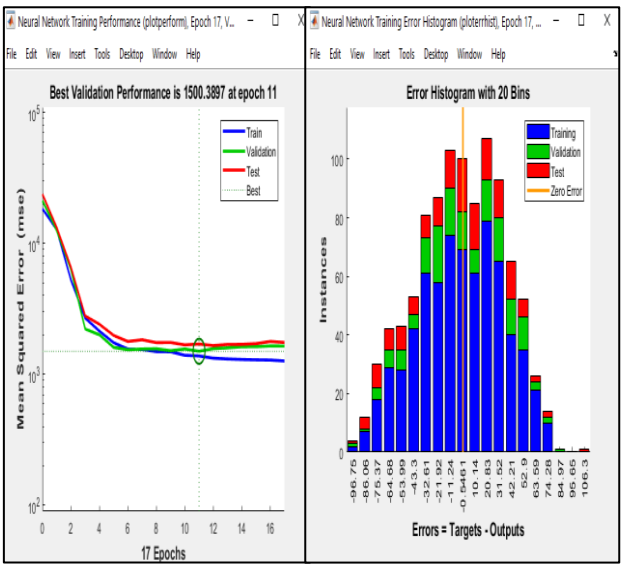

Figure 7 - ANN training and validation (source: author)

Proposed system with the proto type data predictions of the water level was plotted against the actual water level of the river at the same time (figure 8). This plot indicates the reliability and the feasibility of using Water level, water flow and rain status variables in predicting Flood where most available systems only monitor the water level of the water body in order to provide alerts and notifications on rising water level

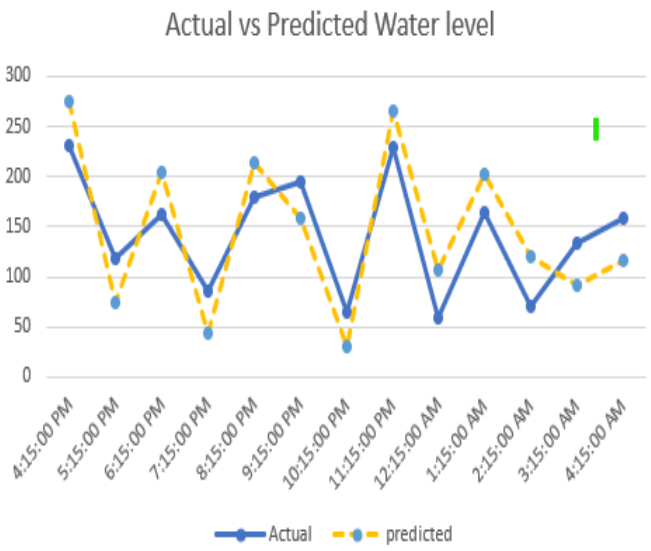

Figure 8 - Actual Vs Predicted Water level (source: author)

This proposed system provides predictions 1 hour prior and prediction time can be extended by using more data to train and optimize ANN, also NARX neural network also can be used which will be more accurate in predicting short time predictions than long time. This Flood Early warning and prediction system is developed using affordable sensor modules and Microcontrollers. When analyzing the results of the project there is an anomaly in the sensor data when it is plot. This is due to the usage of rain sensor. It is mapped only to output 3 values from 0 to 2 according to the dryness. But this has affected the full data set when plotted with required output, water level. To resolve this, this rain sensor output should be mapped to a further range. However, it is not possible to this FC-37 rain sensor to differentiate Rain intensity (status) with this simple collected board. This should be replaced with a rain gauge which can measure the actual rain in real time, which can produce matching data. Otherwise, this biasing of data is affecting the accuracy of water level forecasting.

The Main data collection segment of this project is the data collection module which is placed near the river remotely. When placing a remote device in a remote location without external power source, it is needed to use batteries. However, due to the standby and operational usage of the devices, these batteries tend to drain quickly within few days. Hence, sleep-mode or low power modes of the micro controllers and sensors should be used to avoid such quick drain of batteries. Another main thing discovered is that the ultrasonic sensor used (AJ-SR04M) has only range of 8 meters. Consequently, If the difference between maximum possible water level and the depth of the river is greater than 8 meters, it is not possible to use this sensor. In those cases, higher range radar sensor should be used instead.

Conclusion and Future Work

This project uses locally trained ANN using MATLAB implemented in Thingspeak, in order to successfully load the trained ANN into Thingspeak, external drop box connection is needed. Trained ANN can be saved as '.mat' file and uploaded into Dropbox. Which can be then linked and loaded in MATLAB Analysis platform in Thingspeak. No other method was found during the research to cater this demand. Currently with this project this only predicts the water level one hour ahead. It is possible to forecast several hours ahead but the RMSE and the percentage error gets higher when going more than 1 hour ahead. With some modifications to the neural network and training set, it can be improved to predict several hours ahead. Also, this uses a fitting neural network, usage of other Neural Networks can also be tried to improve the ahead time significantly.

Acknowledgements

The Authors would like to thank to Mr. Rajeewa Darshana for the support and the motivation given to go for this type of work and for the Department of Information technology, CINEC for the guidance. Some of the information were collected from state officials and residents before implementing the prototype. Hence this gratitude extents to all who helped during the research and implementation of this project.

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Original Article

Identify the CLIA's Effort Towards to Mitigate the Environment Impact by Cruise Tourism Industry

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Abstract

Cruise tourism is the fastest growing industry in the leisure travel market, and annually nearly 30 million passengers engage in cruising. Thereby it encounters for massive negative impact on the marine environment. The cruise industry is under the leadership of **Cruise Lines International Association** (CLIA) which has over 95 % global capacity under the membership. CLIA establishes policies and procedures to undertake by its members to ensure the sustainability of the industry. The primary objective of the study is to explore the negative environmental impact caused by cruise shipping industry and the secondary objective is to recognize the contribution of CLIA towards mitigating the negative environmental impact. The study is conducted using an exploratory approach and the data is drawn from the official website of CLIA and other websites and publications regarding cruise tourism, waste management and environmental impacts. Cruise industry policies and environmental stewardship reports of CLIA are used to manifest the negative environmental impact caused by the cruise ships and implement policies and procedures to mitigate them using high end technology, driving towards sustainability. The study provides an understanding on how the implied mechanisms of CLIA is driving the cruise industry towards sustainability.

Keywords*: Cruise Industry, Environmental Impact, Environmental Stewardship*

Introduction

Cruise tourism is recognized as trending, the most luxurious form of travel blending the attractions, accessibility, amenities, activities and accommodation (Siriwardena, S., & Silva, D. A. C. 2017) (Senevirathne, M.B.D.R, Siriwardana, S, 2020). Generally, Cruise ships are known as the most luxurious way of travel in terms of cruise tourism, and it is also known as floating cities as it comprises all facilities which a land base luxury resort hotel can experience. The industry has commenced booming from previous years and has encountered for huge economic, social and environmental impacts globally. In 2018, 28.5 million passengers cruised globally, and it was a 7% increment compared to 2017 (CLIA, 2018). The total economic impact in 2017 was $134 billion which encountered 1.1 million jobs in the industry. However, the industry makes a huge negative environmental impact on the world as it consumes lot of resources for facilitating its customers with transportation, accommodation,

Energetic resources and it contribute to air pollution such as carbon emission and due to the solid and liquid wastage and sewage emerging from the enormous operations of the cruise ships contribute to the ocean pollution. When passengers are engaging in shore excursion, it causes negative impact to the destination in terms of higher carbon footprint, air, water and soil pollution, wet and solid garbage dumping and higher consumption of resources. At the same time cruising damage, the marine resources such as corals, sea grass beds and disturb the marine animal species. Generally, these negative impacts drive towards the climate changes, rise of sea water levels, destroying the corals such as Great Barrier Reef which was identified dead in 2019 and several health-related issues to the host community who lives around famous cruise ports and destination. Focussing about these potentially negative results is required to get necessary actions by implementing policies and regulations by related authorities. Cruise lines need to focus on adopting innovative practices or technologies such as LNG powered energy systems in order to mitigate the environmental impacts and contribute towards the wellbeing of the cruise industry. International Cruise Lines Association (CLIA); the world's largest trade association in the cruise industry is concerned about the policy implementation to mitigate the environmental impact of cruise tourism. Currently it consists of over 60 of world major cruise lines which is about 95% of the global cruise capacity. It includes the market leaders of the industry such as Carnival Corporation, Royal Caribbean Cruise line and Norwegian Cruise line (Cruise Market Watch, 2021). Up to 2019, there are 272 cruise ships including ocean, rivers and specialty cruises registered under the association more than 340 executive partners such as suppliers and cruise line partners are with the association. The association has registered 13000 global travel agencies and 50000 travel agent members. Globally it operates in 7 regions such as Australasia, Asia, Brazil, Europe, North America, Canada, UK and Ireland (CLIA, 2019). It serves as a non-governmental consultative organization to the International Maritime Organization (IMO), an agency of the United Nations (CLIA, 2021). CLIA states its main vision as "Promote policies and practices that foster a safe, secure and healthy cruise ship environment; educate and train its travel agent members; and promote and explain the value, desirability and affordability of a cruise holiday" (CLIA Asia, n.d.). Two mission statements have been stated to their members to adhere to mitigate the environmental impact; minimal environmental impact of their vessel operations on the ocean, marine life and destinations and a regulatory environment that will foster the continued growth of the industry. CLIA has initiated an environment policy and a waste management policy which the member companies have to adhere, and they have invested in adopting new technologies in order to mitigate the impacts of the environment. Generally, CLIA put their commitment to mitigate environmental impacts from the cruise ships through leadership, investment in adopting new technologies and by collaborating with worldwide respective organizations. The primary objective of the study is to explore the negative environmental impact caused by cruise shipping and the secondary objective is to recognize the contribution of CLIA towards mitigating the environmental impact. Identification of the negative environmental impact caused by cruise tourism and the contribution of CLIA towards mitigating them to conserve the environment create awareness in the government bodies, stakeholders, industry practitioners regarding what ought to be done and what should be avoided in cruising.

Research Methodology

The study is conducted using an exploratory approach and the data is drawn from the official website of CLIA and other websites and publications regarding cruise tourism, waste management and environment impact. To collect the data secondary sources are used; CLIAs' environmental stewardship report, cruise industry regulations and cruise industry policies. Under the Waste Management Policy of CLIA the Environmental protection chapter is used to access information. Ocean planning, transparency and industry environmental technologies and practices chapters of the Environmental Stewardship report are used to access information. This does not measure the effort but merely explore the policies, practices, procedures that CLIA has implemented to identify and mitigate the negative environmental impact.

Results and Discussion

According to United States Environmental Protection Agency (EPA) there is an increasing concern about the environmental impact of cruise ship discharges as the industry is continuously growing. Some of the waste streams are as follows (EPA , 2017)

- Bilgewater- water that contains oil, grease and other contaminants
- Sewage - which are the solids wastewater from toilets
- Ballast water – water that taken in to the onboard and discharge from the vessels to maintain the stability of the ship
- Gray water – wastewater from showers, sinks, laundries and kitchen operations
- Solid waste – food waste, garbage including plastic, paper, wood glass, cans

Other than that, the Bureau of Transportation Statistics (BTS, 2017) has recorded that waste streams of cruise ships and their estimated amount of waste generation and the potential impact from each type of waste stream. According to that typically one-week cruise tour creates 21000 gallons of sewage which can heavily impact the water ways through releasing diseases via microorganisms. Grey water which has potential to cause negative impact as the water discharge oxygen demanding substance to the waterways, nearly generate 1 million gallons per week of voyage. Solid waste is another type of waste stream from ships including paper, wood, glass, plastic, food waste and glass. Due to the massive operation of the cruise ships, it generates 8 tons of waste in a weeks' voyage. There are 25000 gallons of Oily Bilge generating typically from one-week voyage which consist of oil grease and other contaminants. According to research briefing (Jennings & Ulrik, 2016) cruise ships contribute to negative environmental impact in many ways. It emphasizes that one of the main environmental impact of cruise ship tourism is the huge energy consumption and the carbon emission as the cruise ships consume more energy than for the operation of the ship for on board facilities, including laundry, water treatment, refrigeration and air conditioning. Thereby the considerable amount of CO2 is releasing into the environment by single cruise tour. For example according to the environment report of the Carnival Cruise Line, their ships releases 712kg of CO2 per kilometre on average, or about 0.4kg per passenger per kilo meter. A result of the huge production of carbon emission, it may impact on climate changes; global warming, increasing the sea levels, melting of polar ice caps and disturbances to natural habitats. However, with the implementation of new technologies, modern cruise ships have environmental standards regarding energy consumption and carbon emission comparing to the old vessels. Another impact on the environment from this industry is

air pollution. Air pollution is occurring in many ways. One is that from the burning the bunker fuel which contains a huge amount of Sulphur content. Another way is from the diesel particulars and emission with Sulphur dioxide and nitrogen oxide which releases when docking ships to the ports. It makes a huge negative impact to the human health and to the environment effecting on global warming. When it comes to marine pollution, cruise ship tourism is encountered for the largest portion as cruise ships are quietly similar to a floating town and they generate liquid wastage, bilge oil and sewage in the larger amounts due to the heavy operation of the ship. Even though the ships carry out its systems for purifying these liquid wastes, sewage ships can legally dump the black water (toilet wastewater) anywhere beyond three miles from shore. And when it comes to the sewage, the ships are still using old technologies to treat sewage by dumping to the sea while it contains significant number of faecal bacteria, heavy metals, and nutrients. This may cause damage to the quality of the water and the natural habitats. Another harmful liquid waste is toxic water and bilge oil which is a combination of a mixture of water, oil, lubricants, and other pollutants that collect in a ship's hold. Even though it is illegal to dump the bilge oil, some ships are discharging it illegally as it is cheaper than discharging at the ports. Thereby it may cause diseases to the fish breeds and to the birds. Since this is a massive operation, ships are normally creating a larger amount of solid waste including food waste, paper, plastic, wood, cans, and glasses. Under regulations imposed by MARPOL these wastes can be discharged to the sea. As an example, some cleaning agents and food waste can be discharged over 12 miles from shore. It causes damage to the quality of the water and also harmful to the live organisms in the sea. Damage to the eco system and coral reef is another major impact and due to anchoring and common sea routes, these coral reefs significantly getting damaged. Coral reefs are major attraction among tourists. This has become a principal income generating source. And also, these corals are home to 25% of fish species and it protects the coastlines from erosion. Once it gets damage it may not get heal and it will die for permanent. Therefore, it is essential to impose strict rules and regulations to protect these natural attractions.

Practices and Procedures outlined in the CLIA's Waste Management Policy.

As the leading trade association in the cruise industry, CLIA's primary objective is to provide leadership through implementing policies and procedures to its' members to adopt regarding the cruise operations. The regulatory framework undergoes CLIA members by the International Maritime Organization and flags and the Port States regarding the waste management practices. International Convention for the Prevention of Pollution from ship (MARPOL) is the international convention covering the prevention of marine pollution from the ships by implementing regulation under six annexures which addresses different waste streams and the practices that need to carry out when dumping them in to the waterways. Apart from these national and local legislations, CLIA members are agreed to incorporate with the waste management practices and procedures under the waste management policy of the CLIA and add them to their respective safety management systems. Basically this waste management policy consists of the best practices that need to be adopted by the CLIA members regarding the traditional wastes such as garbage, grey water, sewage, oil residues, sludge oil, bilge water and some other hazardous waste produced from the cruise operations. CLIA Members have voluntarily agreed to adopt the more stringent

practices outlined in this policy, which exceed legal requirements, during all normal operations. According to the Waste Management Policy (CLIA, n.d.) the members agree to manage the waste and to implement more effective waste minimization processes within their ships. The members of CLIA agree to conduct training programs for the ship crew and raise the awareness of the shipboard environment procedures. And, to take necessary steps to raise the passenger awareness on the environment protection by displaying videos on cabin TV channels of shipboard on environmental protection commitment and by placing booklets in public lounges about environment practices. As there is a massive generation of different type of waste from the cruise operations, members have agreed to establish proper waste management plan for collection separation and processing. Wastewater reclamation is another significant area that need to be addressed as per the enormous amount of water generation from the cruise operations through large scale of pools, recreational facilities such as Symphony of the Seas' 10 whirlpools, Ultimate Abyss water slide stimulator, surf simulators, three multi-story water slides (RCL, n.d.) and other operational activities. Thereby under the policy, CLIA members have agreed to adopt techniques to minimize onboard water usage such as to use technical water to flushing toilets, laundry and open deck washing as possible, use of water recovery systems, use reduce flow shower heads and other possible active water conservation and also to train the crew to reduce the water consumption in operation. The following table indicates how the CLIA members are treat the different waste streams as per the waste management policy.

Waste Stream	Practices
Bilge & Oily water Residues	Members agree to meet or exceed the international requirements for removing oil from bilge and wastewater prior to discharge.
Plastic	Members are committed to reducing plastics disposed of in landfills and increasing recycling volumes. Plastics are separated and recycled whenever possible.
Wastewater Reclamation	This management includes minimizing water usage and reclamation and reuse of water for non-potable purposes
Gray Water	Only be discharged while the ship is underway and proceeding at a speed of not less than 6 knots and at a distance not less than 4 nautical miles from the nearest land or such other distance as agreed to with authorities having local

	jurisdiction or provided for by local law except in an emergency or where geographically limited.
Sewage	Members agree to process sewage through a sewage treatment system that is certified in accordance with international regulations, prior to discharge during normal operations.
Incinerator Ash	CLIA members use testing standards for test the Incinerator ash and at least they tested it annually for any hazardous components.
Cooking oil	Waste cooking oil typically strain to remove hazardous components then collected and landed ashore for recycling. Or it may use as a fuel to make steam or electricity on board.

Figure 1: Treatment of Waste streams

Investment and technology adopting by the CLIA members to mitigate environmental impacts

Liquefied Natural Gases (LNG) LNG is an eco-friendly alternative fuel source that mitigates the carbon emission from cruise ships and burning LNG produce zero sulphur emission. AIDANOVA by Aida Cruises is the world first launched LNG powered cruise ship. It has the capacity of accommodating 5252 passengers and its' gross tonnage is 183853 GT. As per the cruise industry report's environmental commitment, innovation, and results (Oxford Economics, 2020), 25 ships are in order or under construction to get LNG powered.

Exhaust Gas Cleaning Systems

ECGs are important to reduce emissions by as much as 98% of the level of sulphur oxides in a ship's exhaust. According to the data (Oxford Economics, 2020) 69% global capacity of cruise ships utilize ECGs to meet air emission requirements

Cleaner Fuels and reduce emission

Currently, the cruise industry has invested in ships with $ 23 billion to adopt energy efficient technologies and cleaner fuels. The target of the cruise industry is to reduce carbon emission by 2030 in 40%.

Shore-side electricity

This technology drives towards to achieving CLIA's carbon reduction goal. This method generally allows cruise ships to turn off ship engines while in ports and rely on efficient municipal power systems when available. According to (Oxford Economics, 2020) 50% of new ships ordered and under construction are specified with shore-side electricity system.

Advance wastewater treatment systems

This is the method that can be used to remove the hazardous contaminants in the grey water and the black water. CLIA members have broadly adopted this system and according to (Oxford Economics, 2020) 70% of global capacity of cruise ships adopted this system and 99% new cruise ships are equipped with this system.

Discussions and Conclusion

CLIA, one of the pioneering bodies of the industry takes environmental practices and actions focusing on the sustainability. According to the waste management policy implemented by CLIA, members are committed to eco-friendly practices which may exceed the international regulations such as zero discharge policy for untreated sewage and advanced wastewater management. As per the investments and the technology adaptation, the marine environment benefit in terms of reduction of carbon emission, sulfur emission, reduction of waste, reduction of water usage, reduction of energy usage. CLIA members are investing 8 billion USD to development of environmentally friendly technologies and fuel alternatives such as LNG (Liquefied Natural Gas) from which 25 new built ships from 2018-2027 will be LNG powered. In cooperation with International Maritime Organization (IMO), CLIA develops compulsory measures for lowering CO2 emissions of new built ships by 40% as of 2030. Despite the promising progress of the industry in reducing environmental impacts, there is still a need for more effort to accelerate sustainability transition of the industry

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11) Table 1 Summary of Cruise Ship Waste Streams Bureau of Transportation Statistics. Bts.dot.gov. (2017). Retrieved 11 March 2021, from https://www.bts.dot.gov/bts/bts/archive/publications/maritime_trade_and_transportation/2002/environmental_issues_table_01.

12) Login date must be include…..

Original Article

Identity Investigation System with Suspect Predication

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Abstract

Crime is one of the major problems encountered in any society. Thus, there is an important need for security agents and agencies to battle and eradicate crime. Sri Lankan police is responsible for investigating and detecting criminals of any crime committed within the country. Crime is an act usually deemed socially harmful, specifically defined, prohibited and punishable under criminal law. Crime rates are rapidly increasing and changing. Crime prediction is very important in any country. In Sri Lanka, crime detection among people is very crucial to Department of police office. The purpose of Identity investigation system with suspect prediction that tracks the investigation status of criminal cases with logs and also predicts primary suspects. This project is mainly based on Android Studio and WEKA tool. This project has main two parts. In system has suspect prediction part. In this system it uses data mining techniques for prediction process. For that purpose, mainly system uses WEKA Tool. Identity investigation process is second main part of this project. It is doing by using SQL functions. It uses Short Message Service (SMS) and other functions for data security. Basically, mobile application development doing by Android Studio.

Keywords: SMS, Alarm, Android Application, Data Mining, WEKA Tool, SQL Function

Introduction

At the present crimes are increasing highly in Sri Lanka. In Sri Lanka, police department is the largest unit for preventing crimes, maintaining law orders, rules and peace throughout the country. However, problem with the Sri Lankan police is that they are still using the traditional manual process to keep and analyse the records of crime and criminals. On the other hand, criminals use more advance technologies to commit the crime in more tactful ways. Crime rates in Sri Lanka are increasing enormously among countries and their variations in this dimension is orders of magnitude greater their variation through the time in a given country. [1]. Over the previous few years most of the countries of the world has experienced a remarkable increase in rate. There is no explicit reason for any disorder for criminal activities. Generally, society, cultural factors, totally different family systems, political influences and enforcement are responsible for criminal activities of an individual. Crime rate is growing in Sri Lanka. Crime is also found in numerous forms. Organized crime includes drug trafficking, shooting, concealing, extortion, and murder for rent, fraud, human trafficking. [2] Several criminal activities result in political violence, religiously impelled violence, terrorism, and abduction. The opposite sort of crimes includes homicide, robbery, assault etc. Corruption may

be an important drawback that is faced by Sri Lanka. Thus, there is a large need for

situation. Sri Lankan police is responsible for investigating and detecting criminals of any crime committed within the country. This research aims to develop a smart mobile system for criminal information analysis for Identity Investigation System with Suspect Predication. The main purpose of the system is to correctly classify the crime data and use the most appropriate data mining algorithm to reveal the hidden knowledge from crime data. This knowledge can be very useful in identifying possible suspects of the crime. Selection of appropriate data mining algorithm will be done by J48 decision tree algorithm obtained from WEKA mining software.

Research Methodology

In order to answer the research questions, the author has followed this process.

A. Requirements Gathering

Requirement management is the most important area of this research project. In this Process author has identified the major requirements of this project.

- Create a dataset for the scenario.
- Identify the suitable algorithms for scenario.
- Identify the suitable prototype for scenario.

To address first requirement of the project the author has to generate **suitable dataset for process.** Data Mining (DM) is the process for automatic discovery of high level knowledge by obtaining information from real world, large and complex data sets [3], and is the core step of a broader process, called Knowledge Discovery from Databases (KDD). In addition to the DM step, the KDD process includes application of several pre-processing methods aimed at facilizing application of DM algorithms and post processing methods for refining and improving the discovered developing smart solution for this

knowledge. This idea of automatically discovering knowledge from databases present a very attractive and challenging task, both for academia and industry.

First of all, author generate the crime dataset through two sequential steps

(1) Data Extraction extracts the unstructured crime data from various crime Web sources, namely—. National Crime Records Bureau (NCRB), Committee to Protect Journalists (CPJ) and other Web sources during the period of 2000–2012[4].

(2) Data set cleans, integrates and reduces the extracted crime data into structured 10,000 crime instances (.csv format). The structured crime dataset is represented using 11 crime attributes. The formulated dataset is implemented using two JAVA tools— (1) Netbeans for crime detection, criminal identification and prediction. (2) WEKA for crime verification. Some of the crime attributes are mentioned in following figure.

Figure 1:Train Data Set
(Source: Created by author)

To address second requirement of the project the author has selected **Decision Tree Analysis on J48 Algorithm.** [5] Basically, decision makers prefer a decision tree because it is not complex as well as easy to understand. Tree complexity has its effect on its accuracy. Usually, the tree complexity can be measured by a metrics that contains: the total number of nodes, total number of leaves, depth of tree and number of attributes used in tree construction.

[6] Decision trees are the most powerful mining. It includes the technology of research large and complex bulk of data in order to discover useful patterns. This idea is very important because it enables modelling and knowledge extraction from the bulk of data available.

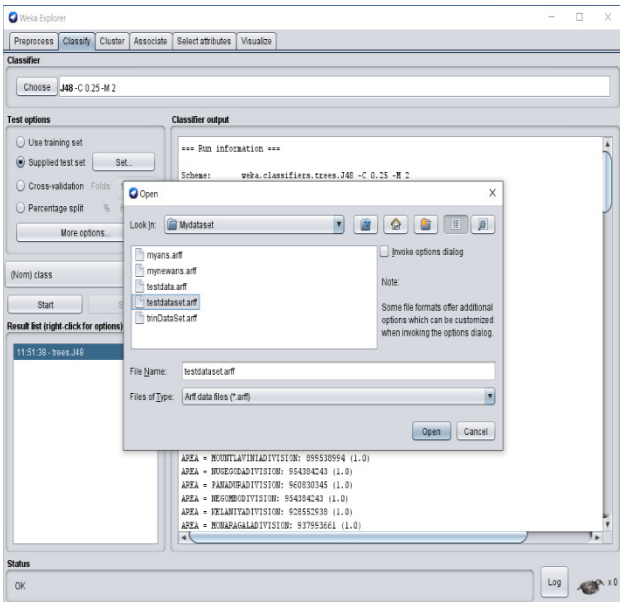


Figure 2: Select J48 Model
(Source: Created by author)

To address third requirement of the project, the author has selected the good **proto type** for the project.

To implement this research the author has selected the **prototyping** model. The prototyping model is a systems development method in which a prototype is built, tested and then reworked as necessary until an acceptable outcome is achieved from which the complete system or product can be developed [7].

B. Analysis

In this analysis part author carries deep investigation about the algorithms. To develop a accuracy high system, author has to select good algorithm for system. Basically, the author has selected two major algorithms and comparison has done by considering the accuracy levels. approaches in knowledge discovery and data Classification technique is used to find the common properties among different attributes of crime and criminal dataset and organizes them into different predefined classes. Classification is a data mining technique which is often used for predicting crime patterns and it also can reduce the time required to identify these crime patterns. However, classification technique requires proper training and testing data because a certain number of missing values may limit the prediction accuracy. [8] For example, we can apply classification in crime application that given all past records of criminals who commit the crime, predict which current criminals are probably to commit the crime in the future.

Firstly, author should have a set of training instances. This uses a J48 decision tree algorithm and merit selection criteria to choose the best splitting attribute to create a branch. Thus, author has two partitions. Algorithm will apply same top-down analysis to make further more partitions. One of the stopping criteria is when all the attribute's values belong to a single class. There is only difference in splitting criteria if do comparison between multi and univariate tree construction. [9]. From the experimental results, J48 algorithm predicted the unknown category of crime data to the accuracy of **94.25287%** which is fair enough for the system to be relied on for crime prediction system.

In second section, the author has tried to train data set with k-means clustering, the results of k-means clusters are verified with WEKA. WEKA verifies an accuracy of 52.62 and 52.99 % in the formation of two crime clusters using the selected crime attributes.
Error Calculation:
Cluster 1 = MOD(2,445 - 2,289) / 2445 = 0.0638

Cluster 2 = MOD(2,593 - 2,749) / 2593 = 0.0601

So, Accuracy Measure: ..

Cluster 1 = 52.62 %

Cluster 2 = 52.99 %

It is obvious that, the best algorithm is **J48** and it is fair enough for the system to be relied on for crime prediction system.

C. Identifying Business Values

The system is designed to aid investigation teams to work collectively on cases, coordinate and also speed up the process by suggesting logical suspects based on data provided. It is their sole responsibility to enforce the law, find and apprehend irresponsible society, reduce and curtail any and every form of indiscipline. Some of the crimes in this situation include: burglary, sexual harassment (and/or rape), abuse of drugs, alcoholism, homosexuality, misuse and abuse of school properties, disobedience of school rules and regulations, stealing and many other crimes included in the Sri Lanka Conduct/Rules and Regulations [10]. After a crime is committed, it becomes the duty of the assigned police officer to forecast the potential suspects of that crime, perform a series of investigations, apprehend and then prosecute the real criminal. Implemented system helps to overcome this situation.

D. Design

Figure 01 and 02 explains the design of the system through a use case and the data flow diagram architecture.

These are the main functions of this suspect prediction system.

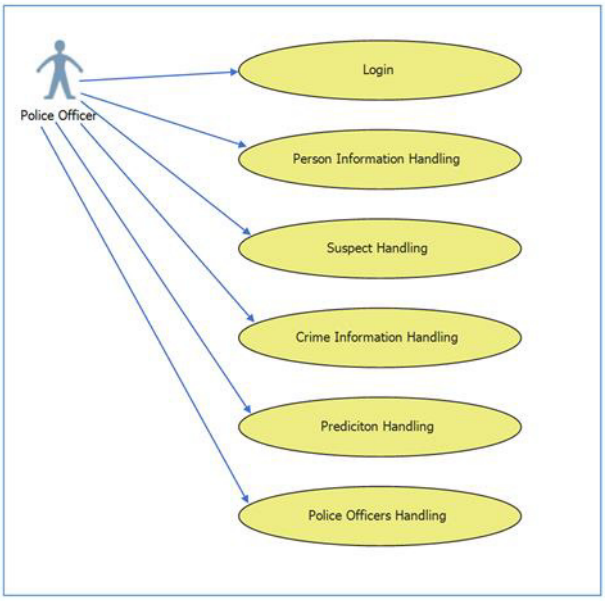


Figure 3: Usecase Diagram for system.

(Source: Created by author)

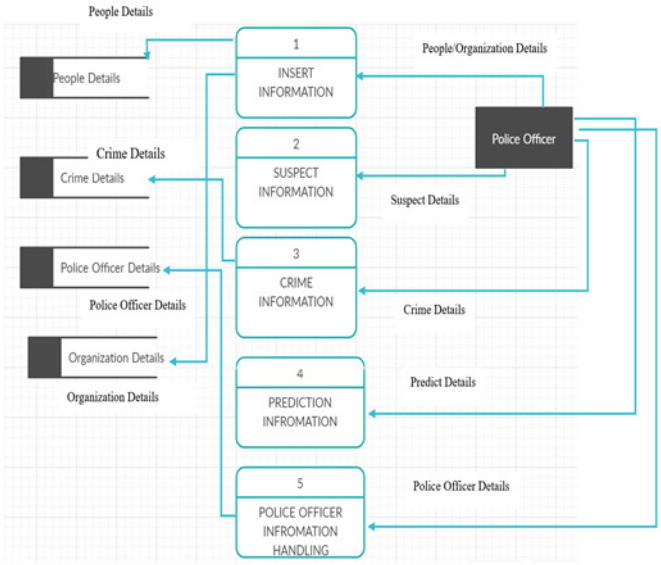


Figure 4: Data Flow Diagram.

(Source: Created by author)

UML use case is a popular modelling technique especially in object-oriented based software development. A UML model produced consists

of different diagrams, views of different level of abstraction and contributes from different stakeholders and modellers. These open to consistency problems between diagrams [11]. In this system the main actor is the Police office. Police officer. Police officer can insert information, prediction process to the system.

Data Flow diagram basically shows all data stores and basic operations of the system. Mainly police officer can access and handle all data stores. Above diagram shows all data flows of this system.

E. Implementation

In this project author has used main three components. Data Mining (WEKA Tool), database, Android application.

In implementation stage, basically authors have created this project according to the following process flow chart. In a software implementation, it is often easier to trade off reliability for performance because the software can be changed or adopted to specific needs. Mainly this system develops under WEKA Tool. It has been indicated through Figure 03.

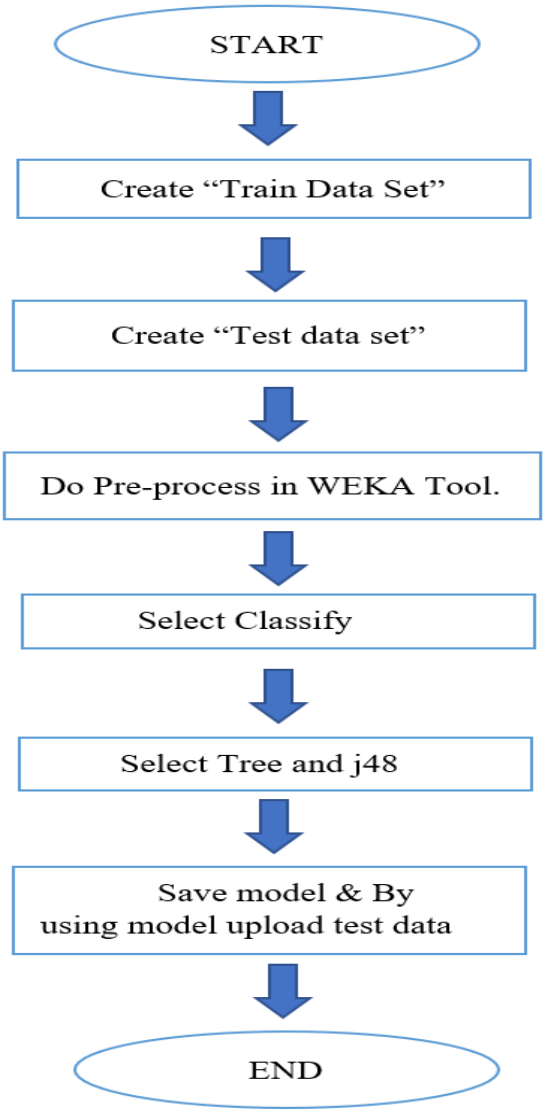


Figure 5: Process Flow chart Diagram.

(Source: Created by authors)

STEP 01- Preprocess

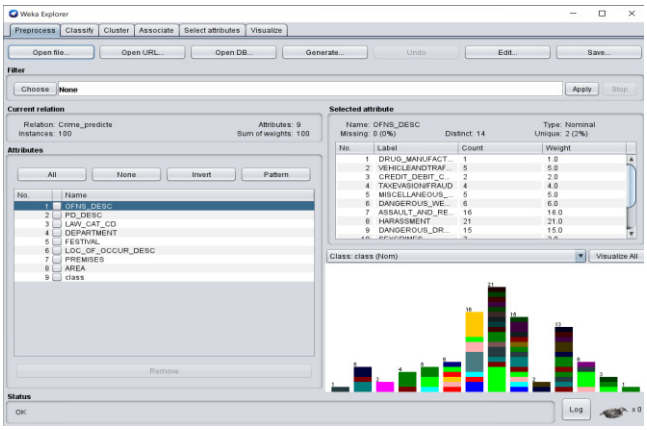


Figure 6-Preprocess
(Source: Created by authors)

STEP 02- In Classify · Select tree · j48

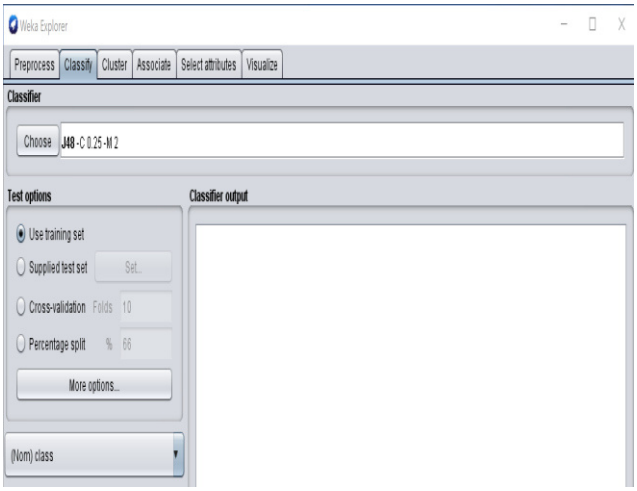


Figure 7-Classify
(Source: Created by authors)

STEP 03- Save Model

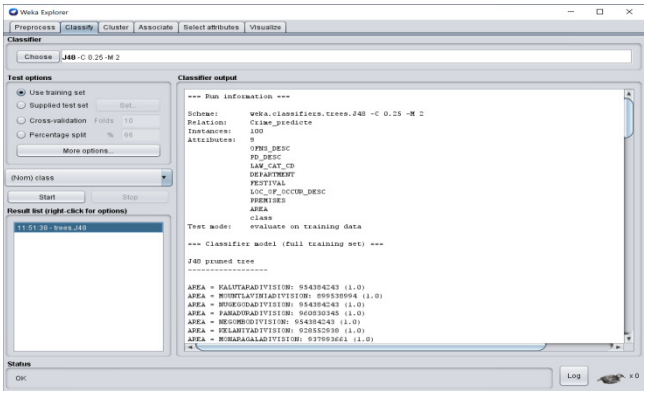


Figure 8-Save Model
(Source: Created by authors)

TEP 04- By using model upload test data file

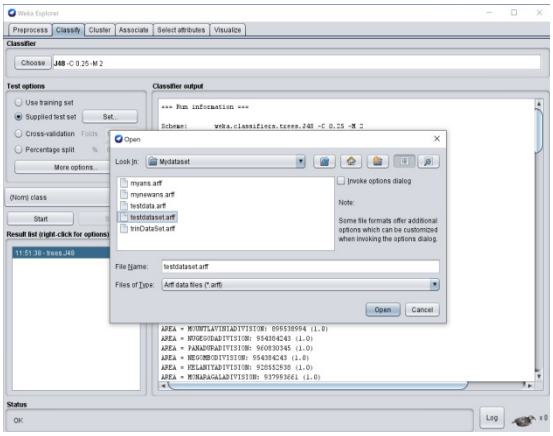


Figure 9-upload test data file (Source: Created by authors)

STEP 05- Start Predicting.

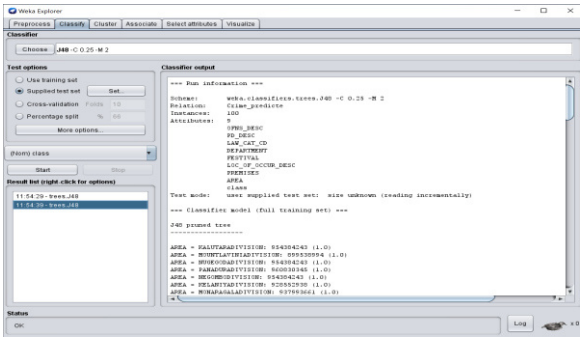


Figure 10-Start Predicting (Source: Created by authors)

Figure 11: Admin Page (Source: Created by authors)

F. Testing

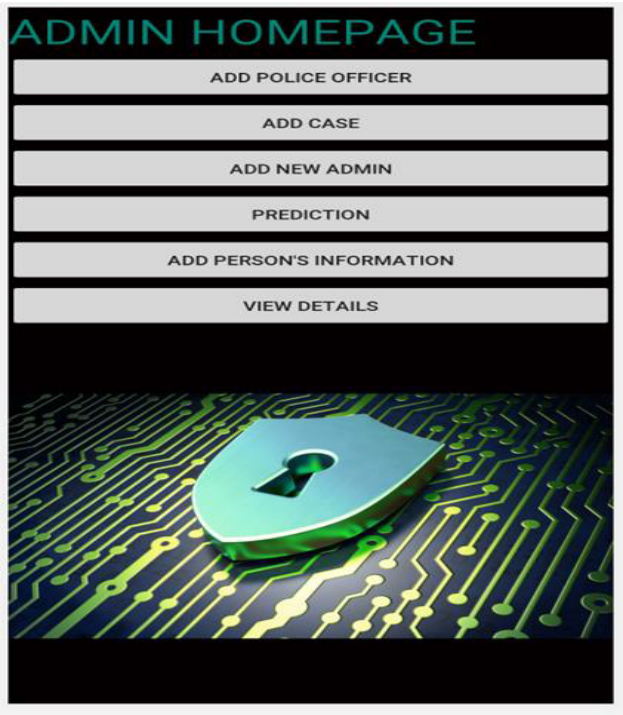
In computer programming, unit testing is a software testing method by which individual units of source code are tested to determine whether they are fit for use. A unit is the smallest possible testable software component. Usually, it performs a single cohesive function.
In this project authors mainly did test major two parts.

01) Mobile Application in Android Studio.
Authors did simple testing to my mobile application and all functions are checked under it.

02) Data Mining WEKA TOOL

Results and Discussion

This content covers the results that were achieved from the research project and what were the new approaches found to address further research in the undergraduate context.
This is the final outcome of this product. By using this Admin page, the users can move to prediction page



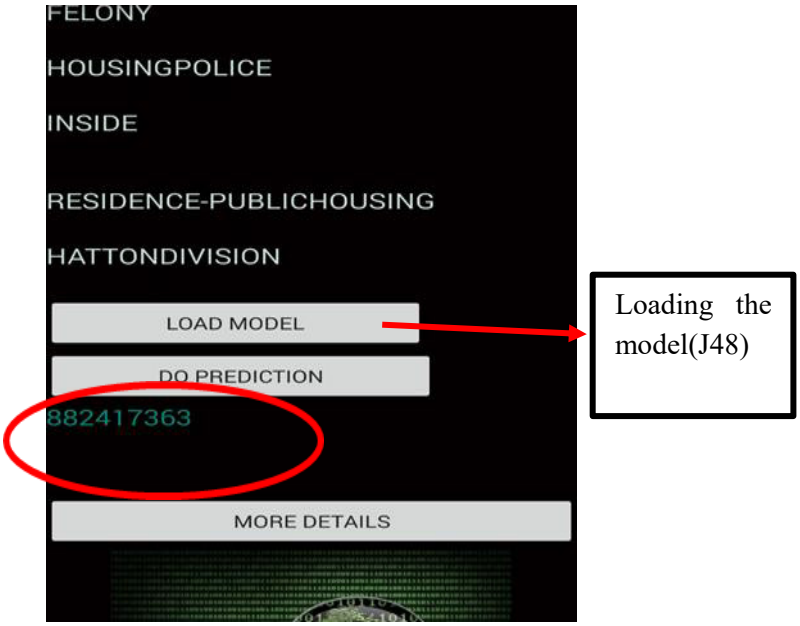


Figure 10: Prediction Page
(Source: Created by authors)

Identity Investigation System with Suspect Predication searches for immanent patterns and relations in the given crime data by using the J48 techniques. In this section, the results of J48 are verified with WEKA. Here the classification result of J48 – a decision tree is shown using parameters such as correctly classified instances, true positive rate, and false positive rate [12]. This technique provides an overview of large amount of the crime data and facilitate in handling, searching and retrieving of the desired crime information. Identity Investigation System with Suspect Predication can also be useful for crime prevention

Future works and Conclusions

Implemented system presented an efficient and affordable method for real time problem solve system this system can be updated to the extraordinary level. Therefore, authors are strongly recommended this system will be solve numerous problems regarding its administration in high level.

In order to use this system research, authors have not enough data to data mining to get good prediction. Though the data for data mining is a limitation. Recommendation to those who willing to develop this system further as follows;

- Add more data and do the data mining to get good result.
- Develop the system to get more accurate result.
- Add international prediction algorithms to this system.
- Add more security features.
- Enhance number of users.
- More user-friendly interfaces.
- Add more algorithms.
- Increase accuracy.

Above changes can add more quality for this system.

As a future extension of this study, a web based criminal identification system is proposed which will give information of criminal at a single click from any place. This system will also serve the purpose of crime information sharing and investigators can access the criminal information from any place.

Declarations

Study Limitations

When developing this project, authors followed sample data mining projects. Authors achieved their target scope and authors face some difficulties when working with data sets. Here for data mining purpose authors needed very large amount of data records and when handling that data set, authors faced some limitations. In data mining process, it is a known fact that data mining collects information about people using some market-based techniques and information technology. To run this data mining-based project authors required high performed machines. These are main identified study limitations of this project.

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Author would like to take this as an opportunity to thank everyone who has helped to finish this project. Author would like to offer sincere gratitude to Mr. Dhishan Dhammearatchi for his quality service. It was very helpful for us to gain proper knowledge, to correct this mistake and finally to make a enhance project.

Another special thank is going to Project reader Mr. Rajeewa De Silva for his valuable assistance in this project.

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Original Article

Impact of Recruitment and Selection on Performance of Primary School Teachers in ABC International School

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Abstract

Enhancement of Private Education in Sri Lanka is becoming acceptable and provides more opportunities for students and teachers. Primary Education has been always the foundation of the individuals' life. Therefore, in order to provide effective learning teaching process recruitment and selection of teachers is an integral part of a school since this leads to performance of teachers. Objective of the study is to examine the impact of the recruitment, selection process on performance of Primary School Teachers. It is mainly a quantitative study and complemented with the qualitative data. Population of the study was primary school teachers in headquarters and sample of the study size is hundred primary school teachers. Questionnaire, interviews documentary analysis were used as data collection instruments. Responses given by the teachers to see the level of performance indicated that highest level of performance positioned as averaged (47 per cent). Some Recruitment methods in ABC schools are newspaper advertisement, internal advertisement, internet advertisement, recruitment agencies, head hunting, transfer and promotion and transfer and retrenchment. School uses combination of recruitment methods to attract most suitable and qualified candidates rather than rely on one method. The study revealed that teachers impression about recruitment practices in the school and 61.5% have mentioned recruitment practice is effective, 14.6% have believed it was non-effective, 9.4 and 14.6% have responded the practice was poor and bias respectively. Further there was no statistically significant relationship between level of performance and recruitment methods. The study concluded that teachers' performances were in averaged category and the recruitment and selection have association with performance of primary school teachers. However, the impact of recruitment and selection on performance of primary school teachers is low.

Keywords: Performance, Primary Teachers, Private Education, Recruitment, Selection

Introduction

Recruitment and selection are very vital HR functions and crucial employee resourcing strategy. Since attracting employees is a major role to play because all other activities depend on having qualified, experienced, skilled and competent staff. Therefore, in order to achieve organizational objectives and accomplish good performance sound recruitment and selection procedure are must, if not consistency, legality of the process could be overlooked. Performance of primary teachers and implications of recruitment and selection has been questionable in private and international

schools recently. Since the salaries are low, private schools tend to recruit teachers without proper training which has impact on teacher performance later. Little (2000) argued that the primary grades have sunk in a weak position while higher grades attract prestige, resources and consideration of the principals. However, recruitment, selection and performance of primary school teachers are very important since the primary education is the basic stage in the formal system of education. It is the stage where foundation for child's future development is laid. According to the education reform of 1997 the aim of primary education is to lay a firm foundation for the development of the personality of the child to enable him to face challenges successfully as future citizen. To achieve above objectives performance of a primary teacher is a must. This study is carried out in one of the well-known international schools in Sri Lanka. However, in order to achieve the research objectives headquarters of the school has been considered and Performance of the Primary school teachers and impact of the recruitment and selection process are focused here.

According to Oon Seng Tan (n.d.) globally more than 60 million teachers are engaging in learning and teaching process and making teaching the largest profession. Without any question teacher plays catalyst role and education can be identified as the most significant investment in any society. Many education systems struggle with issues with regarding to recruitment, teacher preparation, performance management, teacher development and empowerment. Arunathilaka (2014) stated that best performing schools ensure that teacher quality started with recruitment. Recruitment and Selection of any organization is very vigorous because all other activities depend on hiring the right person for the right job at the right time. Therefore, this has to be done according to valid policies and procedures rather than doing it in a haphazard manner also that process must be free from biased and discriminatory operations.

The development of international schools has worsened the problem in recruitment of teachers who can teach in English and instructing the pedagogical knowledge in English and perform well showed in the study (Little and Hettige, 2013, as cited in Maduwanthie 2016). Recruitment and selection process are not the sole factor that affects the performance though some researchers have identified that sound recruitment and selection practices should lead to employees' performance since all other activities may depend on the recruitment and selection of individuals. ABC International School is a well reputed international school facing some problems especially with regards to newly recruits because some of them have inadequate knowledge of the subject and this could be a problem. Most teachers lacked in skills in planning the work, writing lesson plans, classroom management, motivating students and directing students in conducive participation in learning indicated in the study. (Jayasena, 2000, as cited in Primary Education, OUSL 2010).

It is doubtful that ABC International Schools have a recruitment and selection policy and procedure. Without having sound procedures any organization tends to be biased in recruitment and selection practices. In order to provide a good service an efficient, effective and professionally qualified staff is a must. ABC International School operates without HR Department though they carry out all HR activities. These HR activities include

recruitment and selection function and they are delegated among the Coordinating Principal, Principal and other administrative staff. It is questionable whether the organization is able to do all HR activities efficiently and effectively without an experienced staff in the relevant department since the significance of the HR activities are not being considered. Hence the recruitment and selection process in the school is conducted by an untrained staff in HR Practices. This will ultimately lead to issues with the performance and behavioral issues with the teachers and other staff.

Least possible researches have been done in connection with the recruitment, selection and the performance of teachers in primary section in Sri Lanka. Hence the researcher intends to find out whether the recruitment and selection affect the performance of teachers in primary section of ABC International School.

Research Questions

1) What is the impact of recruitment and selection process on the performance of Primary School Teachers?

Objectives of the study

1. To examine the impact of the recruitment, selection process on performance of Primary School Teachers.

Research Methodology

The study can be considered as a survey research and quantitative data has been complemented with the qualitative data. Area of the study is one of the largest international schools in Sri Lanka. Though the school consists of seven branches (or networking schools) schools, the study has been conducted only in the headquarters. In order to achieve the research objectives out of hundred and thirty Primary school teachers only hundred self-administered questionnaires have been distributed among them. Hence, over all hundred primary School teachers participated in this study. Simple Random sample have been used to select the respondents. The process involved distributing one to hundred and thirty numbers to all primary school teachers. Writing one to hundred and thirty numbers in pieces of paper and folded, placed in a container and assorted together. Hundred numbers have chosen and that was included in the study. In order to collect data both primary and secondary data collection methods have used. Primarily data collection techniques are self-administered questionnaire for teachers and key informant interviews with prominent people in the organization. Questionnaire consists of main sections on demographic characteristics, recruitment and selection and performance of the respondents. Questionnaire has comprised of both closed and open-ended questions. Objectives of the study and value of the questionnaire have mentioned at the beginning of the questionnaire. Further the researcher has assured the confidentiality of the information gathered and courteous request for teachers' co-operation in the questionnaire and encouraged them personally to answer the questionnaire. Three key informant interviews have been conducted with some key stakeholders in the organization viz with Principal, Headmistress and Human Resources officer. Particularly Key informant interviews were design to collect qualitative information. This was deliberately planned to search out more information on impact of recruitment and selection on performance of primary school teachers.

Results and discussion

All statistical assessments for instance cross tabulation, chi-square test, regression analysis were executed under SPSS version of 21 software programmes. The hypotheses have developed to see the relationship between performance and recruitment and selection.

Performance and recruitment methods

Some Recruitment methods in ABC schools are newspaper advertisement, internal advertisement, internet advertisement, recruitment agencies, head hunting, transfer and promotion and transfer and retrenchment. school uses combination of recruitment methods to attract most suitable and qualified candidates rather than rely on one method. The teachers have responded their impression about recruitment practices in the school and 61.5% have mentioned recruitment practice is effective, 14.6% have believed it was non-effective, 9.4 and 14.6% have responded the practice was poor and bias respectively. In order to see the association between performance and recruitment methods B1 and C2 questions were considered in the questionnaire (B1- How do you identify the level of performance of teachers in this school and C2 - To what extent does the school use the following recruitment methods).

H0: There is no association between performance of teachers and recruitment methods.

H1: There is an association between performance of teachers and recruitment methods.

Table 1: Performance and recruitment methods Chi-square test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	34.554[a]	34	.441
Likelihood Ratio	40.821	34	.196
Linear-by-Linear Association	1.002	1	.317
N of Valid Cases	84		

a. 51 cells (94.4 per cent) have expected count less than 5. The minimum expected count is .10.

P value (0.441) > 0.05 and therefore no significant statistical association. H1 is not rejected. Therefore, association is low between performance level of teachers and recruitment methods.

To assess the current performance of the primary school teachers, there were few questions have been designed and findings have been measured according to the five point Likert scales varying from strongly agree, agree, disagree, and strongly disagree to undecided. 43 per cent teachers have believed that performance of the teachers in the school is good however 47 per cent teachers decided performance of the teachers is average and 10

per cent teachers considered performance is poor (Table 2). According to response from the performance. Therefore, it has indicated that performance levels should be improved.

Table 2: Performance of Primary School Teachers

Performance category	Frequency	Percentage
Poor	10	10
Average	45	47
Good	41	43
Total	96	100

To achieve the objective of the study (To examine the impact of recruitment and selection on performance), it is necessary to see whether there is an association between performance, and recruitment and selection. Therefore, the researcher has developed hypothesis to see the association between performance[1] recruitment and selection.

H0: There is no association between performance levels of teachers and opinion about the recruitment practices.

H1: There is an association between performance levels of teachers and opinion about the recruitment practices.

[1] Variables were performance and recruitment and selection. Question numbers from the questionnaire were No. B1 - How do you identify the level of performance of teachers in this school and No. C5- What is your opinion about the recruitment practices in the school.

primary school teachers it indicates that average performance levels are higher than good

How do you identify levels of performance of the teachers in this school * What is your opinion about the recruitment and selection practices in the school Cross tabulation. Count

Table 3: Levels of performance and recruitment and selection

		What is your opinion about the recruitment practices in the school				Total
		Bias	Poor	Non effective	Effective	
How do you identify the levels of performance of the teachers in this school	Poor	1	3	1	5	10
	Average	7	2	1	35	45
	Good	6	4	8	23	41
	Total	14	9	10	63	96

Table 4: Levels of performance and recruitment and selection-Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.995[a]	6	.030
Likelihood Ratio	13.331	6	.038
Linear-by-Linear Association	.041	1	.839
N of Valid Cases	96		

Cells (58.3 per cent) have expected count less than 5. The minimum expected count is .94.

As per results of chi-square test, chi-square value is significant (0.03<0.05) at the 5 per cent level of significance. It can be concluded that there is a significant association between performance of the teacher and recruitment practices. Therefore, H1 is accepted.

In order to achieve the objective to see the impact of recruitment and selection on performance of teachers, the regression analysis has conducted. However, that is not presented in the report since the relationship between performance and recruitment were statically not significant.

Conclusion

To see relationship of recruitment and selection process on performance of Primary School Teachers, chi square test performed. According to chi square test it indicated that there was no statistical significant relationship between level of performance and recruitment methods, found that (0.441>0.05) at 0.05 significance level. Nonetheless descriptive statistics have concluded that school has been using combination of recruitment methods which will enrich the practice. Further to see the relationship between level of performance and recruitment and selection practices chi square test has conducted. It concluded according to the chi square test there was a statistical significant association between level of performance and opinion of recruitment and selection practices in the school, found (0.03 < 0.05) at 0.05 significance level. Correspondingly evidence denotes that there was a positive significant relationship between recruitment and selection and performance (Gamage 2014). Further Jocyline (2014) and Kanyemba et al (2015) have conducted studies on recruitment practices and performance and examined impact of recruitment, selection and organizational productivity. To see the impact, regression analysis performed and, not presented in the study since the value is statistically not significant. Study concluded that recruitment and selections have association with performance of primary school teachers though the impact is low.

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Original Article

Level of Stresses and Coping Strategies in Management of Stress in Healthcare Undergraduates; Sri Lankan University Perspectives

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Abstract

University is the best platform which provides opportunities for undergraduates to develop their successful career. However, it is noticed that university life has become stressful for undergraduates due to different reasons. Stress is known as a serious issue which affects the performance of undergraduates of healthcare system. Coping strategies are in demand for managing stress in the context of delivering prudent healthcare professionals to the nation. This study aimed to identify the types of stressors and coping strategies practiced by healthcare undergraduates of University of Ruhuna, Sri Lanka. The study was based on a cross sectional survey. Data were collected from 343 healthcare undergraduates from Faculty of Medicine and Faculty of Allied Health Sciences, University of Ruhuna, having used stratified random sampling method and a self-administered structured questionnaire. Data were analysed using SPSS version 16.0 software. The study revealed that majority of undergraduates (98.8%) were affected by stress. The level of stress reported regarding examinations was very high (52.7%) compare to the other stressors. Results showed that the commonly practiced coping strategies were sleeping (93.6%) and talking to a friend/ meeting loved ones (89.8%). Results suggested that facilities rendered by two faculties including student counselling services (79.9%), mentoring programme (75.8%) and career guidance services (69.4%) were used by considerable number of undergraduates as coping strategies. There were statistical significant differences among coping strategies with regard to gender, year of study, faculty and degree programme. Our findings suggested that the majority of healthcare undergraduates in University of Ruhuna were affected by stress. The present study revealed that most of students used positive stress management strategies while some students used maladaptive coping strategies. The results provided valuable information for academics in healthcare undergraduate programmes and university administrators in supporting students with stress.

Keywords: Coping strategies, healthcare undergraduates, stress, university

Introduction

Stress is defined as any type of change that causes emotional, physical, or psychological strain [1]. All types of stresses are not harmful. Stress can be short-term or long-term with variety of symptoms. Acute stress is a very short-term type of stress that can either be positive or more distressing. Chronic stress is long-term which is never ending and inescapable [2]. Stress has become a serious issue in a variety of social, employment and academic settings [3]. The studentship of the

university is a stressful time for many students because they go through process of adapting to new educational and social environments. Transition of the status of the students from school to university may cause a psychological, academic and social shock due to the new/unfamiliar environment/ education system of the universities [3-6]. Researchers have documented the prevalence of stress to be high among university students [5] and this is even worse among healthcare professional students due to the trainings that expose them to stress. It is reported that the effects of stress could be reflected in student's social, mental health and academic performance [7]. Research studies conducted on stressors and their implications for both students and lecturers in the university environment have showed that stressors are increased over the years [3-11]. Healthcare undergraduate degrees are stressful programs of study due to complexity of academic curricula and clinical trainings [12,13]. Implementing stress-management techniques in these degree programs have a positive effect on student retention and their academic performances [14]. Every individual face event and circumstance in a way which is unique to them. Hence some will be able to adopt new circumstances and some may have end up with stress. People use different strategies consist of cognitive and behavioral efforts to tolerate, reduce the stress. These stress management strategies play a vital role in adaptation to stressful life events [15-17]. Use of correct stress management strategies helps to overcome stress while maladaptive strategies reinforce stress [18]. Hence it is essential to identify types of stresses and stress management strategies used by healthcare undergraduates in order to help them to overcome the stress, maintain and achieve their academic goals. Although many studies on stress management have been conducted internationally, there are few studies conducted and reported on stress management among healthcare undergraduates of University of Ruhuna in Sri Lanka. Therefore, this study was aimed to identify the types of stresses faced by healthcare undergraduates of University of Ruhuna, Sri Lanka, and the coping strategies used to manage stress.

Materials and Methods

This is a descriptive cross-sectional study carried out among first year and final year students of Faculty of Medicine and Faculty of Allied Health Sciences, University of Ruhuna, Sri Lanka with the aim of identifying the types of stresses faced by healthcare undergraduates of the university and the coping strategies used to manage stress. Specific objectives were to assess stress and identify stressors among healthcare undergraduates, to determine coping strategies used by healthcare undergraduates, to compare coping strategies between healthcare undergraduates with regard to faculty, degree program, year of study and gender and to appraise facilities rendered by the Faculty of Medicine and Faculty of Allied Health Sciences of University of Ruhuna for reducing the impact of stress. The sample size was calculated based on proportion in a single cross-sectional survey with the expected proportion was considered as 50% [19]. Since the estimated sample size was 384 for an absolute precision of 5%, 400 subjects were included accounting for 5% of non-respondents. Stratified random sampling method was used to include adequate and representative sample units from each stratum by considering that the first year and final year students have higher level of stress. All male and female first and final year (fifth year) undergraduates from Bachelor of Medicine and Bachelor of Surgery (MBBS) degree program and all male and female first and final year

(fourth year) undergraduates from Bachelor of Science (BSc.) in Nursing degree program, Bachelor of Pharmacy (B. Pharm) degree program and Bachelor of Science in Medical Laboratory Science (BSc. MLS) degree program who can understand English questionnaire and willing to participate were included in the study whereas students who did not consent the participation for the study were excluded. Data collection was started after obtaining the approval from the Ethical Review Committee of the Faculty of Allied Health Sciences, University of Ruhuna, (Reference No: 30.05.2019:2.30). Institutional approvals were obtained from Deans of each faculty. Student counts of each batch were obtained and calculated the number of students required to represent each stratum. Participants were informed that data will be used for the study purpose only and that participant's identity and responses will not be revealed to any third party. Informed written consent was obtained from participants prior to administration of questionnaire. Data collection was carried out by distributing a self-administered structured questionnaire among the consented students. The structured questionnaire was drafted and tested for content and face validity. The questionnaire is consisted of three parts including, Part A consisted of basic demographic data of students, and Part B consisted of nature of the stress and types of the stressors. Nature of stress was assessed by using a five-rating scale (always to never) and level of stress was assessed by six-rating scale (not applicable to very high), Part C was used to determine usage of stress management strategies/coping strategies and how those were helpful to them. It was assessed by using five rating scale (very helpful-not helpful).

Data was analyzed by using Statistical Package for Social Sciences (SPSS) software version 16. Standard descriptive statistics were used to characterize the study population and responses to survey items. Chi-square test was used to determine the associations between variables. Statistical significance was set at $p < 0.05$.

Results

Baseline characteristics of the study sample

The response rate of the study was 85.75% (343/400) as shown in the Table 1.

Table 1: Baseline characteristics of participants.

Variable	Category	No. of respondents (%)
Gender	Male	94 (27.41)
	Female	249 (72.59)
Year of study	First year	198 (57.73)
	Final year	145 (42.27)
Faculty	Medicine	226 (65.89)
	AHS	117 (34.11)
Degree programme	MBBS	226 (65.89)
	B.Pharm	32 (9.33)
	B.MLS	29 (8.45)
	BSc.Nursing	56 (16.33)

The study revealed that majority of participants (n=339, 98.8%) was affected by stress. There were, 35.6% (n=122) who are "often" encountered stress, followed by 28% (n=96) responded that they "more often" encountered stress, and 20.1% (n=69) "always" encountered stress. There were 52 (15.2%) who encountered stress "less often" and there were 4 (1.2%) responded that they were not stressed. Academic curriculum was the major cause of stress prevailing amongstudents (n=330, 97.6 %). However effect of stress was very high due to the examination (n=178, 52.7%) followed by examination time table (n=118, 36.2%) (Table 2).

Table 2: The effect of stress caused by academic activities.

Types of stressors	Prevalence						
	Very high N (%)	High N (%)	Modest N (%)	Low N (%)	No stress N (%)	Not applicable N (%)	Total
1. Academic curriculum	93 (27.5)	**111 (32.8)**	102 (30.2)	24 (7.1)	7(2.1)	1(0.3)	338
2. Clinical training	42 (15.5)	46 (17)	53 (19.6)	18 (6.6)	6 (2.2)	**106 (39.1)**	271
3. Lectures	38 (11.2)	63 (18.6)	**118 (34.9)**	70 (20.7)	46 (13.6)	3 (0.9)	338
4. Lecturers	47 (14.2)	57 (17.2)	**119 (35.8)**	71 (21.4)	35 (10.5)	3 (0.9)	332
5. Assignments	70 (22)	77 (24.2)	**86 (27)**	39 (12.3)	16 (5)	30 (9.4)	318
6. Presentations	69 (22)	68 (21.7)	**96 (30.6)**	48 (15.3)	11 (3.5)	22 (7)	314
7. Exams	**178 (52.7)**	105 (31.1)	26 (7.7)	15 (4.4)	14 (4.1)	0 (.0)	338
8. Academic time table	75 (23.1)	87 (26.8)	**89 (27.4)**	57 (17.5)	16 (4.9)	1 (0.3)	325
9. Exam time table	**118 (36.2)**	88 (27)	79 (24.2)	29 (8.9)	9 (2.8)	3 (0.9)	326
10. Results	73 (22.3)	68 (20.7)	**79 (24.1)**	61 (18.6)	42 (12.8)	5 (1.5)	328

Apart from academic related activities, study found that students were affected by some other factors not related to academic activities (**Table 3**).

Table 3: The effect of stress caused by activities not related to academic.

Types of stressors	Prevalence						
	Very high N%	High N (%)	Modest N (%)	Low N (%)	No stress N (%)	Not applicable N (%)	Total
1. Food	33 (9.9)	38 (11.4)	59 (17.7)	83 (24.9)	**102 (30.5)**	19 (5.7)	334
2. Money	36 (10.8)	64 (19.2)	**78 (23.4)**	77 (23.1)	69 (20.7)	9 (2.7)	333
3. Family/ Home	24 (7.5)	24 (7.5)	47 (14.7)	72 (22.6)	**133 (41.7)**	19 (6)	319
4. Girl/boy friend	12 (3.8)	10 (3.2)	29 (9.2)	49 (15.6)	**127 (40.4)**	87 (27.7)	314
5. Friends	13 (4)	13 (4)	59 (18.4)	79 (24.6)	**143 (44.5)**	14 (4.4)	321
6. Loneliness	23 (7.3)	29 (9.2)	63 (20)	73 (23.2)	**102 (32.4)**	25 (7.9)	315
7. Senior students	4 (1.2)	7 (2.2)	28 (8.6)	56 (17.2)	**190 (58.5)**	40 (12.3)	325
8. Health problems	9 (2.8)	26 (8.2)	66 (20.7)	**103 (32.3)**	95 (29.8)	20 (6.3)	319
9. Hostel life	20 (6.3)	26 (8.3)	47 (14.9)	60 (19)	70 (22.2)	**92 (29.2)**	315
10. Boarding life	11 (4)	13 (4.7)	29 (10.5)	39 (14.2)	51 (18.5)	**132 (48)**	275

Stress Management Strategies / Coping Strategies

Results showed that most commonly practiced coping strategy was sleeping (n=321, 93.6%) followed by talking to a friend/ meeting loved ones (n=308, 89.8%). Facilities rendered by two faculties including student counselling services (n=274, 79.9%), mentoring programme (n=260, 75.8%) and career guidance services (n=238, 69.4%) were also used by considerable number of undergraduates as coping strategies **(Table 4)**. In addition to that, students have used maladaptive strategies such as using alcohol (n=178, 51.9%) and smoking (n=173,50.4%) as stress management strategies.

There were statistical significant differences among coping strategies with regard to gender, year of study, faculty and degree programme **(Table 4).**

Table 4: Association between commonly practiced stress management strategies and socio-demographic and academic characteristics of healthcare undergraduates of University of Ruhuna.

Coping Strategies	Usage of coping strategies N (%)	No. of undergraduates/ (%)			
		Gender	Year of study	Faculty	Degree Programme
Counselling from student counsellors, UOR	274 (79.9)	M – 80 (29.2)	1 – 154 (56.2)	MED – 175 (63.9)	MED – 175 (63.9)
		F – 194 (70.8)	Fi - 120 (43.8)	AHS - 99 (36.1)	PHA – 27 (9.8)
					MLS – 23 (8.4)
					NUR - 49 (17.9)
Counselling from psychologists	240 (70)	M - 75(31.2) *	1 – 134 (55.8)	MED – 153 (63.7)	MED – 153 (63.7)
		F - 165(68.8)	Fi - 106 (44.2)	AHS - 87 (36.3)	PHA – 23 (9.6)
					MLS – 18 (7.5)
					NUR - 46 (19.2)
Career Guidance Services, UOR	238 (69.4)	M -69 (29.0)	1 – 134 (56.3)	MED – 151 (63.4)	MED – 151 (63.4)
		F - 169 (71.0)	Fi - 104 (43.7)	AHS - 87 (36.6)	PHA – 24 (10.1)
					MLS – 18 (7.6)
					NUR - 45 (18.9)
Mentoring program	260 (75.8)	M - 74 (28.5)	1 – 149 (57.3)	MED – 164 (59.9)	MED – 164 (59.9)
		F - 186 (71.5)	Fi - 111 (42.7)	AHS - 96 (40.1)	PHA – 27 (10.4)
					MLS – 23 (8.8)
					NUR - 46 (20.9)
Meditation	260 (75.8)	M - 75 (28.8)	1 – 152 (58.5)	MED – 158 (60.8) *	MED – 158 (60.8) *
		F - 185 (71.2)	Fi - 108 (41.5)	AHS - 102 (39.2)	PHA – 28 (10.8)
					MLS – 26 (10)

					NUR - 48 (18.4)
Taking a walk	288 (84)	M - 79 (27.4)	1 – 165 (57.3)	MED – 181 (62.8) *	MED – 181 (62.8) *
		F - 209 (72.6)	Fi - 123 (42.7)	AHS - 107 (37.2)	PHA – 31 (10.8)
					MLS – 26 (9.0)
					NUR - 50 (17.4)
Eating	296 (86.3)	M - 79 (46.2)	1 – 171 (57.8)	MED – 185 (62.5) *	MED – 185 (62.5) *
		F - 217 (53.8)	Fi - 125 (42.2)	AHS - 111 (37.5)	PHA – 32 (10.8)
					MLS – 26 (8.8)
					NUR - 53 (17.9)
Sleeping	321 (93.6)	M - 84 (26.2)	1 – 187 (58.3)	MED – 205 (63.9) *	MED – 205 (63.9) *
		F - 237 (73.8)	Fi - 134 (41.7)	AHS - 116 (36.1)	PHA – 31 (9.7)
					MLS – 29 (9.0)
					NUR - 56 (17.4)
Aesthetics activities	280 (81.6)	M - 74 (26.4)	1 – 163 (58.2) *	MED – 173 (61.8) *	MED – 173 (61.8) *
		F - 206 (73.6)	Fi - 117 (41.8)	AHS - 107 (38.2)	PHA – 29 (10.4)
					MLS – 27 (9.6)
					NUR - 51 (18.2)
Talking to a friend/ Meeting loved one	308 (89.8)	M - 84 (27.3)	1 – 181 (58.8)	MED – 193 (62.7) *	MED – 193 (62.7) *
		F - 224 (72.7)	Fi - 127 (41.2)	AHS - 115 (37.3)	PHA – 32 (10.4)
					MLS – 28 (9.1)
					NUR - 55 (17.9)
Surfing in social media	280 (81.6)	M - 80	1 – 164	MED – 178	MED – 178

		(28.6)	(58.6)	(63.6)	(63.6)
		F - 200 (71.4)	Fi - 116 (41.4)	AHS - 102 (36.4)	PHA – 25 (8.9)
					MLS – 28 (10.0)
					NUR - 49 (17.5)
Watching T.V., films	289 (84.3)	M - 79 (27.3)	1 – 162 (56.1)	MED – 179 (61.9) *	MED – 179 (61.9) *
		F - 210 (72.7)	Fi - 127 (43.9)	AHS - 110 (38.1)	PHA – 27 (9.3)
					MLS – 29 (10.0)
					NUR - 54 (18.7)

**p*<0.05, *M–Male, F-Female, 1-First year, Fi-Final year, MED-Medical Faculty/MBBS Degree Program, AHS-Allied Health Science Faculty, PHA-Pharm, MLS-B.MLS, NUR-BSc. Nursing.*

Discussion

Stress is a global phenomenon and it has become an important issue in a variety of social, employment and academic settings [26]. University is a stressful time for many students because they have a process of adopting to new educational and social environments. It may cause a psychological, academic and social shock to students because of the huge differences in the educational system. Researchers have documented the prevalence of stress to be high among university students and this is even worse among healthcare professional students [5]. Because of all these, stress management has become a more important issue in order to cope up with stress and to bring out higher academic achievements and to balance the social life as well. The study findings suggested that almost all participants (98.8%) were affected by stress. similarly, studies conducted in Universities in Sri Lanka, Uganda and Saudi Arabia reported that relatively high stress prevalence were observed among undergraduates [5-6, 20-22]. Academic curriculum (97.6 %) is found as the most common type of stressor perceived by study participants followed by exam timetable (96.3%), exams (95.8%) and academic timetable (94.8%). Similarly, some studies have shown that academic curriculum, performance in examinations, workload, lack of time for recreation, competition with fellow students are very stressful for healthcare undergraduates [4, 20]. A study also reported that perceived high expectations from parents was the most stressful factor for both third year and fourth year medical students [4].

The current study suggested that, the most common coping strategy used by the study participants were sleeping (93.6%), followed by talking to a friend/ meeting loved one (89.8%) (**Table 04**). Similar finding was observed in a study carried out in Islamia University of Bahawalpur, Pakistan on the coping strategies which the students used were watching TV/movies, listening to music or taking part in other leisure time activities [23]. The current study found that the participants using alcohols and smoking as maladaptive coping strategies. Several studies also reported usage of alcohol,

smoking and illicit substances among undergraduates with lesser and higher prevalence [24, 25]. The study suggested that most of the coping strategies showed significant association with type of the faculty and degree program, but few coping strategies showed significant association with gender and year of study (**Table 04**). Similar finding was observed in a study conducted in Nepal. It has revealed that the coping strategies showed variation by GHQ-caseness, year of study, gender and parents' occupation [7]. In contrast Abasimi, et al. reported that there was no significant difference in coping strategies between male and female students [26].

The findings of the present study also suggested that the frequency of the usage of the facilities such as counselling from student counsellors (79.9%), career guidance services (69.4%) and mentoring program (75.8%) rendered by the University of Ruhuna for stress management were well acquired by the participants.

Conclusions

Our findings suggested that the majority of healthcare undergraduates in university of Ruhuna were affected by stress. The present study revealed that most of students used positive stress management strategies while some students used maladaptive coping strategies. The results provided valuable information for academics in healthcare undergraduate programs and university administrators in identifying students' needs, effective strategies to reduce excessive stress and increase the utility of positive coping strategies.

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Conflict of Interests

The authors declare that there is no conflict of interest.

Ethical Approval

The ethical approval was granted by the Ethics Review Committee of Faculty of Allied Health Sciences, University of Ruhuna under the reference no: 30.05.2019:2.30.

Informed Consent

Participants were informed that data will be used for the study purpose only and that participant's identity and responses will not be revealed to any third party. Informed written consent was obtained from participants prior to administration of questionnaire.

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Original Article

LinkGenn - SEO and SEM Explorer with Free and Paid Optimum Solutions

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Abstract

Nowadays with the development of digital platforms digital marketing have been most important thing that every business needs to focus on. This study discusses the review of Search Engine Optimisation (SEO) and Search Engine Marketing (SEM) explorer with free and paid optimum solution tool which is aimed to give a better understanding about digital marketing, SEO site performance which is a must to know before going forward with digital marketing plans. Lack of knowledge in digital marketing has effect small scale to large scale business owners. This tool helps to identify their website performance speed and SEO in understandable way which suggests free and paid optimum solutions. The main purpose of this study is to get more business to LinkGenn by giving better understanding to the customer to identify websites performance problems and suggest free and paid solutions to fix it from their side or with Linkgenn, the entire project develop according to waterfall method. The finding of the study indicated how website performance affecting on digital marketing campaigns, and it uses new developed Linkgenn metrics to give ranking scores and solutions based on website results, with the pandemic lot of businesses have changed their traditional marketing pattern with digital so the site nevertheless the site need to go through web audit and analyse to identify the areas to be fixed to perform well in SEO as it's take this would be an important tool for every business to archive their sales goals with remarkable KPIs.

Keywords*: *SEO, SEM, Digital Marketing, Web performance, Website Audit

Introduction

Having a website is being important in every business and it's play vital role in digital marketing, but just having website without meeting the standards will be a negative fact when perform in digital as more users does not have any idea about website performance. This new comprehensive tool helps to understand the website performance and is all about Search engine optimization audition, it gives an all-analysed report including the features of SEO improvement suggestions, Analytics performance, tips to ranking the website and page speed scoring, mobile page loading time, score to perform Cost Per Clicks(CPC) advertising and overall grading system. Understanding website current state is bit of a critical task, at the first stage of a website as it's hard to ranking in SEO because it takes considerable time search engine algorithms to catch site data and ranking according to site performance and keywords. Many developers does not follow SEO rules when developing months. There are Paid ads but customers are aware from that knowledge in Search Engine Marketing (SEM). There are several new

metrics base on page insight results and packages will be offered by the tool after understanding the current situation of the website. There are search ads to show website in first few results but that is also based on a bid strategy and the prominence depends on the ad score.

This tool provides a help hand for new business and existing E-commerce business to get a report of their site performance including site loading speed, SEO structure of site, audit report, overall performance of the site and get a summarized report to your email, analysis report which help to identify whether the website is in a level to perform in SEO or not and according to that it helps to build up the site SEO friendly with free suggested tips. For Sri Lanka it is still a new field and lot of people does not have an idea about how to perform their brand on digital world correctly. Therefore, this tool gives main artifact of SEO about explaining each step with a user tip. There are lot of tools in SEO, but it is hard to understand the interpretation for those who does not have an idea about SEO and digital marketing. Therefore, this tool was developed to give a basic understanding about SEO and how to analyse the performance of their own website in digital world with free tips. Moreover, tool suggested plans to who does not know about SEO.

Literature Review

The purpose of this study is developing successful web site audit tool for digital marketing agency to increase brand awareness, revenue and give an understandable idea of web site performance to the customers, business is mainly catering to B2B segment.

Nicolas has shown thriving website performance using web analytics, in 2013 there were more than 500 websites worldwide [1]. It has made internet a highly competitive environment, which mandated the need of website performance in order to perform among competitors.

With emergence of 2000 analytic tools become strategist element for website optimizing, most website also use web analytics tools to make it efficient for the assessment and optimizing the website, Nicolas research aim to overview website performance and establish list of optimization actions to be implemented, to testing whether there is a positive impact on website performance, with good website performance there have been increased positive traffic and good conversion rate.

Anthony's research has shown limitation and trends in web analytics, as web popularity continues to grow and new uses of the web developed, competitiveness in websites increases and ranking decreases, with the competitiveness. It's must to optimize website performance to perform in SEO, there are many tools have been devised to help access website performance, generally those known as web metrics or indicators used to measure website performance [12].

In order to have good web traffic website performance it is must to maintain good traffic in the website otherwise it will reasoning to have higher bounce rate, Nelson Norman group research article of "How long users stay on web page" shows 45% of visitors expect to website load in less than 2 seconds [10]. Web analytics could not check prior to the web so performance only can check through.

Digital marketing is a component of marketing which utilized internet and online based digital technologies there are many ways of reaching customers in digital. Such as Content

marketing, web marketing, SEM, Email marketing, SMM and more [5].

Sarah Silvia shows the importance of digital marketing, in today's world social media and digital marketing activities are very important, it's not only for gaining revenue it also reduces the cost of marketing activities, also digital marketing can track competitive brands how they are doing their activities on digital marketing. There are many advantages of using digital marketing as it can track all the records and in the cost apparently is lower than other traditional marketing methods, with digital and social media activities, able to track people's behaviour and create a database for marketing purposes. The advertisement can be targeted directly to the specific age, gender, location, and even their shopping patterns and lifestyle. Using digital platforms, it eases to know business consumers' profiles. Assessing competitor information will also be also easier than past marketing activities [6].

Google has found more than 50% of mobile site visitors will leave if the webpage doesn't load within three seconds so that will reason to charge CPC amount and higher bounce rate and no conversions, [7] that may reasoning to decrease business revenue, [4] and SEO ranking also depends on the site audit scores.

In these days lot of people tend to do websites but that does not mean the site has optimized and well-structured Therefore, factors that are affecting with that, it is necessary to be concerned about minimal text on website for good content attention, infographic explanations rather than the text, short paragraph, use of 72dpi resolution images, think about how navigate through the page, simply the navigation, optimize design for the mobile and monitor the page load speed and reduce the loading time to lesser than 4 seconds [7].

The performance of a website is affected by many factors such as networks, server, website platform, and end user. Performance Test gives an idea of the application's response to different loads or stresses. It depends on response times, results and reliability levels that meet website performance targets. The load test describes that if more than one person asks the same data can the system retrieves the appropriate result to users or not in the allotted time [2]. A website should manage user's requests, input data, database connectivity as well as a heavy load on data. Stress tests describe how a website reacts beyond its limit. Stress testing is used to distract the main functionality of the website [5].

Proper SEO helps to enhance the visibility of website in the search engines search results, therefore well perform on SEO Adjustment on keywords, proper website indexing and ensuring the site content is unique that will help to better ranking on SEO[8]. SEM is an approach of a digital marketing, those are paid advertisements appear on search engine result pages, Keyword Bid strategy is using to rank the ad and cost[8].

When it is comes to discuss about SEO & SEM there should need to explore about organic search and paid search separately. Organic search traffic comes from the people findings business links among the search engine results there for SEO optimization influence the organic search results. Paid search traffic is assigned from visitors clicking on a link in an advertisement or sponsored listing has the business has paid for the search engine to appear at the top results.

Both organic and paid search characterize the visit originated from a click on search engines such as Google, Bing, Yahoo, etc. Organic

search provides free traffic to the business website while paid search ads are involves fee for click for the form that payment can be charged for click or conversions. By knowing the key search terms will help to decide keywords which is helping to perform on paid campaign and ranking on SEO as well.

Organic search engine marketing can be divided into two classes one is pay for performance and other once is organic search engine optimization. While organic links are better than sponsored links from a customer perspective. Google Trend is treated as a form of research because it predicts the future in volume customer generated requests.

The organic ranking of the website needs to be improved by search engine optimization, therefor must do structure whole website with SEO standards upload XML file with prioritizing the pages, key words and meta tags on relevant all pages. And it is necessary to maintain and updated good quality content on the website because it exhibits a strong positive correlation with customers value, therefore can say that a positive level of organic search. Search engine optimization can improve the quality of the search engine ranking system with satisfying its visitors [1].

Methodology

A. Planning

The primary data collected from research articles that shows there are difficulty in identifying website performance as it takes considerable amount of time and that affect on site SEO ranking.

Secondary data of what can find from other audit tools and google page insights that helps to rethink and create new matrixes for the tool in understandable manner with free and paid suggestions to optimize websites and other advertising performance.

This development of SEO & SEM free and paid explorer with free and paid solutions idea has identified with the real-world problem which is lack of knowledge in Digital marketing and SEO performance among users. It was also identified lot of people doing digital advertising just to get higher traffic to site but there are lot of factors which must be considered before that. As an example, mobile performance of the site, it may take long time to load mobile view of the website and site owner may not consider that but it's highly affects on performs in SEO and advertising because users will not wait more than 3 seconds for page to load on their 1st visit of the site. So, this tool will help to identify website performance with an audit report which has free and paid solutions.

This section discusses about the development methodologies, tools and technologies that are used to building this system.

B. Requirements gathering and analysis.

1) *Google developer Console:* Google developer console is a cloud platform which allows to build websites of any scale, application, and service in infrastructure of Google. It's not limited to that which provides android SDK tools and API documentation tool set to implement parts of apps using native code.

2) *Google API:* Google APIs are application programming interfaces which allow to communicate data with Google servers. Third party apps can use API keys to

gather data, some Google APIs can be used free of charge up to a certain level.

developing HTML5 & CSS has been used. (Google insight, 2020)

3) *JSON:* JSON has so many results of site performance, accessibility, best practice, and SEO but this development only will use understandable most important details only as this is catering to just to have a basic understanding of where their Ecommerce business or website currently in and how they need to improve that.

C. Design

This tool helps customers to understand their website current status because lot of people are moving to digital marketing as thinking it is a new trend but that trend came up base on lot of digital strategies therefore understanding where they are now and where they want to be is a must before they find a digital marketing solution this drive customers to identify how they can perform there site in SEO and CPC advertising for higher revenue, the details which collecting from the customer will be using for marketing purposes to update customers.

D. Implementation

After the gathered information through literature review and according to the waterfall model time plan, the UI/UX design was done for the resulting dashboard, API integration that uses Google Page Speed API results, and Linkgenn planed matrixed for 4G speed result, grading system, package planning and automated suggestions based on performance, solutions to improve website performance, Mobile website speed score, overall percentage

There are some APIs use from Google insight to audit websites data and the system is built using Java scripts and PHP. For front-end of performance and finally summary report with emailing facility.

This proposed website has used WordPress for the main website and package designing and for the tool. It has used programming languages and frameworks of AJAX, JS, CSS, PHP and HTML.

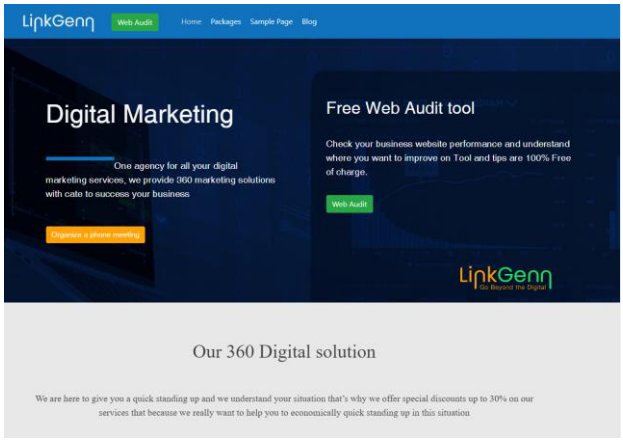

Figure 1 - Website home page

Site home page has information about the 360-digital solution, services that are offering and mainly highlighted the web audit tool.

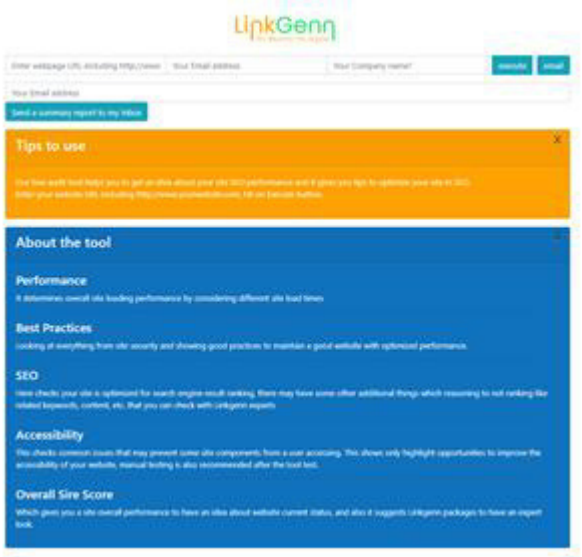

Figure 2 - Tool home page

Figure 2: in the tool home screen user must enter their website name that needs to scan email address and the company name, and it will take several minutes to load up the full report.
And provide tips as to how to use the tool and about other services.

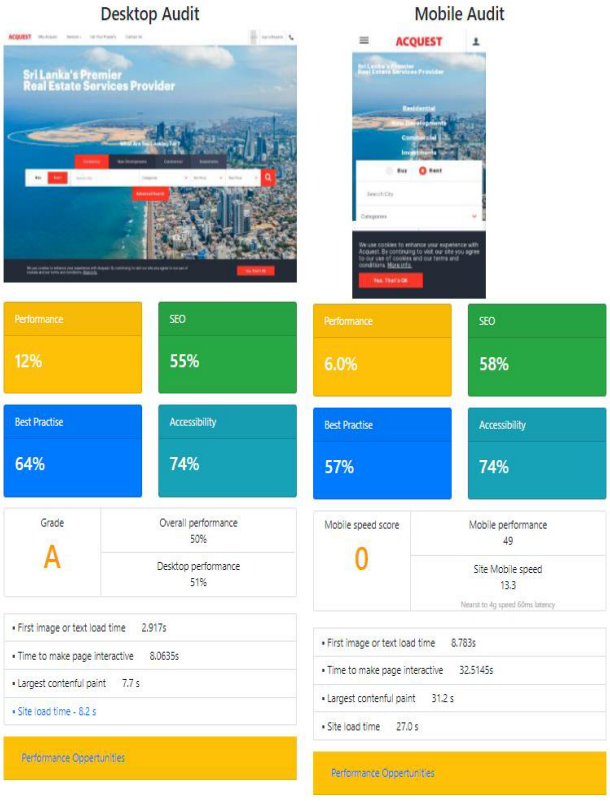

Figure 3 - Analysed audit report (acquest.lk)

The above generated report ~~it~~ shows site performance, SEO performance, best practices of website and accessibility performance. Site grading has been generated with overall score considering all those sub scores and has feature to show website performance in desktop and on mobile. Mobile speed score shows as “0” if it takes longer than 12 seconds on 4G connections, which is not good and immediately need to optimize page for higher performance.

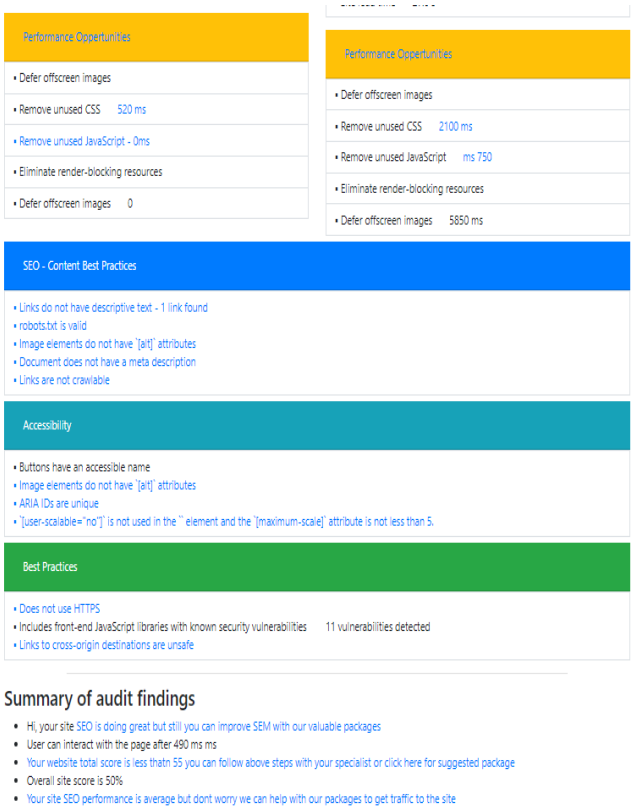

Figure 4 - Summary result with free and paid solutions

Figure 4: shows the suggestions that needs to be done for the optimization of the website for higher score.
Summary section gives you a brief understanding about overall performance and it suggest recomandaded packages to optimize the website.

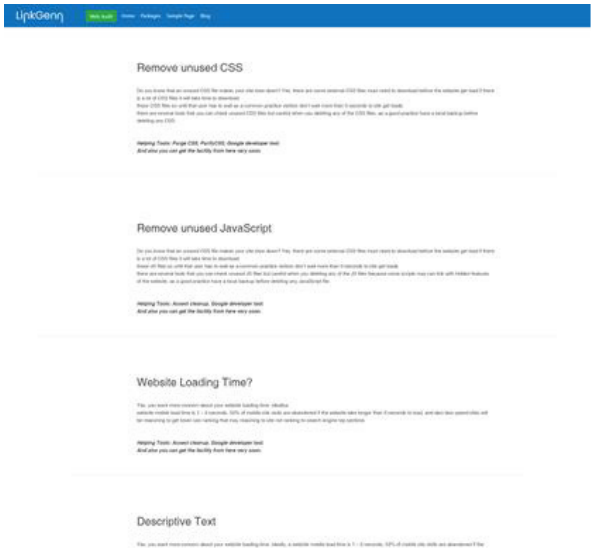

Figure 5 - Free tips to increase website performance.

Figure 5: these free tips are hyperlinked with each section tips so once user click on the problem it shows the ways to fix site performance.

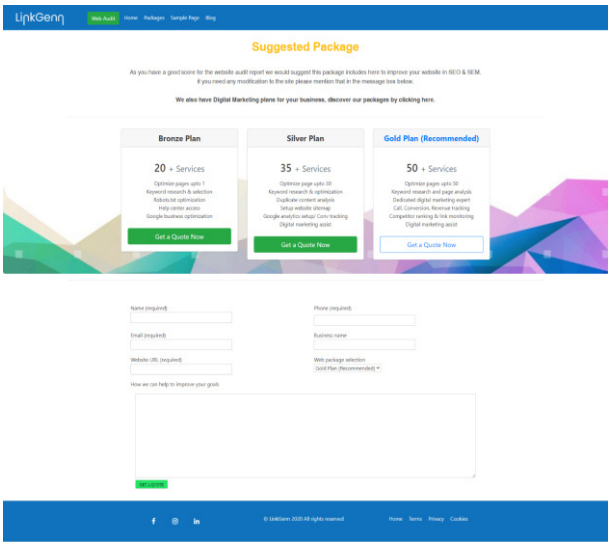

Figure 6 - Package suggestions base on performance

Figure 6: System suggested packages based on site performance, it shows the recommended package. Based on the website performance user can select the package and also they can inquire based on their custom requirement.

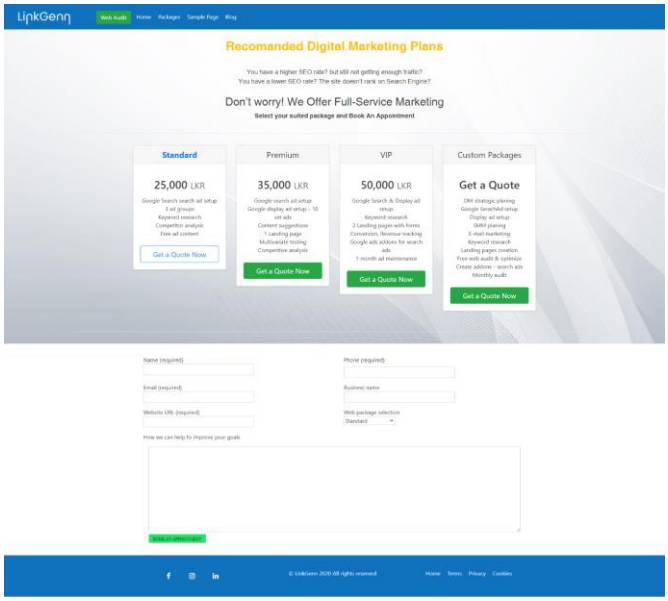

Figure 7 - Digital marketing packages

Figure 7: Shows the digital marketing packages. Those are paid and CPC ads packages, user can select that also based on their requirement and tool suggest which package is more suitable for the website.

E. Testing

This has gone through several test paces to make matrix values, scores, and grading to confirm with several industry digital marketers and about the suited package selection.

Results and Discussion

This tool intends website speed and performance, and the generating results that helps to have an idea about their entire website, which will also help digital marketing and web developing industry to analyse their website before finishing up their projects or digital marketing campaigns, which also generates a brief result report with a summary that will be sent to their email.

The tool is live on www.linkgenn.com and able to check any website providing the website link.

Conclusion

According to the identified problem with digital marketing, this invented solution for any scale of business, who starting their business on digital with own website but who does not have knowledge in SEO, SEM, site speed, page structure, HTML tags, page load time, robot.txt validation, indexing problems and overall performance.~~,~~ This tool helps to identify website/ landing page performance and find solution for errors which will help to have a successful the digital strategy.

This developed tool identified those technical factors and provided a simple overview of their website before going forward with paid packages.

Ranking in SEO decide on several factors but main considerable factor is site speed, best practices of site, descriptive text, robots.txt file which is help to crawl pages on their website, alt tags, page descriptions, crawlable links, buttons do not have accessible name, image alt tags, user scalable options, HTTPS. All these factors will be considered when SEO ranking. This tools checks all of these factors and give a proper report with the site current situation in a manner which is understandable to any user, by simply clicking on the suggestion it directing to full detailed page of selection which has more details to understand what exactly it's about and way to fix it.

The tool generates scores for website desktop and mobile view performance in site overall speed, SEO, best practice and accessibility if any of score are showing rates in lesser than 60%, those require to be improved with suggestions and score in lesser than 50% it might need to check the website with suggested solutions and fix immediately to perform the site.

The tool summary of audit findings shows the site health and overall score it tells if the site overall score is lesser than 50% it tells the site overall performance is very low and suggested paid packages to fix it and it shows free solutions to fix the problem but the expert will only be able to make those changes. Also user can send a summary report to their emails which can be shared with website developer to fix issues if there any, and also suggest some other packages to search engine marketing and social media marketing to increase site traffics, all those links are hyperlinked with each summary points.

Finally, this tool development is success on giving understanding of their websites before starting a digital campaign which helps in understanding a fact why they need to move on with paid advertising where the current site performance is, what are the goals and KPIs that they need to achieve through the campaigns. Usually, only experts consider those factors but LinkGenn, the new invented tool gives understanding to the first who does not have better knowledge in digital marketing performance in SEO, SEM, site performance and traffic generation.

This is not limited to tool it also updates with LinkGenn blog posts and link referrals to gain more organic traffic to LinkGenn website and the tool.

Future implementation

There are many recommendations for this same tool to improve it with many more features like adding user login to track their website performance with save feature so user can mark everything once there done with the suggested changes so do not miss any suggestions that need to be fix.

Also, it can add keyword tool to the same for suggest better matching and performing keywords to the website which has to do separate research base on keywords performing in each industry, so the user have to enter the business industry related to which category. So the tool checks the industry ranking keywords from the system data set and shows higher performing keywords to ranking in SEO but it is only limited to 3 for advertising with search ads for adding more keywords it may also suggest Google search ads packages with the starting packages. Those packages can include ads setup costs, free content ad sets, etc.

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Original Article

Logistics Performance and Its Impact to the Transshipments Operations at Port of Colombo

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Abstract

Transportation services have come to be an increasingly essential part of world trade. Freight shipment movement as a part of the maritime enterprise capabilities very particular traits. For this study, the development of transshipment operations is set in the context of Logistics Indexes of impact. Researches about the outcomes on Port transshipments Operations is particularly untouched. Research will subsidize to the understanding of how Sri Lankan's Logistics Performance Indexes (LPI) influence the transshipments operations at Colombo Port. Using data gathered from Central Bank Reports, Port Annual Reports, World Bank and Questionnaire survey. There are two-analysis part, (1.) Review of the factors consider building of LPI (2.) Relationship among the transshipment operations. This study will contribute to the issues/challenges, achieving hub status barriers, what are the possible solutions to overcome will discuss, and reviewing too. For this using factor analysis, validity, etc. This research contributes to the understanding of transshipments operations in logistics context. This study will use the data from the year 2007 to 2019, because LPIs also published by World Bank every other in two years. This research will answer the research question on which of Sri Lanka's LPI has an association with Colombo Port transshipments operations. Moreover, which LPI have the greatest impact, to what operations enhancements in logistics performance effect on transshipments of Port of Colombo, issues/challenges, and logistics related barriers and possible solutions. The research question is answered using hypotheses, using Pearson's correlation, regarding Sri Lanka's Customs, Infrastructure, Logistics quality & Competence, Tracking & Tracing, Timelines and International Shipments. The data analyzed using a linear regression model and the analysis will reveal the influence of the LPIs that are explanatory for Colombo Port transshipments operations. Through the analysis it was found that for transshipments operations, all the hypotheses, except the hypotheses related to Customs and Timelines were excluded from analysis, which means that transshipments operations, there is a linear association with the identified LPIs except for Customs and Timelines.

Therefore, the main objective of this research is to identify which LPI and affect the operations at transshipment operations handled at Colombo Port. Other objectives include – Identifying issues in enhancing Transshipment's operations in port of Colombo, Identifying the LPI indexes related to the logistics related respondents and Identifying the issues/challenges, logistics

related barriers in order to achieve hub status and possible solutions to overcome these problems.

Keywords: Logistics Performance, Transshipment's Operations, issues/challenges, barriers, solutions.

Introduction

In this layout of the marine sector advancement, the transshipments and logistics performance of Sri Lanka connected with the improbable eagerly of the Port of Colombo due to Logistics has become a vital measurement within the field of worldwide exchange with later universal changes. In addition, this chapter present problem statement objectives, questions and significance of the study, scope and structure of the study. In this study background, study divided into four parts, which is Seaports, Port of Colombo, Logistics Performance Indexes (LPI) & Transshipment Operations. A seaport may be an advanced system that consists of the various interacting elements, which are captivate with many random elements. Port offerings might be a derived call for from import, export and transshipment, it solely takes place due to the interplay between individuals or sectors inside the economy or across countries who exchange merchandise, which be made and consumed at unique geographic places. Furthermore, it has recommended as a Colombo Port as a major Multi Country Consolidation hub due to geographical location (Gajanayaka & Mudunkotuwa, 2015). The port is tremendously sizable as the Colombo International Container Terminals (CICT) is the most effective deep-water terminal in South Asia that is able to handle the biggest vessels and extra shipments. With three operational terminals instead of the single terminal operator in each Singapore and Dubai, the Colombo port has a collective hooked up capacity of over 7 million TEU[1]s implements in December 2018. Sri Lanka has four primary seaports, particularly: Colombo Port, Galle Port, Hambantota Port, and Trincomalee Port. Colombo Port amongst others is the largest and handled 94.84 % of shipment in 2017. Due to the fact Sri Lanka is that the totally land mass extending out into the Indian Ocean between the Arabian and Malayan peninsulas additionally as being handiest six to ten transportation miles some distance from one amongst the busiest East-West shipping routes. It provides land a locational gain as soon as developing as a maritime hub (Sri Lankan Ports Authority, 2018) Transshipment centers encourage global shipping as an center of the street intention by changing shipment from bulky vessels to minor vessels and vice versa, and serve the enduring ports of purpose or any other transshipments port. Transshipment hubs facilitate global delivery as an intermediate vacation spot by means of transferring cargo from large vessels to smaller vessels, and serve the previous ports of end or any other transshipments port. Arvis, et al., (2016), year from 2007, the arena World Bank distributes LPI[2] for each different a long time. The six parameters of LPI can be classified into bunches. The primary three relate to route and considered as contributions to supply chain. The instant three components are associated with performance effects.

Inputs of supply chain:

- Customs: The output and adequacy of the tradition readiness technique are measured through pace, straightforwardness and consistency of traditions corporations

[1] **Twenty Footer Equivalent Units**
[2] **Logistics Performance** Indexes

- Infrastructure: The best of the country is shipping and broadcast communications framework measured under this difficulty.
- Logistics quality and competence: It measures how positive parties give best logistics administrations to clients and optimize the relationship between groups and clients.

Outputs of supply chain:

- Tracking and Tracing: It measures the following and following of shipments. Following alludes to spotting the appropriate region and the course of each dispatch as a good deal as its conveyance to the conclusion consumer.
- Timeliness: The promptness of cargo conveyance times measured thru convenience. The delays of shipments influence unfavorably on the prevailing tall level of opposition.
- International shipments: It measures how easy it is to set up shipments at competitive prices.

Literature Review

The classical assumption such as the hypothesis of emergence supply mileage, shipment tracking: traceability of the shipments, international transport: competitive pricing in loading and a few present – day assumptions taken to clarify. Under the second part review, the studies on causal flows from LPI to transshipments and its components reviewed from the view of trade facilitation through a macro to micro perspective. In addition, the key concepts of hypotheses taken beneath the think about will give an establishment for planning questions within the logistics overview and triangulating the experimental discoveries. The World Bank LPI summarizes the performance of nations on six dimensions or indexes, which might be customs, infrastructure, international shipments, logistics quality and competence, tracking and tracing and timeliness. The index makes an essential statistical contribution by means of setting up a harmonized scale of all of the nations a good way to become aware of the problems faced by using bilateral trade, together with their necessities in terms of logistics related from the present facilities (World Bank, 2018). It has helped growth consciousness of the difficulty, establishes priorities for reform and improve public-personal communicate, and promotes trade and shipping in extraordinary nations. Until 2005, the ones responsible did no longer have enough records to been had to them to make comparisons and perceive limitations to trade, and accordingly the LPI is a key device that explains the relationship between trade and shipping facilitations (Desarrollo, 2010). The World Bank has published this index for years Arvis, et al., (2007) ranking 150 countries and presenting an in depth clarification of logistic overall performance of those nations. The first edition depicts records compiled in 2005 and published in 2007, the second one incorporates statistics processed between 2008 and 2009 and published in 2010 and the modern day version refers to records for 2010 that was published in 2012. The index makes an essential statistical contribution by means of setting up a harmonized scale of all of the nations a good way to become aware of the problems faced by using bilateral trade, together with their necessities in terms of logistics related from the present facilities. It is a strong aggregate of numerous dimensions from a global attitude and is constructed using well-known econometric strategies to maximize significance and improve self-assurance levels.

Methodology

Sampling bias may be minimizing through enhancing the accuracy of the acquired data with the aid of using valid resources to gather the desired statistics. This research based totally on quantitative statistics, which has been collect through primary and secondary information sources. First of all, the conceptual show of the entire reflect on consideration on supplied with the foundation of the shape of the whole proposition. This methodology chapter will focus on the strategies and processes a good way to be used to emerge as privy to the connection among the country's LPI, Logistics typical overall performance Indexes (independent variables) and Transshipment Operations at Colombo Port (established/ dependent variable). This is turned into planning to be try through using facts set comprising of different secondary statistics and primary data sources bringing up to a go-location examination for analyzing the improvements inner a time define from 2007 to 2019

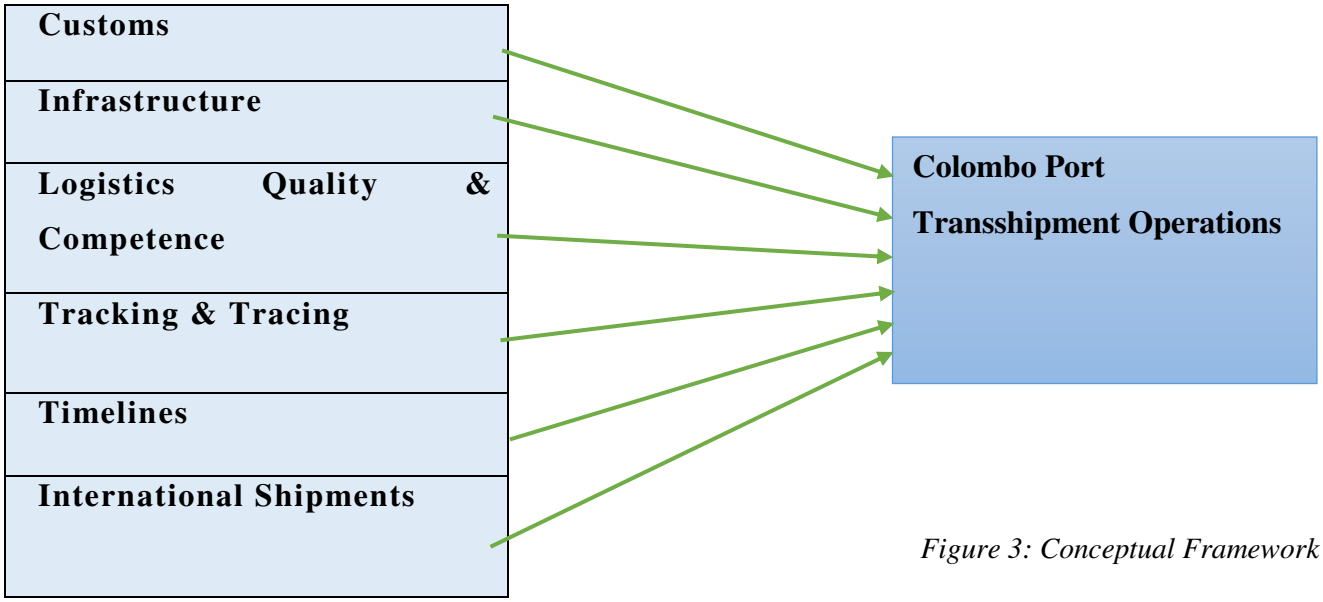

Figure 3: Conceptual Framework

Data Analysis and Discussion

In this using primary and secondary data for the analysis. Firstly, using questionnaire data as a primary data for the analysis Review of the factors consider building of LPI, and using secondary data find Relationship among the transshipment operations.

In primary data analysis, essentially, it was felt that participants had been reluctant to respond revealing their identification due to the fact many questions were addressed problems of government rules and strategies of government corporations. This phase presents a qualitative analysis via the outcomes of logistics survey, which changed into carried out to analyze the status of logistics performance of Sri Lanka. Only 271 population under that using stratified sampling method 160 participants were target as the sample to the answer questionnaire survey via email. Consequently, only one hundred and forty (140) participants responded and among them are Senior Executives 47.14%, Country Manager 24.29%, Department Manager 18.57%, Supervisors and Other (Junior Executives) 2.86%. Over half of those responded, 37% represented Freight Forwarding/NVOCC operating Business firms, whereas 34% respondents were shipping agents. The 22% of responses from manufacturer/importer/exporter were report. Organizational level and, the cargo of your company is mainly transport by. Only 72 respondents are Country Branch Office, 30 respondents from Local Branch Office, 22 respondents from Headquarters and only 16 respondents from Independents Firms.

In following graph shows the descriptive statistics of the variables,

Table 2: Descriptive Statistics

Variable	Mean	Standard Deviation
Time for Trade	2.05	0.984
Cost of Trade	4.04	0.808
Quality of infrastructure	4.15	0.885
Efficiency of customs clearance process	1.94	0.883

According to Issues/challenges of Sri Lanka logistics performance, major logistics related barriers; possible solutions to Sri Lanka's logistics performance challenges are accept level.

Below two hypotheses are defined for Bartlett test for above three factors, Cronbach's Alpha method used to find out the reliability of the data set and it was found above the accepted value 0.6.Hence data set can be accepted as a reliable data set. KMO value for the data set was accepted which is greater than the 0.6. It is the recommended value for the test and exceeding 0.6 shows an adequate sample in the study ((Gamachchige & Mudunkotuwa, 2017).

H_0: Correlation metrics is an identity matrix.

H_1: Correlation metrics is not an identity matrix.

Table 6: Factor Reduction Summary

1) Issues/challenges of Sri Lanka Logistics Performance	Main Issues and Challenges	Poor Quality infrastructure Government regulations/restrictions Issues of Inland Transportation causes to delays & high costs Technology barriers/Lack of usage
	Other/ Environmental Issues	Criminal activities(stealing/corruptions) Informal Payments
2) Possible Solutions to Sri Lanka's Logistics Performance Challenges	Government based solutions	Infrastructure development (Port, Air, Road, Rail & Warehouse) Trade friendly regulations & policy cohesion Development of Inland Transportation
	Activity based solutions	Automation of Logistics industry with reengineering & restructuring systems
3) Possible Solutions to Sri Lanka's Logistics Performance Challenges	Government based solutions	Infrastructure development (Port, Air, Road, Rail & Warehouse) Trade friendly regulations & policy cohesion Development of Inland Transportation
	Activity based solutions	Automation of Logistics industry with reengineering & restructuring systems

Discussion, Limitations and Conclusion

Among the above – mentioned significant factors, Infrastructure, Logistics quality & Competence, Tracking & Tracing and International Shipments for the enhancement at the Transshipments Operations at Port of Colombo. The study examines the impact of Sri Lankan's Logistics Performance Indexes (LPI) on transshipments operations at Port of Colombo. This data and variables used to develop regression models to help identify the significant logistics indexes, which affect Transshipment operations at Colombo Port. The operations project will assist Colombo Port to stay in advance of the demand curve, this is crucial not only for the port's operations, but also for the survival of Colombo Port as a transshipments port. All with all of this, the intention turned into to create a transshipments hub in Sri Lanka could require proper transshipments forecasts in order that Colombo Port can be geared up to deal with upcoming demand, particularly whilst designing the expansion project. Therefore, studies carried out in this research area became not effortlessly to be had or accessible and hence most of the inspiration to this study changed into based on research that had been accomplished on the subject of port throughput rather than port transshipments operations. Even though there was lots of research achieved on the relationship between logistics activity and port throughput, unfortunately, there has been very little prior studies finished when it comes to LPI and transshipments operations. For this study, the data gathered through secondary sources and primary source, this done as the resources and authorization to collect the required data was not available because collecting data on LPI and port throughput is usually done through government funding and large cooperation. However, due to the fact port throughput is a broader concept than transshipments, relating to research based totally on throughput may have an effect on the manner the research on transshipments become conducted. Recommended to read "The Colombo Port Vol I and II written by Prof. K. Dharmasena."

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Original Article

Macroeconomic Performance and its Impact to Container Throughput at Port of Colombo

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Abstract

Services for freight transport have become an increasingly important aspect of global trade. The transport of freight cargo as a result of the shipping industry has very unique characteristics. The creation of container throughput volumes for this research is described in the sense of macro-economic effect variables. This research will lead to the understanding of how the economic variables of Sri Lanka affect the volume rate of container throughput at Port of Colombo. The study question answered using hypothesis testing using data obtained from the Department of Census and Estimates, Central Bank Reports and Port Annual Reports, and the data is evaluated using a multiple linear regression model of E-Views. There is a linear relation with the defined economic variables for container throughput capacity, except for the inflation rate. There is also a clear correlation, except for the rate of inflation, between the economic variables and all the response variables. At Colombo Port, the Number of Imports & Exports of Sri Lanka were the most explanatory variables for container throughput ratios, where it is seen that Number of exports has a greater effect compared to the other macro-economic variables. In a more macroeconomic context, this analysis adds to the interpretation of container throughput volume trends. Further studies should concentrate on the evolution of broader datasets.

Keywords: Colombo Port, Container Throughput Volume, Macro-economic Variables, Economic Impact, Multiple Linear Regression Model (E-Views)

Introduction

Efficient logistics management and the full use of available services to increase container throughput performance are the key objectives of any port. Growing the port throughput capacity, which is mentioned, is also contributing to sustaining the economy of the country positively. At the centre of commercial activity, ports have always been. It is primarily dependent on the quantity of port throughput over a given span of time. Port throughput is known as the average amount of cargo containers that may move through a port on a regular basis when a ship is loaded into the port or discharged from the ship for clearance. Throughput is commonly expressed in tons of measurements.

Sri Lankan macro-economic factors mostly affecting to the container throughput

volumes at Colombo Port. In this research mainly focusing on analysing the most affective macro-economic factor which are identified by literatures (Jung (2011) Hao & Xiaohong (2008) , Inland Navigation Market, (2017)) the to the container throughput volume and the relationship between all the macro economic variables and container throughputs at Colombo Port. After analysing the macroeconomic factors, the ports throughput, it can provide information to both private sector and government officers for planning & managing their future development. The results can be providing as a support for port business investment, decision making and risk control, and also can provide assistance for port enterprises or other researchers.

- Research Problem

There has no particular study on calculating container throughput at Colombo port. Therefore, this study can be refer to the future researches with the relevant information.

- Objectives

✓ Primary - Identifying the factors and measures which impact economically on Colombo Port throughput

✓ Secondary - Determine the relationship between macro-economic variables and Colombo Port throughput levels and identifying which variable has the greatest impact on Container Throughput Level at Colombo Port.

Methodology

Augmanted dickey fuller test and Phillips Perron test will be applied in order to check the stationarity of the variables. Stationarity of the data is important for forecasting. Also checking for stationarity, unit root testing has been carried out prior to modeling. In order to make accurate predictions, unit root testing will provide guide to build the models (Mudunkotuwa, 2015)

$$\Delta Y_t = \alpha + \beta T + \gamma Y_{t-1} + \sum_{i=0}^{p} \varphi_i \Delta Y_{t-1} + \varepsilon_t$$

Yt is level and ΔYt is first difference time series. T is time in year. α is the intercept constant. β is the coefficient on the time period. γ is the coefficient presenting root. p is the lag order of first difference autoregressive process. α ,β, γ are parameters which are estimated.

The hypothesis of stationary test is as followed;

H0: variable has a unit root (non-stationary)

H1: variable has no unit root (stationary)

Co-integration is a statistical property generally applies for set of stationary series. When the observed series are stationary at the first difference, it is said to be that the series are integrated of order one. That is series are in I(1). Once a unit root has been confirmed for all data series as stationary, it is required to test whether there is any possibility for the existence of a long run equilibrium relationship among a given set of variables. In this aspect it is required to find the lag period Johansen's cointegration test is very sensitive to the choice of optimal lag length. Thereafter, the sequential modified likelihood ratio test statistics is used to select the number of lags required in the cointegration test (Mudunkotuwa & Karunaratne, 2017). Hathurusingha & Mudunkotuwa (2015) have cited that Granger Causality is a technique based on

predictions rather than causation and was developed by Prof. Clive Granger (1969) to determining the causal relationship between two variables. This concept is used to determine whether one variable can be used to predict the other and if so, what the direction of that relationship is. Ordinarily regressions mirror "mere" co-relations. According to Poof.Clive Granger's definition (1969), "a variable Y is Causal for another Variable X if knowledge of the past history of Y is useful for predicting the future state of X over above knowledge of the past history of X itself. So if the prediction of X is improved by including Y as a predictor, then Y is said to be Granger causal for X.".

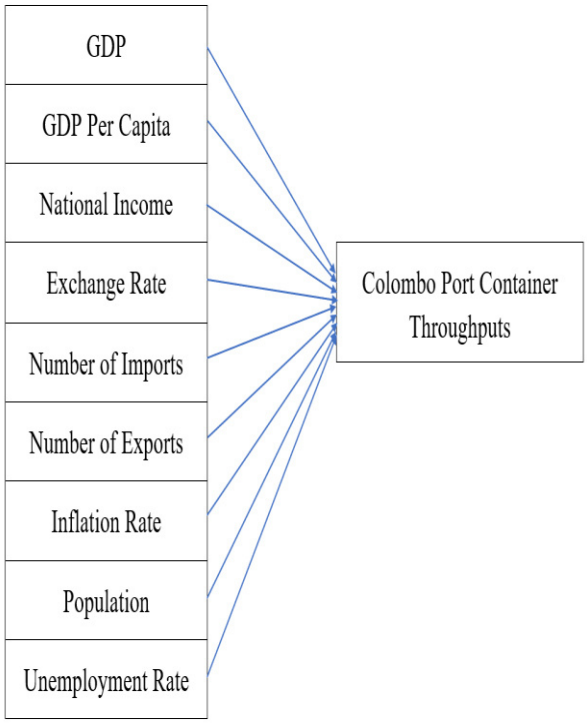

Figure 1: Conceptual Framework

Collecting data using secondary data collection method. Data from sources such as the Department of Census and Statistics, Sri Lanka Central Bank Study Publications, Port Annual Accounts, related articles, newspapers, blogs, conference papers, thesis papers, academic papers and literature books have been collected for this research. I was collected statistical data from Mr.Upul Jayatissa, who is a Managing Director at Sri Lanka Ports Authority. And refer the SLPA annual reports. For the research to be carried out, 20 years of data are gathered in order to establish the relationship between variables. Using a sample size of 20 years. The 10-year timeframe for this analysis is the period from 2000 to 2019, the most recent data available.

Data Analysis

Vector Error Correction Model

R-squared	0.584305	Mean dependent var	245373.1
Adjusted R-squared	0.435843	S.D. dependent var	323108.5
S.E. of regression	242688.0	Akaike info criterion	27.86394
Sum squared resid	3.30E+12	Schwarz criterion	28.50316
Log likelihood	-1051.762	Hannan-Quinn criter.	28.11962
F-statistic	3.935714	Durbin-Watson stat	2.124783
Prob(F-statistic)	0.000027		

According to the VECM statistic, P value is significant as the probability is 0.00027. This indicates that Vector Error Correction Model is highly valid.

Granger Causality

Null Hypothesis:	Obs	F-Statistic	Prob.
DEXCHANGE_RATE does not Granger Cause DCONTAINER_THROUGHPUTS	17	0.54897	0.5914
DGDP does not Granger Cause DCONTAINER_THROUGHPUTS	16	0.95284	0.4153
DGDP_PER_CAPITA does not Granger Cause DCONTAINER_THROUGHPUTS	16	0.49878	0.6204
DNATIONAL_INCOME does not Granger Cause DCONTAINER_THROUGHPUTS	16	1.24385	0.3258
DNUMBER_OF_EXPORTS does not Granger Cause DCONTAINER_THROUGHPUTS	17	8.63368	0.0048
DNUMBER_OF_IMPORTS does not Granger Cause DCONTAINER_THROUGHPUTS	17	15.8245	0.0004
DPOPULATION does not Granger Cause DCONTAINER_THROUGHPUTS	17	1.02841	0.3870
DUNEMPLOYMENT_RATE does not Granger Cause DCONTAINER_THROUGHPUTS	16	0.73481	0.5017
INFLATION_RATE does not Granger Cause DCONTAINER_THROUGHPUTS	17	1.50649	0.2608

According to the Granger Causality results, there are only two independent variables highly impact to the dependent variable in short run. Number of imports and exports are does not granger cause with Container Throughputs at Colombo Port. And having 0.0048 and 0.0004 significant P-Values. Therefore, it may consider those variables contribute to the container throughput volume changes.

OLS Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.013190	0.019306	-0.683218	0.5138
DEXCHANGE_RATE	-0.000226	0.001461	-0.154610	0.8810
DGDP	-0.000379	0.002911	-0.130220	0.8996
DGDP_PER_CAPITA	-1.82E-05	6.10E-05	-0.297875	0.7734
DNATIONAL_INCOME	0.002444	0.003548	0.688866	0.5104
DNUMBER_OF_EXPORTS	0.123716	0.019923	6.209734	0.0003
DNUMBER_OF_IMPORTS	-0.006114	0.006991	-0.874669	0.4072
DPOPULATION	0.038270	0.053545	0.714718	0.4951
DUNEMPLOYMENT_RATE	-0.016656	0.010626	-1.567446	0.1556
INFLATION_RATE	0.001816	0.001415	1.283111	0.2354

R-squared	0.968554	Mean dependent var	0.050511
Adjusted R-squared	0.933177	S.D. dependent var	0.088755
S.E. of regression	0.022943	Akaike info criterion	-4.411397
Sum squared resid	0.004211	Schwarz criterion	-3.916746
Log likelihood	49.70257	Hannan-Quinn criter.	-4.343191
F-statistic	27.37796	Durbin-Watson stat	1.417606
Prob(F-statistic)	0.000045		

When considering about the OLS Model Results, there is only number of exports has a significant P-value. According to that number of exports which is greatly affect to the Container Throughput of Colombo Port in short run.

Discussion of Findings

Augmented root analysis of the Dickey Fuller (ADF) unit was used in the report. As more variables at the first discrepancy are stationary, they can be cointegrated to have a long-term relationship. All theI (1) variables have also been added to assess their long-term relationship. As there are several factors, through applying the temporal disaggregation process, researchers interpolated the low frequency of annual data to the high frequency of quarterly data. The Cointegration Equation (CE) number was calculated by the Johansen Cointegration test. In the analysis, researchers established VECM by choosing four cointegration equations based on trace statistics. Therefore, overall container output has a long-term relationship with other macro-economic influences.

After evaluating long run association using VECM, used Granger Causality Test and LS Model to evaluate effect from the independent variables in short run. In Granger Causality test, can be identified two variables with the significance of P-value. Number of imports and exports have more relationship with the Container Throughput in short run association. Then run the OLS Model as well. To identify which variable has the greatest influenced to the dependent variable than granger causality

test. After analysing have identified only number of exports has a greater influenced to the Container Throughput.

Conclusion

This research explores the effect on container throughput levels at Colombo Port of the macro-economic variables of Sri Lanka. The goal is to broaden scientific awareness and add to current studies on the effect of economic factors on the level of port throughput. Research objectives are fulfilled with the VEC Model, Granger Causality Test, and OLS Model. Number of imports and exports have more relationship with the Container Throughput in short run association with granger causality while it has identified that only number of exports has a greater influenced to the Container Throughput from the OLS Model.

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Original Article

Perceptions of Sri Lankan Seafarers about the Necessity of Ratifying the Ballast Water Management Convention in Sri Lanka

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Abstract

The International Maritime Organization (IMO) developed and adopted the "International Convention for the Control and Management of Ships' Ballast Water and Sediments" (Ballast Water Management Convention or BWM Convention) in February 2004 to prevent the uptake or discharge of invasive alien species and harmful aquatic organisms and pathogens within ballast water and sediments [5]. The BWM Convention entered into force on the 08th of September 2017. In 2020, 85 countries have ratified the Convention, representing 91. 11 per cent of world merchant shipping tonnage [4]. Yet, Sri Lanka as a Flag State (FS) has still not ratified the BWM Convention [8]. This research explored the perception of the Sri Lankan seafarers about the necessity of ratifying the BWM Convention by Sri Lanka. The data for this qualitative/ quantitative study were gathered via interviews and questionnaires given to 80 merchant navy officers from both deck and engineering departments. Results of this study show that the Sri Lankan merchant navy officers bear the idea that Sri Lanka should ratify the BWM Convention as Sri Lankan waters receive ballast water from international vessels threatening the Sri Lankan marine ecosystems, economy and human health. Findings of the study revealed most of the Sri Lankan merchant navy officers have identified the need of ratifying the BWM Convention to preserve the coastal and marine environment and protect the endangered and indigenous aquatic species living in Sri Lankan waters. The respondents also viewed that Sri Lanka as a Port State (PS) should establish port reception facilities and provide training for port state control officers. Most of the merchant navy officers highlighted the need of a national policy framework strengthened by scientific research to address the issue. The financial incapacity to develop a task force and a national strategy, as well as the financial inability to develop scientific research skills and continuous monitoring & training were identified by the respondents as the main challenges to ratify the BWM Convention by Sri Lanka.

Keywords: ***Ballast Water Management Convention, Sri Lankan merchant navy officers, Sri Lankan Marine Ecosystems***

Introduction

More than 90% of the globally traded goods are transported through the ocean [8]. International trade by merchant ships has created many environmental issues threatening the marine eco-systems and organisms. One

of the major environmental threats that has caused the destruction of marine eco-systems is the improper discharge of ballast water by merchant shipping vessels.

From 1880's many vessels use water as ballast to maintain the stability and balance in sea going vessels. Ballast water is pumped into vessels to ensure safe operating conditions throughout a voyage. Ballast water reduces stress on the hull, provides transverse stability, improves propulsion and manoeuvrability, and compensates for weight changes in various cargo load levels and due to fuel and water consumption [4]. Also, vessels use water as ballast for its availability and the feasibility to load or discharge off a ship. Discharge of ballast water has been recognized as a major environmental threat as ballast water carry Invasive Aquatic Species (IAS) [6]. This mechanism has resulted in the translocation of marine species from their natural habitat to other oceans and water bodies around the world threatening marine ecosystems. It is estimated that up to 14 billion tons of ballast water are transferred globally each year, and 7,000 – 10,000 species of living organisms may be present in the ballast water at a given time [8].

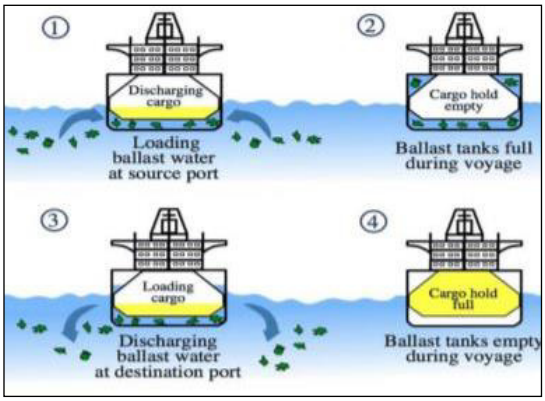

Fig. 01 The process of loading and discharging of ballast water

To reduce the likelihood of new invasions, ships are increasingly being required to manage their ballast water prior to discharge in coastal waters [1]. As a result, Marine Environment Protection Committee (MEPC) and the Maritime Safety Committee (MSC) of International Maritime Organization (IMO) have been taking actions to prevent, minimize and eliminate the threats associated with the discharge of ballast water to main water bodies. The first guidelines were adopted on 27th November 1997 by Resolution A868 (20) and were then developed as the new Ballast Water Management (BWM) Convention. The International Convention for the Control and Management of Ships' Ballast Water and Sediments was adopted in February 2004 in a Diplomatic Conference setting standards for improving BW management worldwide [8]. When a country ratifies the Convention, it will enter into force after 12 months from the date of ratification [8]. As of 2020, 85 countries have ratified or acceded to the Convention with 91.11% of the world's merchant shipping gross tonnage [4].

Many countries have ratified the BWM Convention as a precautionary measure to protect their marine environments. According to the convention, all vessels are required to manage their ballast water according to a certain standard. The BWM Convention comprises of Articles and an Annex which include requirements in the regulation of ballast water and sediments. Under the annex, Section D Standards focuses on the ballast Fig. 01 The process of loading and discharging of ballast waterwater exchange standard and a ballast water performance standard.

D1	D2	D3	D4	D5
Ballast water exchange standard	Ballast water performance standard	Approval requirements for ballast water management systems	Prototype ballast water treatment technologies	Review standards by the organization
Exchange efficiency: 95% volumetric exchange	Ships conducting BWM shall discharge <10 viable organisms per cubic meter ≥ 50 micrometres in minimum dimension.	Include systems which a) Make use of chemicals or biocides b) Make use of organisms of biological mechanisms c) Make use of organisms which alter the chemicals or physical characteristics of ballast water	Allows for ships participating in a programme approved by the administration to test and evaluate promising ballast water treatment technologies	IMO is required to review the ballast water performance standards
Ships exchanging BW by the pumping through method: 3x the volume of each ballast water tank	Ships conducting BWM shall discharge <10 viable organisms per millilitre <50 micrometres in minimum dimension		It allows promising ballast water treatment technologies to have a leeway of five years before having to comply with the requirements	The review should look into: a) Safety considerations b) Environmental acceptability: not causing more or greater environmental impacts than it solves c) Practicability: compatibility with ship design and operations d) Cost effective e) Biological effectiveness: removing or rendering inactive harmful aquatic organisms and pathogens in ballast water.
Pumping through less than three times the volume: Accepted if the ship demonstrates at least 95% volumetric exchange	Ships conducting BWM shall discharge ≥10 micrometres n minimum dimension			The review should include a) A determination of available technology to achieve the standard b) An assessment of the above-mentioned criteria c) An assessment of the socio-economic effect(s) specifically

				in relation to the developmental needs of developing countries, particularly small island developing States
	Indicator Microbes need to be a) Toxicogenic Vibrio cholerae (O1 and O139): <1 colony forming unit (cfu) per 100 millilitres or < 1 cfu per 1 gram (wet weight) zooplankton samples b) Escherichia coli <250 cfu per 100 millilitres c) Intestinal Enterococci < 100 cfu per 100 millilitres			

Table 01 Annex D Standards in Ballast Water Management Convention

The necessity of the implementation of the BWM Convention in Sri Lanka is a timely requirement. Therefore, the present study summarizes perceptions of Sri Lankan merchant navy officers about the necessity to ratify the BWM Convention in Sri Lanka.

Problem Statement

Sri Lanka is an island nation which has seven main ports including the port of Colombo, Trincomalee harbor, port of Galle, and port of Hambantota, port of Point Pedro, Kankasanthurai harbor and Oluvil harbor. Due to Sri Lanka's strategic location in the center of the Indian ocean at the crossroads of the major shipping routes, more than 4000 ships annually reach all the ports in Sri Lanka [7].

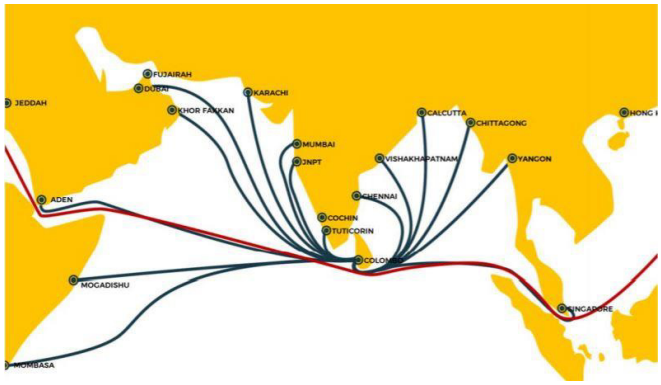

Fig. 02 Strategic location of Sri Lanka

Sri Lankan waters receive an estimated 826,600MT of ballast water annually [10]. Even though Sri Lanka has ratified certain IMO's conventions and protocols such as

MARPOL 73/78, OPRC, SOLAS and STCW, Sri Lanka as a as Flag State (FS), Port State (PS), and Coastal State (CS) has still not ratified the BWM Convention [8]. Due to the country's failure to ratify the BMW Convention, the marine environment in Sri Lanka is under a great threat as Ballast water transfer is the main reason for the spread of IAS and Harmful Aquatic Organisms and Pathogens (HAOP) in Sri Lankan waters.

Significance of the Study

This empirical study is significant for legal and policy making processes in Sri Lanka related to protection of Sri Lankan marine ecosystem. Less research has been conducted on the necessity of ratifying the BWM Convention in Sri Lanka and on the perceptions of seafarers about the need of ratifying the BWM Convention in Sri Lanka. The existing lack of knowledge and awareness about marine pollution and the destruction of marine ecosystems in Sri Lanka and the persistent necessity to plan and implement policies to protect the rich marine biodiversity in Sri Lanka is not much studied. Therefore, this research will fill the existing gap between in the necessity of protecting the marine ecosystems and the requirement of planning and implementation of legal policies to protect the marine biodiversity that is often being affected by the discharge of ballast water in Sri Lankan waters by sea-going commercial vessels. This research will also serve as a working document for policy makers and other relevant authorities when instrumenting policies and regulations to prevent "the introduction, control or eradicate IAS from entering into marine ecosystems" [9] in Sri Lankan marine environments. Furthermore, this research will also facilitate other countries who have still not ratified the BWM Convention and will provide insights into the necessity of ratifying the BWM Convention.

Aims and Objective of the Study

The main aims of this study are:

1. To highlight the importance of the ratification of BMW Convention in Sri Lanka.
2. To emphasize the necessity of ratifying the BWM Convention in Sri Lanka.

The main objectives of this study are to

1. Understand the perception of Sri Lankan seafarers about the ratification of Ballast Water Management Convention in Sri Lanka.
2. Determine the main obstacles to ratify the Ballast Water Management Convention in Sri Lanka.
3. Analyze the environmental threats that exist due to the failure of ratifying the Ballast Water Management Convention in Sri Lanka.

Methodology

Data for this qualitative/ quantitative study were gathered via an online questionnaire (Google form) with open ended questions. The questionnaire included 25 items arranged under three sub-headings. A Likert scale was constructed [2] to measure the level of agreement of seafarers in ratifying the BMW convention in Sri Lanka. These qualitative data will be converted to quantitative data using a coding system for a more accurate evaluation. The results of gathered data from the questionnaire will be analyzed through multiple representation methods such as tables, bar charts and pie charts. In addition, structured interviews were conducted by randomly selecting respondents from the determined sample. The sample of this study

consists of 80 merchant naval officers. 40 junior merchant naval officers of sea experience below 30 months and 40 senior merchant naval officers with more than 30 months of sea experience representing both engineering and deck departments were selected using random sampling technique. The overall response rate was 92 per cent. To analyze primary data that were collected from the above sample, Statistical Package for Social Sciences (SPSS) Software Package version 23 was used. To collect secondary data, the researcher has used magazines, journals, annual reports and other published and unpublished written materials collected from libraries and online sources.

Findings

According to the findings of this study, the majority of respondents are junior merchant navy officers from the engineering department. The percentage of these respondents is 28 per cent. From the respondents who belong to the deck department, 53 per cent had sea experience of more than 30 months while 47 per cent of respondents were of less than 30 months of sea experience. Out of the respondents who belong to the engineering department, 49 per cent of respondents possessed more than 30 months of sea experience and 51 per cent of respondents from the same department had less than 30 months of sea experience.

According to sample data, 79 per cent of respondents strongly have agreed with the idea that Sri Lankan marine environment should be protected. According to research data, 68 per cent of respondents have highlighted that the discharge of engine bilge water as a main method that can cause marine pollution. 65 per cent of respondents stated that the use of noxious liquid substances as a method that can result in the pollution of marine environments. 62 per cent of respondent have mentioned that the disposal of sewage as another cause of marine pollution and 63 per cent of respondents have stated that ballast tank waste as another reason for marine pollution. Emission of Ozon depleting substance was identified by 60 per cent of respondents as another main reason that causes marine pollution.

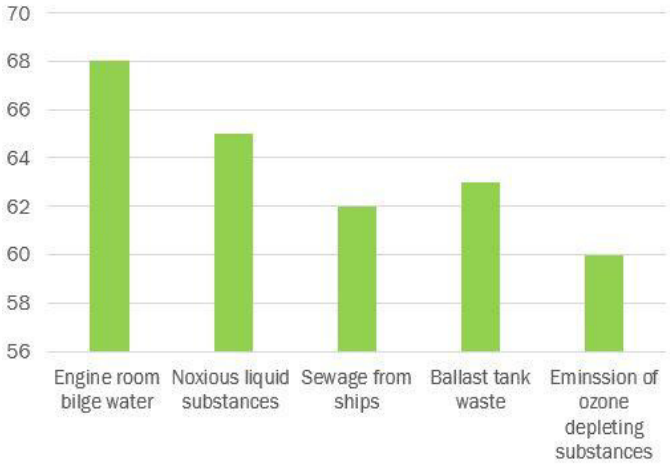

Fig. 03 Main methods of marine pollution

According to survey data, 58 per cent of respondents are not satisfied about the measures taken by the Sri Lankan government to protect the marine ecosystems in Sri Lanka.

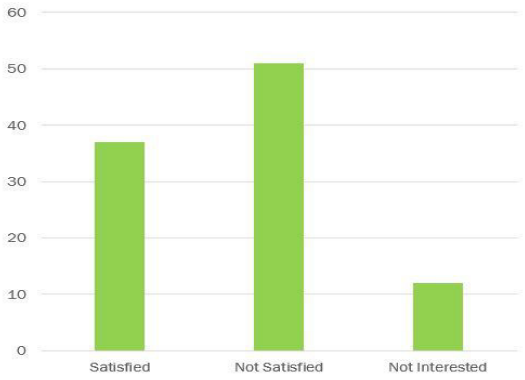

Fig. 04 Satisfactory levels of respondents about the measures taken by the Government of Sri Lanka to protect the marine environment

Furthermore, 85 per cent of the respondents are aware of the introduction of BWM Convention by IMO and 86 per cent of them have

identified the need to ratify the convention to prevent marine pollution. 92 per cent of respondents have stated that Sri Lankan marine ecosystem is in a great danger due to Sri Lanka's failure to ratify the BWM Convention. Furthermore, 73 per cent of junior merchant navy officers and 63 per cent of senior merchant navy officers believe that Sri Lanka has the ability to make the necessary preparations to ratify the BWM Convention in Sri Lanka.

Fig. 05 Attitude of senior merchant navy officers about Sri Lanka's preparedness to ratify the BWM Convention

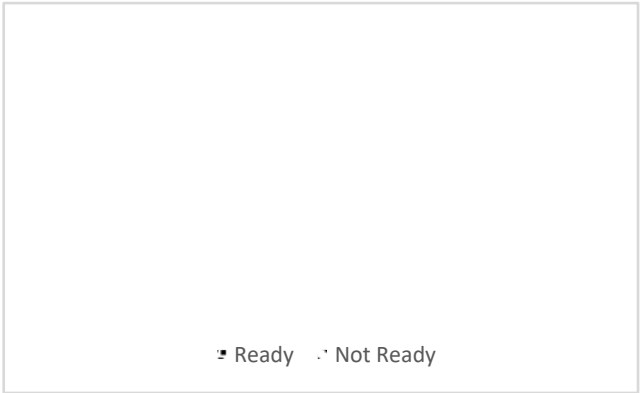

Fig. 06 Attitude of junior merchant navy officers about Sri Lanka's preparedness to ratify the BWM Convention

Many respondents believe that Sri Lanka as a FS, PS and as a CS should ratify the BWM Convention. 85 per cent stated that Sri Lanka as a FS should introduce a government legislation to ratify the BWM Convention. 83 per cent stated that certification of flag ships as another measure that should be taken by Sri Lanka before ratifying the BWM Convention. Moreover, 83 per cent of respondents highlighted the necessity of training the crew members as a main area of improvement that Sri Lankan government should introduce as a FS before ratifying the BWM Convention. 73 per cent of respondents believed that Sri Lanka as a FS should also take measures to detect violations of regulations when vessels discharge ballast water.

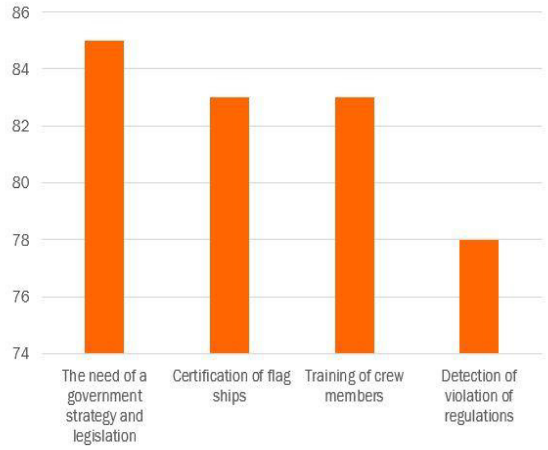

Fig. 07 The main areas of improvements that Sri Lanka should introduce as a Flag State to ratify the BWM Convention in Sri Lanka

Sri Lanka a PS should give proper training to port state control officers before ratifying the BWM Convention. 85 per cent of respondents of both senior and junior merchant navy officers believed Sri Lanka as a PS should establish sediment reception facilities and 84 per cent of respondents believed that Sri Lanka should build international corporation before ratifying the BWM Convention in Sri Lanka.

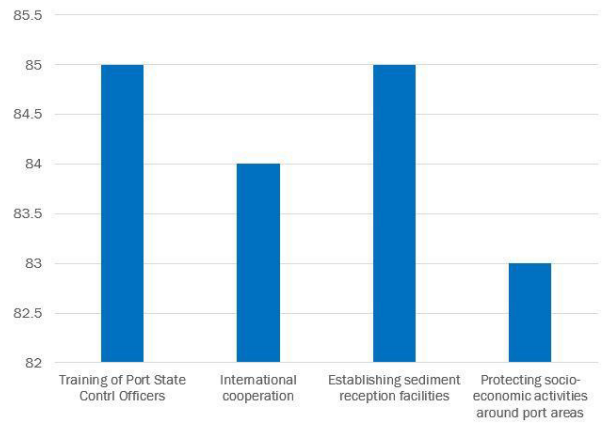

Fig. 08 The main areas of improvements that Sri Lanka should introduce as a Port State to ratify the BWM Convention in Sri Lanka

Moreover, as a CS, 87 per cent of respondents stated that Sri Lanka should take measures to develop scientific research on cost effective strategies to discharge ballast water and 85 per cent of respondents highlighted the necessity of building public awareness about the destruction of marine environment due to ballast water.

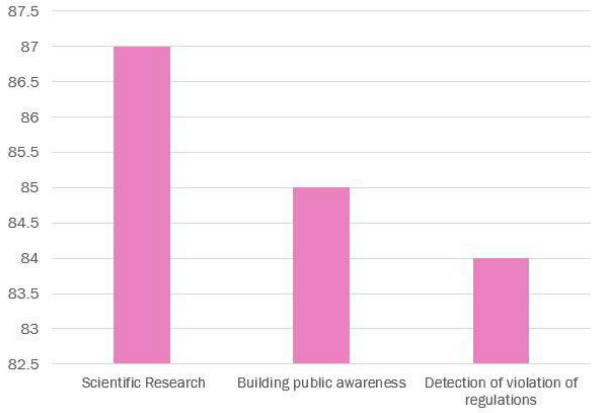

Fig. 09 The main areas of improvements that Sri Lanka should introduce as a Coastal State to ratify the BWM Convention in Sri Lanka

According to the respondents, the main obstacle to ratify the BWM Convention is the absence of a national policy. Moreover, 68 per cent of respondents believed that lack of financial strength as another obstacle to ratify the BWM Convention in Sri Lanka. 65 per cent of respondents highlighted that lack of knowledge and training as well as inadequate research and development facilities as the main difficulties to ratify the BWM Convention in Sri Lanka.

Discussion

The results obtained from this study suggest that Sri Lanka as a FS, PS and CS should take measures to ratify the BWM Convention in Sri Lanka to prevent the destruction of marine ecosystems. These perceptions of the respondents of the study reinstate what [8] has rightfully stated as, “due to high risk for the country, immediate ratification of the BWM Convention is recommended for Sri Lanka. It is clear that ballast water leads to negative externalities for the whole social-ecological system [8] and Sri Lanka, as a nation, is responsible for the ratification of the Convention.

The effects of marine pollution are enormous. As Iduk & Nitonye [3] point out marine pollution mainly occurs through oily-water discharge from ships, tanker accidents, accidental spillage during terminal loading, wastewater discharged from ships, garbage and other solid waste and ballast-water discharged from ships at ports”. Their claim is further strengthened by the perspectives of the respondents who agreed with the idea that ballast water is a main cause of marine pollution.

As a FS, PS and CS, Sri Lanka should take necessary measures to ratify the convention “as an obligation to prevent, mitigate and finally eradicate the IAS carried by the ships' Ballast Water” [8]. Sri Lanka, therefore, should implement a policy making system to mitigate

and control the effects of marine pollution caused by the discharge of ballast water. Furthermore, certification of ships and training of crew members with necessary knowledge and practical training as well as monitoring and detection of violation of

Regulations should be practiced by Sri Lanka as a FS to prevent marine pollution caused by ballast water. [8] also writes that FSs have "the authority and responsibility to enforce such laws and regulations applying to the ship as well as to prevent and sanction violations".

As a PS, when the violations have occurred by the foreign vessel in their jurisdiction causing any damage, "PS has the authority to precede investigations" [8]. Therefore, Sri Lanka as a PS should provide training to Port State Control Officers, enter into international collaborations to protect the marine ecosystems, establish sediment reception facilities in the ports and terminals. Protecting socio economic activities around the port area such as fishery is another responsibility that Sri Lanka bears as a PS that is responsible of preserving the aquatic animals and plants that can be destroyed due to invasive and harmful pathogens that are found in ballast water.

As a CS, Sri Lanka "should take all necessary measures to ensure the observation of international rules when exercising its rights and fulfilling its obligations" [8]. Moreover, Sri Lanka as a CS "should consider developing and implementing a control and monitoring program which could be part of an international management system" [8]. Accordingly, as a CS, Sri Lanka should take necessary actions to promote scientific research to protect marine ecosystems, build public awareness about preserving the marine life and conduct a risk assessment to determine the ways in which ballast water can be a harmful threat to the Sri Lankan marine ecosystem.

Conclusion and Recommendations

The findings of this study prove that there is a pressing necessity to ratify the BWM Convention is Sri Lanka. The senior and junior merchant navy officers are in agreement with the idea that Sri Lanka as a FS, PS and CS should take immediate steps to ratify the BWM Convention in Sri Lanka overcoming the main obstacles such as absence of a national policy, lack of knowledge and training given to those who are directly involved in the sector and inadequate research and development facilities. This study recommends the government to introduce a proper policy as a main initiative to ratify the BWM Convention in Sri Lanka. Moreover, the government should build international corporation in the region to obtain financial aid and gain necessary knowledge and knowhow before ratifying the BWM Convention.

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Original Article

Smart, Embedded & Effective Solution for Conventional, Small-Scale Poultry Farming System

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Abstract

In Sri Lanka, most poultry industries are still managing poultry houses using conventional methods. Thus, the manpower utilization is drastically increased due to this issue, hence, utilized manpower and efficiency is very limited. However, the consumer demand towards the poultry outcome is enhancing day-by-day. Therefore, farmers are looking for advanced technologies to maximize efficiency, productivity, and profitability while reducing the operating costs. Thus, the project is focused on developing a smart and embedded poultry farming system to monitor and control small-scale farming conditions. The integrations of the sensor network and GSM/ GPRS network is implemented to control and remotely monitor environmental parameters (temperature, humidity, and light intensity), watering system, and an egg incubator. If there are undesired variations in the above factors, the system will automatically initiate necessary actions to prevent the bad effect. Also, a warning message is sent through the GSM module to the registered mobile number. Thus, the farmer is able to notify internal changes as soon as possible. Meanwhile, the farmer is able to monitor the status via web applications and mobile applications, and owner can update threshold levels through the mobile application. The automated incubator with an egg moving mechanism is effective for small-scale farmers who are incubating a low quantity of eggs. Thus, the system will help for enhancing animal welfare, food safety, efficiency, hatchability, productivity, and profitability while reducing labor utilization and operating costs.

Keywords: Poultry farm, Incubator, Automation, Microcontroller, GSM module, Sensors

Introduction

The industrial revolution is the most popular and upcoming topic in society with the evolution of the internet. Thus, the system automation concept is one of the main parts of the industrial revolution and technological evolution [1]. And also, it has been emphasized as the future of the Internet and the future of smart technology concepts. The concept of automation is a smart system that connects nearly all internet-enabled devices via the internet to communicate data and provide different services to enhance the quality of life [2]. Hence, most manual systems are integrating with the internet and the latest technologies to provide more effective, efficient, and reliable service to society [3]. Such concepts are helping to minimize unnecessary power wastages, human

intervention, operation costs, safety risks, etc [4].

The traditional methods used in the poultry industry is resulting in low efficiency while increasing the tedious labor power and operating cost when compared to the automated systems [5]. Therefore, there is a significant degradation in poultry productivity and profitability. However, the demand for the outputs of poultry farming is increasing day by day and required advanced technologies for farming to maximize efficiency and productivity [4] [6]. Hence, it's required to implement modern technology in the agricultural and farming sector because the operation costs and human intervention, are expected to reduce considerably while efficiency can be enhanced. In contemporary agriculture, automation systems play an important role. Due to the disadvantages in traditional systems, the market competitiveness, and the hectic schedule in day-to-day life, users are looking for effective and efficient mechanisms to adapt to the latest technological developments. The above systems facilitate users to monitor and control the entire automation systems from anywhere, at any time through a mobile application or web application.

As highlighted in the above section, fully automated systems can be used to overcome high operating costs, the headcount of laborers, low productivity issues, and other conventional manual operating issues, etc. Apparently, there aren't affordable and applicable mechanisms to purchase as per their requirements, knowledge, the business procedures, and the financial status isn't sufficient to purchase in-built automated systems currently available in the market since such systems are much complicated and expensive. Thus, the available systems are suitable and used by the large-scale farming companies like "Ambewela" and "CIC" companies to maintain their market demand within the agriculture industry. Small-scale farms consist of 100 – 300 hens (maximum), and each coop contains between 40-50 hens. The stocking density of adult hens in a small poultry coop should be 8-10 birds per square meter (1m2). But in Sri Lanka, the count has increased up to 13-15 birds approximately due to landscape issues.

As per the analysis, poultry farmers are monitoring ambient temperature, relative humidity, and light intensity by postulated methods. For example, temperature of each coop should be around 35°C - 38.5°C, and it's measured manually by looking at animal behaviors and rarely using a thermometer by labors. Since the livestock behaviors are changed upon the temperature variations. For example, when the livestock showed more stressed, aggressive behavior that indicates they are suffering from high-temperature levels. And also, changes in eating and water drinking methods are due to high temperature and humidity levels. Hence, if the temperature value is higher than the optimal value, laborers are manually switched on the fans or spread water all over the coop to maintain the desired temperature and relative humidity. This process required a minimum of four laborers to complete the task. Thus, the efficiency is getting low as a negative impact. Furthermore, the feeding systems are maintained by them at the same time. Thus, the traditional processes are required 6 to 8 laborers per coop to control all these tasks, and it should be monitored at least thrice a day by two supervisors to maintain the proper conditions inside the poultry-houses.

Another key task of poultry farming is egg incubation, and it must be done under optimal temperature, relative humidity, and light

intensity by laborers or supervisors [7]. So, there are different types of egg incubators in the market, but they are so expensive and consist of high storage capacity. Since, small-scale farms are incubated between 100-150 eggs per month using conventional methods. Thus, it results in low productivity, profitability, and low market demand. On the other hand, the lack of laborers for working has directly affected efficiency and production, especially with the current pandemic situation. Furthermore, traditional mechanisms, folk wisdom about poultry management are other major obstacles that impact efficiency and poultry development [4]. These manual process increases the operating cost and negatively impact on efficiency, productivity, and profitability.

In essence, the environmental parameters and feeding process should be maintained properly during the brooding, egg incubation, and egg hatching periods. Thus, those parameters are more important for bird health, growth, metabolic process, performances. Therefore, small-scale farmers are seeking methods to survive their businesses and maintain productivity even better than before. Thus, the main intention of the project was to introduce an automated system for small-scale poultry farmers to minimize the problems identified in conventional manual operations. Therefore, the project automated main tasks of poultry farming such as controlling environmental factors, watering system, and egg incubation processes. The automated system is specifically designed for small-scale farmers who are using conventional methods to control and monitor the above-highlighted tasks currently maintained by laborers. Also, the general equilibrium theory is used for the designed prototype of 1m2 hen-house.

Research Methodology

A. Software & Hardware Description

The system is aimed to monitor, control environmental parameters and watering systems that affect the bird welfare, egg incubation, production, and performances of poultry birds. If there are unnecessary conditions in the climate in the farm it will automatically control by the developed control system. The system ensures the optimal conditions for proper growth of hens and chicks, efficient performances of birds, enhance production, and reduce human involvement. Based on the fig 1 and fig 2 the entire system is including mechanical components like water motor, bulbs, cooling fans, servo motor, etc. and some mechanical components are omitted including exhausting fan, heating fan, Peltier.

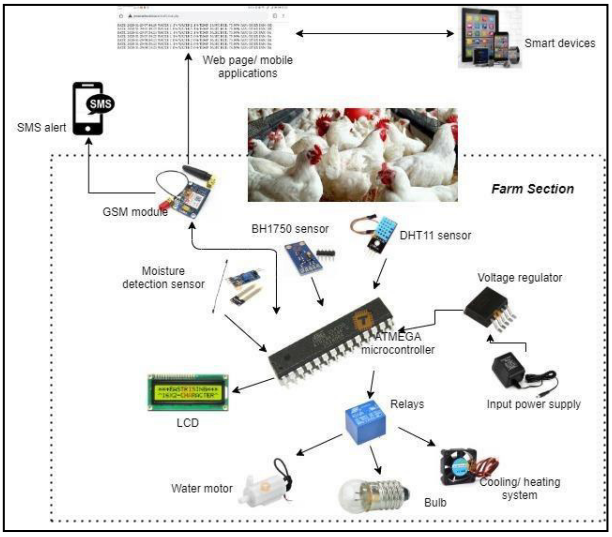


Fig 1: Conceptual Diagram for Farming section

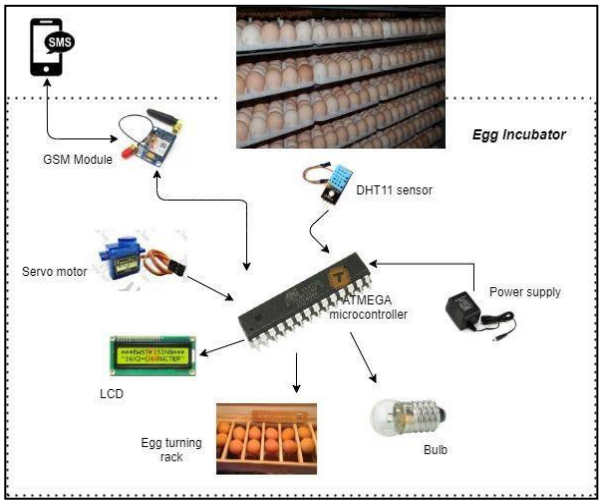


Fig 2: Conceptual Diagram for
Egg incubation section

Atmega328p-PU Microcontroller/ Arduino Pro Mini Atmega328

Atmega328p is used as the processor (microcontroller) and it's directly connected with the GSM module and communicates sensor readings with the communication module to generate the output. All input/ output modules are connected along with the microcontrollers.

Temperature & humidity sensor module

Environmental conditions directly affect animal welfare, performances, and production. Therefore, temperature, humidity are the main parameters to be considered when designing the smart farm concept. The DHT11 sensor is used to provide the required accuracy for inhouse humidity and temperature present in the atmosphere.

Light sensor module

A digital light sensor (BH1750) is used to measure light intensity especially for naked eye light called "lux". The connectable voltage range is 3–5V and can accurately measure the LUX value of light from 1-65535lux. Also, the accuracy is +/- 20%. An inbuilt A/D converter is available to convert analogy illuminance into digital data. This sensor is commonly used in the mobile phone to adjust the screen brightness depending on the environment lighting.

Moisture sensor module

The connectable voltage range of the soil moisture sensor is similar to other sensors, and the inbuilt LEDs are used to indicate outputs and power. The LM393 comparator IC is used as a voltage comparator, and it will compare the threshold voltage using the pre-sets.

Communication module

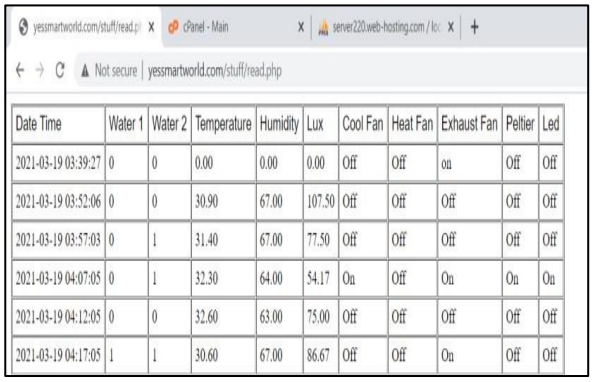
The SIM800L GSM/ GPRS module is used as the communication component. It can accomplish all the tasks done by a cell phone like making and receiving phone calls, send SMS connecting to the internet. Here, the GSM module is used to send and receive SMS messages and GPRS data. All real-time sensor readings and threshold values are updated on the system, web page, and mobile application through the GSM module. Also, the SMS message is sent to the registered mobile number to notify all variations and retrieve data from the system. Thus, the GPRM modem is the heart of the monitoring and alerting system.

Interfaces (Web & Mobile application)

Interfaces are the core of the remote monitoring module. Interfaces are used for remote monitoring and controlling tasks. The mobile application is designed using "scratch" and the database of the web applications is programmed using SQL, PHP programming languages via Cpanel. Both web and mobile applications are interconnected along with the GSM module and microcontroller.

As shown fig 3 below, the web interface is designed for remote monitoring purpose. And

the fig 4 shown the mobile application interface which is designed to achieve controlling and monitoring tasks. Thus, the farmer is able to monitor the latest status inside the farm simply via the mobile application. Also, the farmer is able to adjust the threshold levels of the defined parameters as per the bird age and the outer conditions. Also, the mobile application is facilitated to delete entire daily entries from the web interface.



Date Time	Water 1	Water 2	Temperature	Humidity	Lux	Cool Fan	Heat Fan	Exhaust Fan	Peltier	Led
2021-03-19 03:39:27	0	0	0.00	0.00	0.00	Off	Off	on	Off	Off
2021-03-19 03:52:06	0	0	30.90	67.00	107.50	Off	Off	Off	Off	Off
2021-03-19 03:57:03	0	1	31.40	67.00	77.50	Off	Off	Off	Off	Off
2021-03-19 04:07:05	0	1	32.30	64.00	54.17	On	Off	On	On	On
2021-03-19 04:12:05	0	0	32.60	63.00	75.00	Off	Off	Off	Off	Off
2021-03-19 04:17:05	1	1	30.60	67.00	86.67	Off	Off	On	Off	Off

Fig 3: Web interface

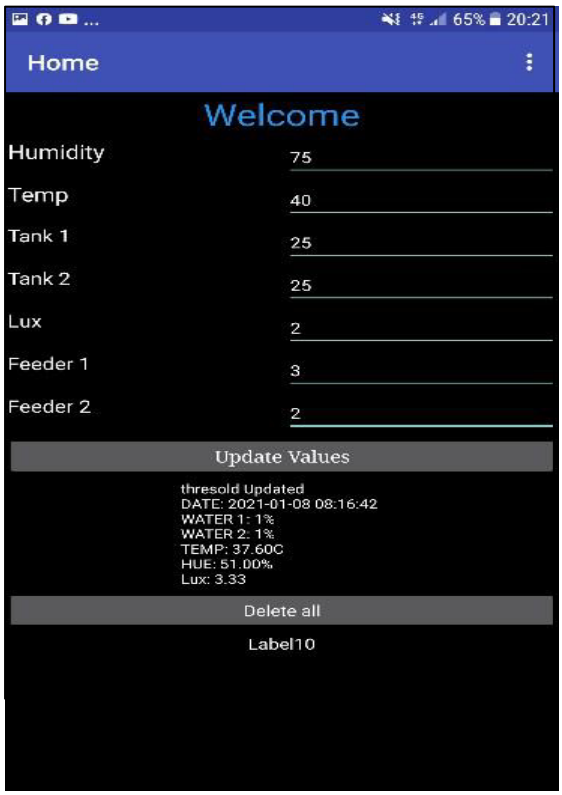


Fig 4: Interface of the mobile Application

B. System Designing

I. Block Diagrams

As shown in fig 5 and fig 6 the designed system is divided into control, alert module, and monitoring module. Both modules have consisted of four main parts; power supply, input components, output components, and communication module.

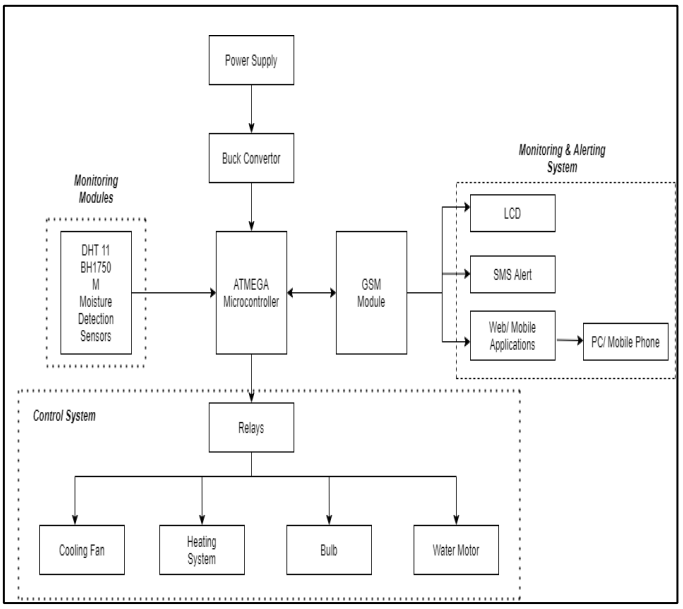


Fig 5: Detailed architecture for the Farming section

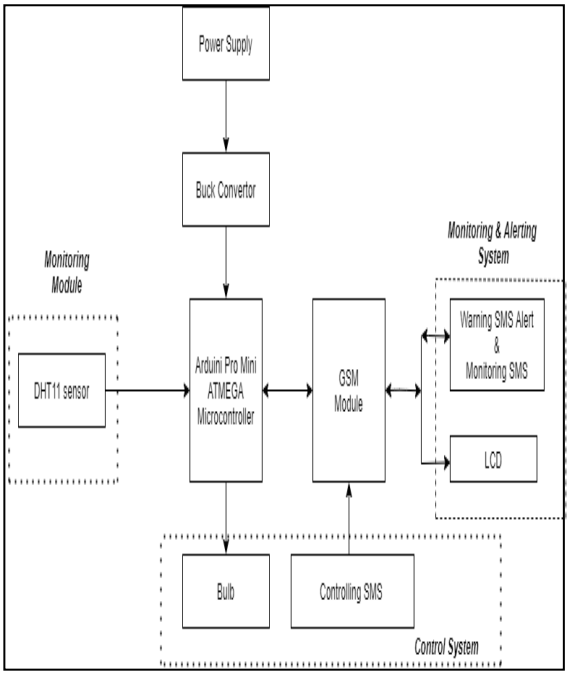


Fig 6: Detailed architecture for the Egg incubator

The Atmega328p microcontroller is the core of the control and monitoring systems that are driven and measured by environmental parameters, watering process, and an incubator. As shown in fig 7 and 8, input components and the communication module are directly connected along with the microcontroller, and the output components are linked to the processor over relay module and transistors. DHT1, BH1750, moisture detection sensors are used to read and collect data in the chicken-coop. The supply voltage of 12V is regulated (step down up to 5V) through the voltage regulator (buck converter) and supply to the microcontroller, sensors, and the GSM module. The Peltier thermoelectric cooler kit is connected to the microcontroller through the relay module. And also, the cooling system, exhausting fan, light, and motors are connected to the microcontroller through the IRFZ44N transistors. Here the relay and transistors are acting as a switch as well as a shield to protect the microcontroller from high voltages. Since the input voltage is 240V and 12V is used by the controlling units. In the egg incubator, the DHT11 sensor, bulb, a servo motor is connected same as the farming section. The fig 7 and fig 8 shown the block diagrams for both areas

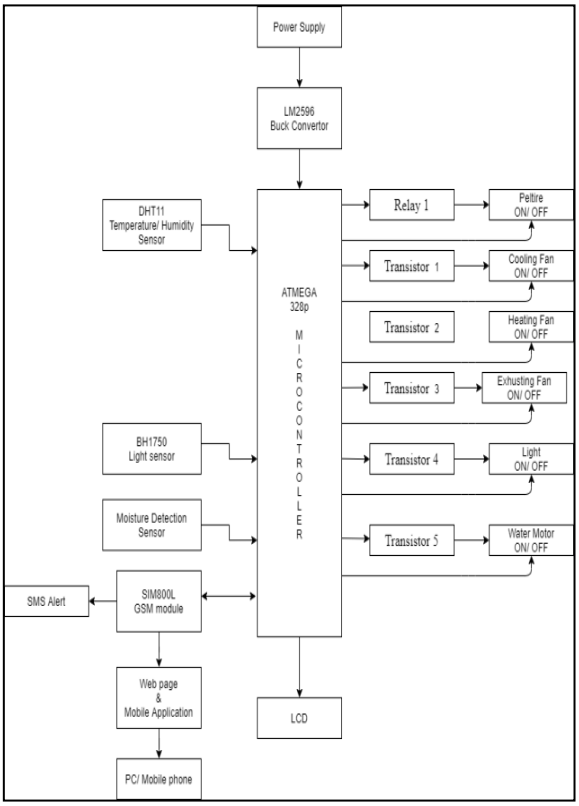


Fig 7 – Block diagram of the farming section

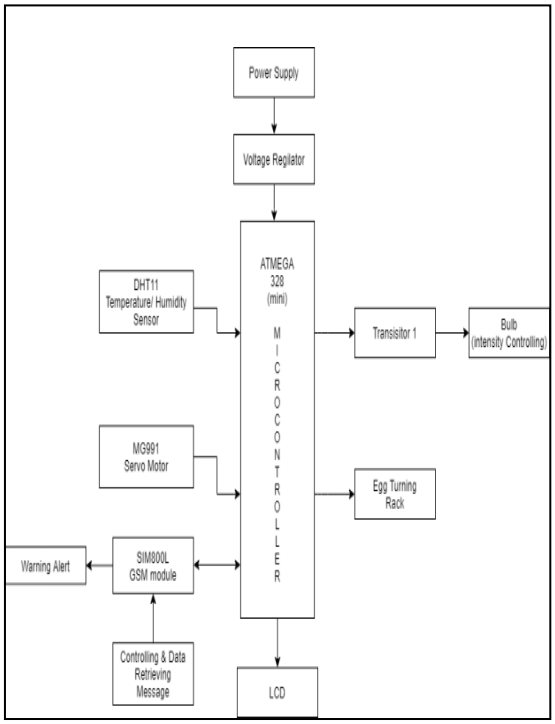


Fig 8 – Block diagram of the incubator

II. Flow Diagrams

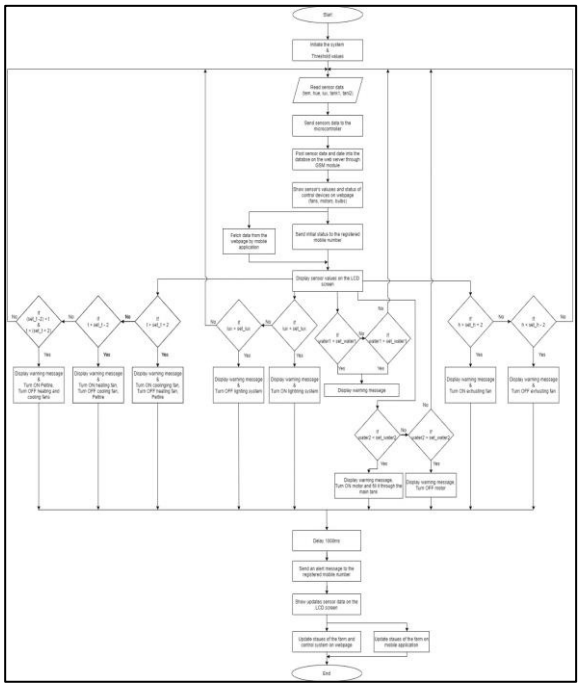


Fig 9: Flow diagram of device Operation

The operational flow chart for the farming section is shown in fig 9. The system is read environmental parameters of the poultry house, water levels, and egg incubation process using Atmega microcontroller and various sensors. The system is developed to check temperature, humidity, light intensity, and water levels to maintain the optimal conditions. The system is programmed to check sensor readings every 5 minutes since the high/ low water levels, temperature, and humidity variations can happen within the day. Also, the read data will be updated on the web interface and mobile application for every five minutes. The microcontroller will decide to switch the relevant relay and transistors to power up either the cooling fan or heating system to provide the required weather condition depending on the temperature readings. The humidity variations are controlled through the exhausting fan system. If the sensor detects a high humidity range, the exhausting fan is automatically activated through the microcontroller to maintain the optimal humidity range. The bulb is operated upon the light sensor readings, and the microcontroller will take necessary actions to manage the conditions respectively. When the sub-tank or the water container level goes below the threshold level, it will refill through the main tank by following the same process. If there are no variations in the sensor readings (not surpass the max & min threshold levels), the system will automatically recheck the sensor reading at the definite time. In the meantime, the communication module will be activated and send a warning message and a response message to verify the changes as well as taken actions by the system and current statuses. Furthermore, all sensor reading and current status of the poultry-house are displayed on the

LCD screen, website, and mobile application for remote monitoring.

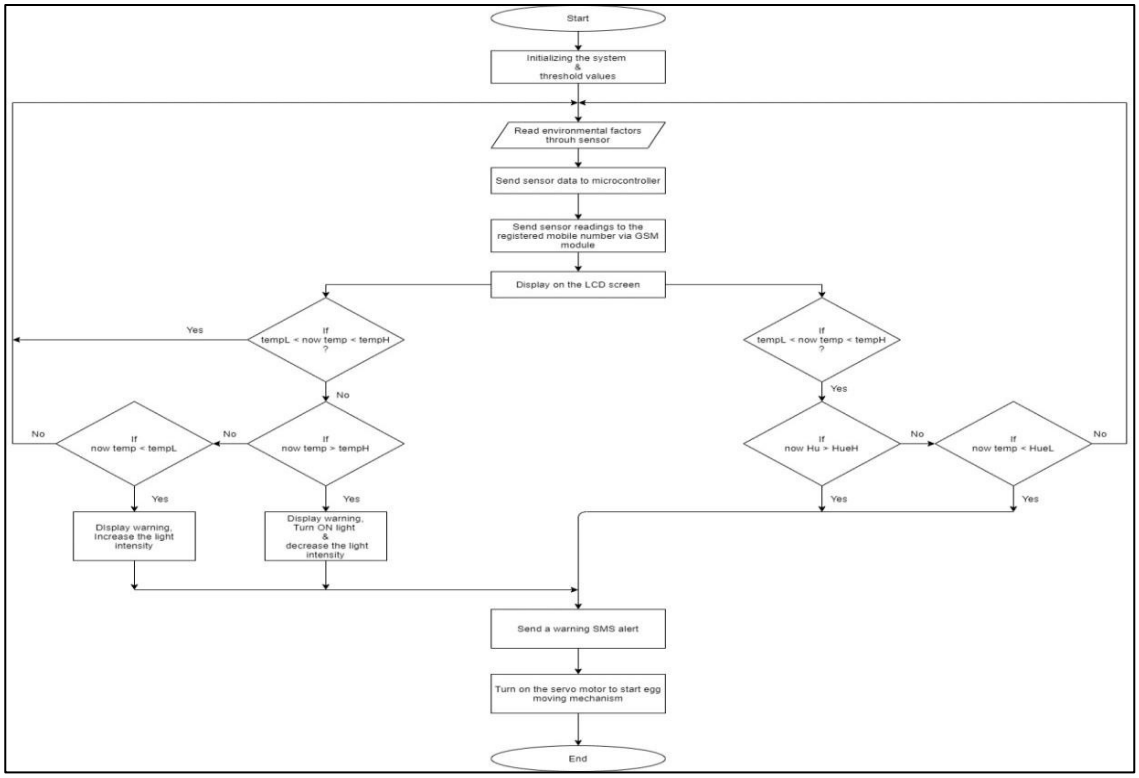


Fig 10: Flow chart of the egg Incubator operation

The fig 10 is shown the operational flow chart for the egg incubator. The DHT11 sensor is used in the egg incubator that monitors inside temperature and humidity levels. Here, the initial threshold range of temperature is programmed as 35°C-37.5°C. Firstly, the system checks the temperature is lower than 35°C or not. If it's lower than the threshold level, the microcontroller will automatically control the intensity of the bulb to maintain the required temperature range inside the incubator. If not, it will automatically re-check the temperature range, and when the sensor reading is fluctuating within the threshold range, the microcontroller keeps the light intensity as it is. The humidity is monitored by defining default humidity ranges into the system to achieve higher egg hatching rates than before. The alerting system is worked as a communication system that is used to monitor and control the incubator. When there are any variations in inside conditions, the system will send a warning message to the registered number. In the meantime, the microcontroller has been programmed to control a servo motor for moving the egg rack to increase hatchability.

C. System Implementation

The designed system is divided into two main modules; control, alert module, and remote monitoring module. The developed control, alerting module features the following major systems i) climate control system, ii) light control system iii) watering control system iv) incubator v) alerting system. The remote

monitoring module is consisting of a web page and a user-friendly mobile application.

Alerting and Controlling

i. Climate Control System (temperature & humidity controlling system)

The DHT 11 sensor is used along with the microcontroller to read the accurate temperature and humidity reading inside the farm. To control the temperature of the hen house, as the normal temperature range for the adult birds is 34°C –38°C, such that the system arranges themselves the poultry-house temperature around that values. Thus, the climate control system is comprised of an exhausting fan, cooling fan, and heating fan systems.

If the temperature reading received from the sensor shows the value beyond the threshold range, the system will automatically trip the transistor to activate the system fan. When the temperature reading goes down below the maximum level, the sensor will automatically turn off the cooling fan system. If there is rainy or cold weather, the temperature reading will go below the defined level, and the processor will automatically turn ON the heating system, and it will turn OFF once the received sensor readings are within the threshold level. Meanwhile, the Peltier is set to turn ON when the detected temperature isn't within the default range. For better poultry management, the humidity is also controlled by defining default humidity ranges into the system, and the exhausting fans are working upon the sensor readings. The exhausting fan system is used to control humidity variations. The temperature and humidity levels and statuses are displayed on an LCD for physical monitoring purposes each second. In the meantime, the same data readings are updated simultaneously on the web page and the mobile application for remote monitoring.

ii. Light Control System

The BH1750 light sensor and incandescent bulbs are serially connected to the microcontroller. The light intensity is affecting the bird's growth, health, and performance. Such that, the farmers can easily control the light intensity via the designed system. The OFF status is the initial state of the light control system. Such that, all bulbs are switched OFF during the day time and switching ON during low light intensity (night or dark condition). Meanwhile, the microcontroller will send an alert message via the GSM module to the farmer by considering the light level. Also, the statuses will be updated on the web page, mobile application, and the LCD screen at the same time for internal monitoring.

iii. Watering System

Two moisture sensors are used to measure the water levels inside the main tank and the sub-tank. The sensor kits are directly connected to the processor, and the supply voltage is 5V. Further, the motor is connected to the microcontroller through the transistor, and the supply voltage is 12V.

Farmer is capable of setting the watering schedule using the mobile application. The automated system will help farmers to reduce the laborers count while increasing efficiency. The threshold tank levels are defined for both tanks, and the farmer is capable of setting the default watering time as he wished. If the water level is getting low in any tank, the warning message will be sent to the person-in-charge to notify the variation with the tank details. Then the farmer can adjust the default timing to fill up tanks.

iv. Incubator

The egg incubator is designed with temperature, humidity monitoring, and egg turning mechanism. It's designed to monitor temperature, humidity variations to maintain a proper egg incubation rate in order to enhance productivity and food quality while reducing operating costs.

The egg incubator is designed using another Atmega328 mini microcontroller connected with DHT 11 sensor, servo motor (mg991), bulb, and GMS/ GPRS module. The inside temperature of the incubator is controlled by the microcontroller using a bulb. Furthermore, the light intensity is controlled to maintain the optimal temperature level inside the egg incubator. The egg rack is connected to the servo motor, and it is designed to move from left to right to achieve proper hatchability, food safety, efficiency while reducing the labor count and wastages. Thus, the rotation of the egg rack is controlled by the microcontroller and the servo motor. Further, the rack is moved left/ right sides every 5 minutes through the motor with a 12V power supply. The processor will send an alert message through the GSM module to the person-in charge if the temperature or humidity levels are below the pre-set value and automatically adjust the inside temperature. Furthermore, the processor has controlled the intensity of the bulb when the temperature isn't within the threshold ranges (3537.5°C) that is necessary for a better hatching rate. The sensor readings are displayed on the LCD screen for monitoring purposes. And also, the system will automatically generate an SMS message when the sensor detected any humidity changes (40-60%). The owner can change the defended temperature, humidity ranges via a text message. In addition, the farmer can retrieve the current status inside the incubator by sending a message request to the system, and it will send the latest updates.

v. Alerting System

This system is comprised of a SIM800L GMS/ GPRS module directly connected to the Atmega microcontroller that sends warning alerts to the registered mobile number when there is variation in any parameter inside the farm and egg incubator. For example, if the moisture sensor reads a value below the threshold level, the system will send a detailed warning message to the person-in-charge to notify the variation. After receiving the message, the farmer will be notified about the changes of the water levels, and he can set time to activate to motor to fill-up the water levels. Furthermore, the alerting module is sent a response message after the relevant tank is filled to the required level. The same process will be following for other parameters.

Additionally, the farmer can send a request message to manipulate and update the status, threshold values. Also, this facility is applicable for the egg incubator. The system is worked based on the assigned keywords (keywords), and also, the farmer is able to send this message through any phone number. For example, in the incubator, remote monitoring is achieved by the text messages which is sent and received through the GSM module. The farmer can send a request message including the "read" keyword to retrieve the current status of the incubator.

Results and Discussion

When the system is initializing, the threshold values and initial sensor readings are sent to the web interface and it is displayed on the LCD screen. It will be updated on the web page after 10-20s. Also, the mobile application will be

gathered the relevant data from the webpage and update on the mobile application with the date and time. Also, the SMS is sent to the registered mobile number based on the initial conditions inside the farm and egg incubator. It is shown in fig 11.

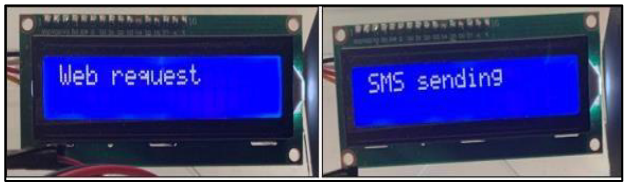


Fig 11: Displayed notifications during the initializing process

If the inside temperature, humidity, light intensity, or the watering levels are below or beyond the defined threshold level, the designed system will be automatically turned ON/ OFF the relevant controlling unit based on the sensor readings. For example, as per the fig 12, the temperature, humidity thresholds are defined as 25°C-28°C, 50%. As per the figure, read sensor data is 31°C and 74%. Thus, the cooling fan and the exhausting fans are automatically turned ON to control the unnecessary climate changes inside the poultry-house. As per the fig 13, the system is managed to send an alert to the registered mobile number and the status will be update don the web interface within 5 minutes. Such that the same process is followed by the other systems to control high/ low parameter changes.

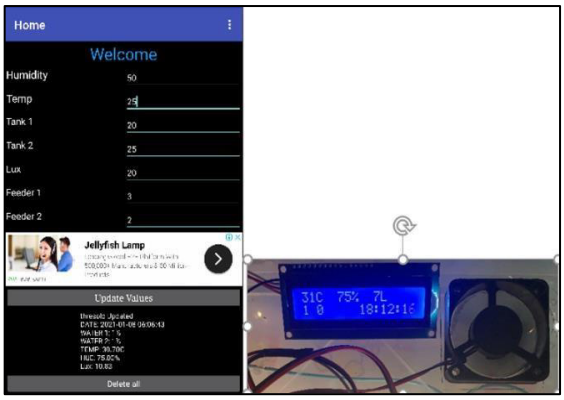


Fig 12 :Defined threshold levels and sensor readings

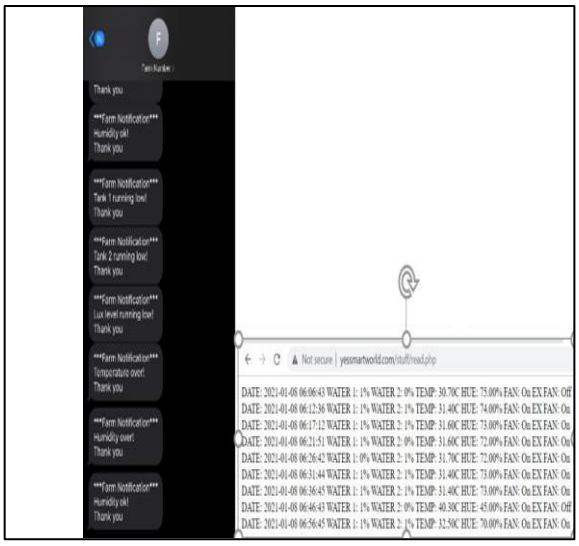


Fig 13: Sent warning message and the updated status

Another data entering and data retrieving method is introduced to the egg incubator. Thus, the farmer can be updated default temperature and humidity ranges via a SMS using the relevant keywords and symbol. This helps to adjust the required parameters based on the age of eggs, growth, and egg conditions. And the defined threshold levels will be displayed on the LCD screen simultaneously. Therefore, owner can be able to set up the

system very easily through any mobile number. The fig 14 shown the SMS method which is used to defined threshold parameters and the fig 15 shown the data retrieving process. *(Note: received data and latest update may be varying with testing time.)*

Operating key words

- Temperature:"thigh<temp>#"&
- "tlow<temp>#"
- Humidity:"hhigh<humi>#"& "hlow<humi>#" Data retrieving: "read"

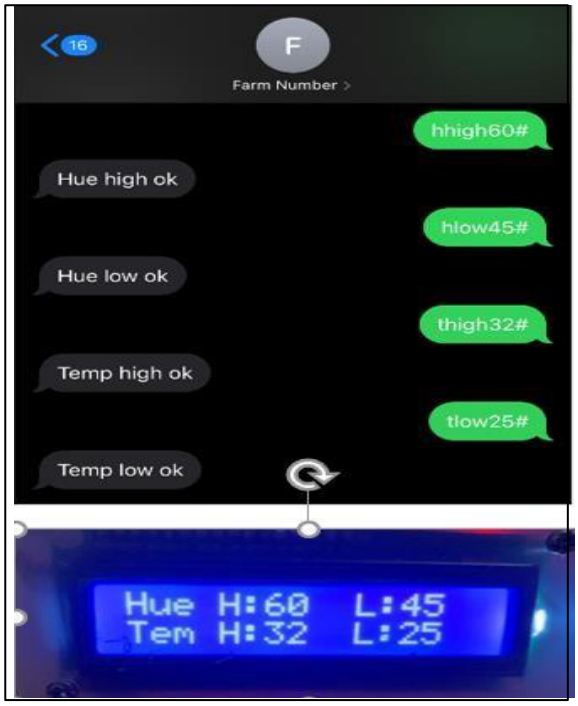


Fig 14: Defined threshold values via a SMS and display method

Fig 15: Data retrieving method

The light intensity inside the incubator is controlled based on the sensor readings and the defined threshold values. As per the fig 16, if the temperature level is higher than the threshold level, the light intensity will be automatically reduced to maintain the approximate temperature. Also, the light intensity will be increased once the temperature is within the defined threshold range. Further, the bulb is turned off when the temperature reading goes beyond the defined maximum level and the alerting messaged will be sent to the registered mobile number. Also, the egg rack is designed to hold six eggs at a time and the egg rack is implemented to move from left to right and right to left for every five minutes (fig 17). All updated will be sent to the registered mobile number for monitoring purposes. It shown by the fig 18.

Fig 16: Temperature controlling Mechanism inside the incubator

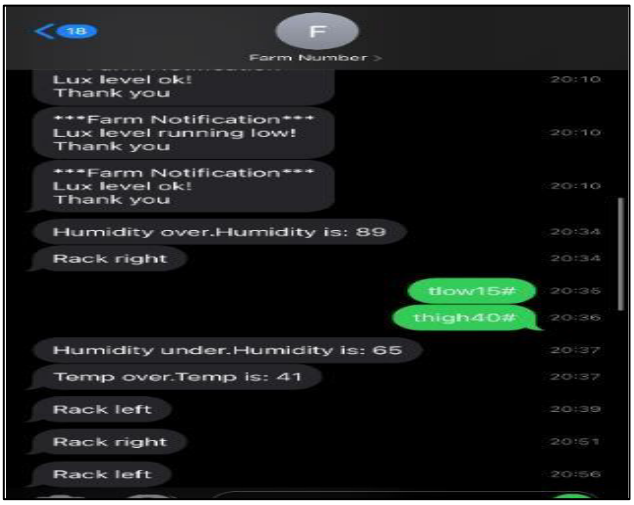


Fig 18: Received status of the Environmental parameters and egg rack

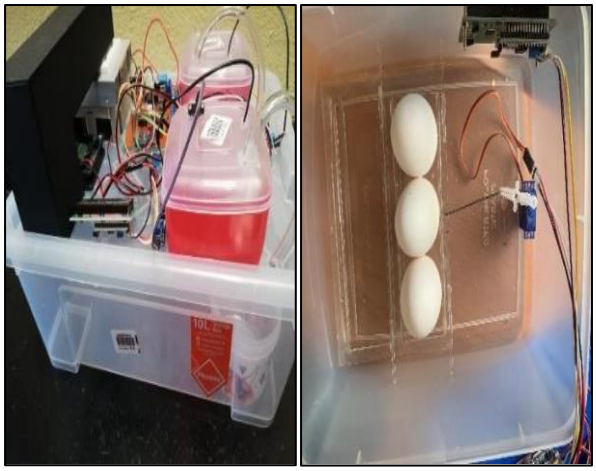


Fig 17: Prototype farming section and Egg rack

Initial threshold levels and defined actions

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	Parameters	Threshold range	Action Perform	Send Warning SMS
Farm Section	Temperature	34-38°C	t > t_max - cooling fan t < t_min - heating fan t < t_max & t > t_min - Peltier	
	Humidity	78% - 82%	h > h_max - exhusting fan h < h_min - heating fan OFF	
	Light intensity	10lux	lux < set_lux - light ON lux > set_lux - light OFF	
	Water level - T1	50%	t1 < w_set -motor ON	
	Water level - T2	60%	t2 < w_set -motor ON	
Egg Incubator	Temperature	35-37.5°C	t > t_max - Light off	
	Humidity	40% - 60%	send SMS	

Table 1: Initially defined threshold levels and actioned to be taken based on the sensor readings

Discussion and Conclusion

The project is aimed to increase efficiency, poultry productivity, and profitability among less labor intervention. Further, the project aimed to reduce the operating costs, wastages while reducing manpower utilization. Besides, the farmers can increase the production rates by providing the optimal environmental conditions inside the poultry-house an incubator to increase animal welfare. As a result, farmer able to increase the profitability. The designed system provides remote monitoring and controlling besides physical monitoring for both poultry-house and egg incubator. Since real-time monitoring of environmental parameters is crucial in poultry and agricultural industries. Such that, the system is monitored significant changes in inside environmental parameters real-time monitoring of environmental parameters is crucial in poultry and agricultural industries.

The system ensures effective egg incubation and hatchability without causing internal issues and damages (at the approximate condition). The developed egg moving mechanism will help to measure the efficiency and quality of the eggs than the manual process. Furthermore, farmers can check the current status by directly sending a message to the incubator. Thus, farmers can connect and check the current status and take quick action to minimize the bad effects, if there are unnecessary changes inside the farm. Further, the farmer can aware of the changes inside the poultry-house and incubator using the alerting system. Hence, farmers can supply quality, fresh, notorious poultry production to

gain market shares and profitability. Thus, the farmer can maximize the production rates, profitability, and efficiency with less human interface and operating costs. Also, animal welfare will be enhanced as an indirect result of automation.

As future working, the mobile application may be re-developed to operate fans, lights, and motors without any hesitation. Also, it is planning to be modified to operate in both android and IOS operating systems. Further, most birds are usually suffering from bird flu which is identified by various surveys. Bird flu is a serious case that affects animal welfare and performance. And also, it will be affecting their metabolism and slow down the growth. Hence this will be harmful to the health of farmers as well as workers and neighbors. Thus, a health condition detection system can be implemented for early detection of bird flu and other health issues. As analyzed, it can be achieved by RFID and AI technologies as future work

Declarations

Study Limitations

The developed system was proposed to implement and test at an actual small-scale poultry house to check the accuracy and effectiveness. Unfortunately, it is unable to achieve as wished due to the current pandemic situation in the country. Thus, it's developed as a prototype system to give the conceptual idea of the proposed concept. Also, the developed mobile application is allowed to use in an android platform. Hence the above-highlighted limitations are figured out as the limitations of the artifact.

Acknowledgements

The author would like to express sincere gratitude to the project supervisor Mr. Nimesh Pollwaththage, and the reader/ module leader Mr. Tilak De Silva for the supervision and guidance given for this project. Also, the author would like to thank the department of IT of CINEC campus and the University of Wolverhampton UK for providing a chance to complete a successful individual project and a study within the given time frame.

Funding source if any

Provide funding source, supporting grants with grant number. The name of funding agencies should be written in full. If no funding source exist, please write none. **Conflict of Interests**

Declare any potential conflict of interest exist in this publication.

Human and Animal Related Study

If the work involves the use of human/animal subjects, each manuscript should contain the following subheadings under the declarations section- **Ethical Approval**

Provide ethical approval authority with name with the reference number. If ethical approval is not required.

Informed Consent

Write a statement of informed consent taken from the participants to publish this research work. The editor may ask to upload scan copy if required.

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Original Article

Vehicle Registration and Traffic Violation Details Detection System by Capturing the Vehicle Number Plate in Sri Lanka

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Abstract

In most parts of the world, traffic law violations have been identified as a significant cause of road fatalities, with the majority occurring in developing countries. It is impossible for a police officer to distinguish between the license numbers of vehicles that break the laws and the license numbers of speeding vehicles. The main objective of this study is quickly identify vehicles that have broken traffic rules and collect information about their owners. For vehicle identification, this device employs image detection and character recognition technologies.

The extracted vehicle number can be compared with database to see whether this vehicle belongs to the right person or not, as well as vehicle details, driver reference, and traffic violation details etc. As a result, developing such a method as a solution to various traffic problems is critical.

Keywords*: **Image Processing, Number plate detection, OCR API***

Introduction

With the increase in population and vehicles on the road, many issues such as traffic violations, from active to inactive or cancel it depending on the traffic infringement. public safety, increasing roadside accidents, and increasing the workload of traffic police and government have arisen in Sri Lanka. This project would aid in reducing these problems around the country and reducing the workload of traffic police officers.

In Sri Lanka, currently, there is no proper way to handle the above-mentioned traffic violation and vehicle details. Many of these operations were carried out manually with the help of books. If a suspicious vehicle has been identified, there is no way to obtain information on previous traffic offences or vehicle registration information immediately. There is no computerized system to maintain the details, and all records are kept in traffic police log books [1]. As a result, by developing a mobile application, this method resolves all of these issues.

The suggested application includes a function for capturing or manually entering the vehicle number plate, as well as processing the picture of the captured vehicle number plate. By certain vehicle number plate it displays registration information. It keeps digital record of prior traffic infractions as well as a driving license information details. The traffic officer has the authority to change or delete those data and alter the status of the driver's license

Literature Review

Kadir Mahamad described how image processing and optical character recognition were used to perform an automated number plate detection of letter sets of plates. Using the LABVIEW platform, an imperative system of training interface was developed [3].

As streets are crowded and a large number of vehicles drive by, number plate identification requires a high degree of accuracy, according to Kuldeepak et al [4]. They were able to achieve a precision of 98% in this study by optimizing various parameters. It is critical that for the identification of stolen cars and car monitoring, 100% accuracy cannot be compromised. As a result, improved precision streamlining is needed. Additionally, streaks, blurred regions, and smudges of different text styles and sizes should be recalled. This work should be expanded in order to reduce errors caused by them.

According to AmrBadr et al. automatic identification of car license plate numbers has been an indispensable aspect of daily life. This research focuses on Morphological operations, Histogram modulation, and Edge discovery Techniques for plate localization and character segmentation in an Automatic Number Plate Recognition System (ANPR). Character detection and identification was done using Artificial Neural Networks [5].

This study consists of information from the ANPR system. The ANPR system consists of the following steps:

- Vehicle image capture
- Pre-processing
- Number plate extraction
- Character segmentation
- Character recognition

The ANPR system works in the following steps:

- Locate the vehicle and obtain the document image of the vehicle from the front or rear of the vehicle.
- Place and extract the number plate.
- Apply image segmentation strategies to segmentation of certain neural network technologies, mathematical morphology, colour analysis and histogram analysis. (Segmentation aims to recognize single characters. Optical character recognition (OCR) is one of the strategies that use a database stored for a single alphanumeric character to recognize each character.)

Kwon and his teammates suggested character recognition method using an optical character reader technology for smartphone applications. Camera on the android smartphone captures documents and then OCR is applied according to the language database. Since some language is added to the database. Different languages can be easily recognized. Since simulation results, can be seen the test results in English, Korean, Japanese, Chinese recognition [6].

Meghana, SagarImambi, Sivateja, & Sairam designed an image recognition system for the number plate monitoring system that is automated. It identifies vehicles using image processing technologies which can be used in densely populated and restricted areas to quickly identify vehicles that breach traffic laws as well as the owner's name, address, and other information. It can also be used if the car is used for terrorist and smuggling activities, invalid number plates, stolen cars, collect electronic road charges and other illegal activities [7].

"Vehitrack," an android-based traffic rule violation detection system, was created by Singh. The primary goal of this project is to

eliminate illegal activity such as stolen cars and to track motor vehicle traffic. The car number was extracted from the image using this method, which processed the image. The system compared this derived picture from the database to determine if the car belonged to the right person or not, as well as whether the records were valid [8].

Namrata Shirodkar and Preksha Uchil suggested a method for collecting tolls electronically using an image processing technique that can identify a vehicle's number plate and thus deduct the toll volume. It is possible to attempt to eliminate corruption from toll checkpoints in India using this strategy [9].

Goyal and Bhatia developed a system called ANPR which
is an image-processing innovation which is used to perceive vehicles by their tags. This expertise is ahead of time ubiquity in security and traffic installation. Tag Recognition System is an application of PC vision. PC vision is a technique for using a PC to take out abnormal state information from a digital image. The useless homogeny among various tags for example, its dimension and the outline of the License Plate [10].

Sanap and Narote created a survey about advanced road traffic systems and found lot of important details about LPR algorithms. So the development of advanced road traffic system provides vehicle numbers that can be used for surveillance analysis [11].

Methodology

This mobile application's main purpose is to identify captured vehicle number plate texts and digits. The App includes a camera capability that may be used to capture the vehicle number plate. After capturing the image, the App reads the registration number from the vehicle's number plate using Google's Android OCR API and Vision API. The App employs regular expressions to match the conventional pattern/format of registration numbers in Sri Lanka after recognizing the number plate. Following the validation procedure, the database will be queried for matching vehicle number plate information. In addition, the app features a Flashlight feature that allows you to record a good image at night.

Camera functions can be separated as following:

- Camera Source - Manages the camera in conjunction with an underlying.
- Camera Source Preview - Manages the camera preview (Swap width and height sizes when in portrait, preserving the correct aspect ratio, crops size to maintain the proper aspect ratio etc.)

OCR function contains the following:

- OCR Capture Activity - detects text and displays the value with the rear facing camera. During detection overlay graphics are drawn to indicate the position, size, and contents of each Text Block. (Initializes the UI and creates the detector pipeline, Handles the requesting of the camera permission etc.)
- OCR Detector Processor - A very simple Processor which gets detected TextBlocks and adds them to the overlay as OCR Graphics.
- OCR Graphic - Graphic instance for rendering TextBlock position, size, and ID within an associated graphic overlay view.

- Result – Fetches the extracted vehicle number plate details from the Firebase Database

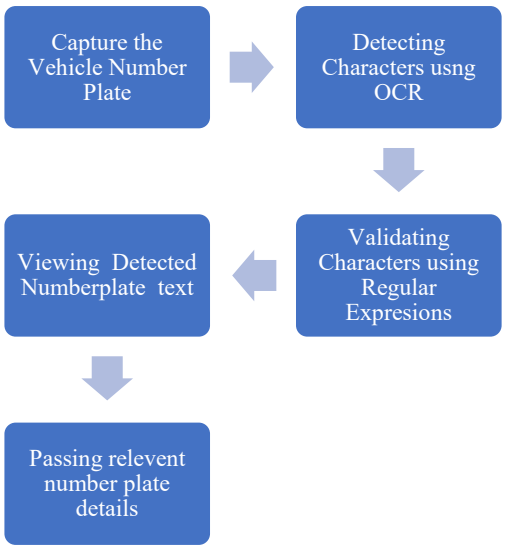

Figure 1: Number Plate Detection Flow

A. *Text Recognition API Overview*

Text recognition is the process of detecting text in images and video streams and recognizing the text in them. Once detected, the recognizer identifies the actual text in each block and divides it into lines and words. The scripting API can detect Latin-based texts (French, German, English, etc.) on the device in real time.

Text recognizer divides text into blocks, lines and words. Generally:

•A block is a set of continuous lines of text, such as paragraphs or columns

•A line is a group of consecutive words on the same vertical axis.

•A word is a group of consecutive alphanumeric characters on the same vertical axis.

The image below shows the descending order of each text structures. The first block marked with cyan is the text block. The second groups of blocks highlighted in blue are lines of text. Finally, the third sets of blocks highlighted in navy blue are words.

The App can recognize letters and digits in the vehicle number plate using this Text recognition API.

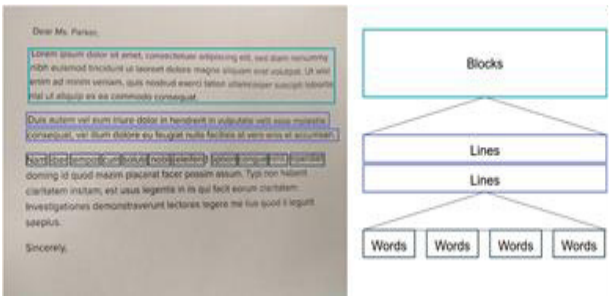

Figure 2 - Text structure

B. *Regular Expressions*

A regular expression is a sequence of characters that forms a search pattern. When you search for data in a text, you can use this search pattern to describe what you are searching for. A regular expression can be a single character, or a more complicated pattern. Regular expressions can be used to perform all types of text search and text replaces operations.

This app also uses regular expressions to match the standard pattern/format of registration numbers in Sri Lanka.

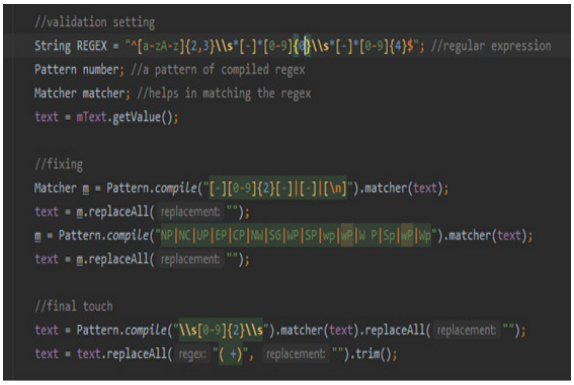

Figure 3 - Regular Expressions

Using above regular expressions the app is formatting the detected number to correct format. It can only recognize character starting from English letters with numbers afterwards. Then it removes province like: WP/SP/NC etc. and removes the dash symbol at the final stage. This application may store records of traffic infraction data in addition to vehicle registration details. After each driver has entered their traffic infractions, a search feature has been developed to find past traffic violation details for that driver.

Entering the driver's license number or NIC number will bring up those data.

I. ARTEFACT

It is always debatable the possibility of utilizing innovative technologies on detecting vehicle registration details and traffic violation details by capturing vehicle number plate in Sri Lanka. Throughout the implementation of the system, the research aimed to reduce the possibility of intruder threats and protect the application and data responsibly. As a result, in order to achieve the desired results, the proposed artefact was planned and implemented using cutting-edge technical features.

A. *Number plate recognition accuracy test*

1) Mobile Application:

- Android Studio (IDE)
- Google Firebase (Database)
- Google ML KIT
- XML
- JAVA
- OCR API
- Vision API

2) Features:

- Capture vehicle number plate
- Detect text from the captured image
- Search relevant number plate from firebase
- View vehicle registration details and past traffic violation details
- View driver licence details and update driver licence's status.
- Backup and Restore Database

Results

The application was vigorously tested for possible bugs and all the test cases were successfully accomplished because this system developed by checking each functions one by one since the beginning. After developing each function it's checked for possible bugs. Through the development process, system encountered bunch of errors such as code errors, Android SDK version mismatches, incompatible widget issues and much more. All of those issues resolved by the support of inbuilt debugging tool of Android studio and the help of internet.

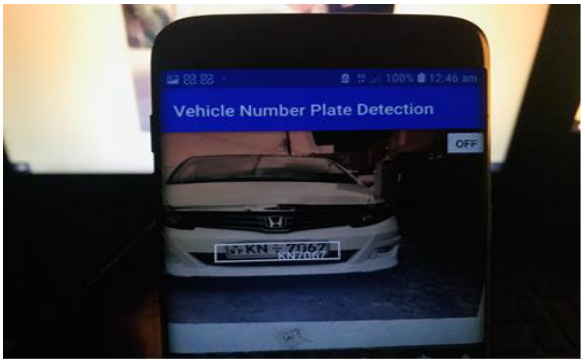

Figure 4: Number plate detection camera screen with flash light & zoom feature

Many tests were carried out to make sure the application is stable and deliver the best user experience. The app was tested for its character recognition accuracy on detecting different vehicle number plates under different lighting conditions.

No	Actual Vehicle Number Plate	Attempt No	Detected Vehicle Number Plate	Pass/Fail	Percentage %
1	CBB5921	1 2 3	CBB5921 CBB5921 BB5921	Pass Pass Fail	66.66
2	QL9904	1 2 3	QL9904 OL9964 QL9904	Pass Fail Pass	66.66
3	KS9597	1 2 3	KS9597 KS9597 KS9597	Pass Pass Pass	100
4	ND8740	1 2 3	PND8740 ND8740 ND8740	Fail Pass Pass	66.66
5	ND4957	1 2 3	ND4957 ND4957 ND4957	Pass Pass Pass	100
6	KN7067	1 2 3	KN7067 KN7067 KN7067	Pass Pass Pass	100
7	GK3895	1 2 3	GK3895 GK3895 GK3895	Pass Pass Pass	100
8	QZ1815	1 2 3	OZ1815 QZ1815 QZ1815	Pass Pass Pass	100
9	KL6036	1 2 3	KL6036 KL6036 KL6036	Pass Pass Pass	100
10	CAA2350	1 2 3	CAA2350 CAA2350 CAA2350	Pass Pass Pass	100

1	CAO	1	CAO	Pass	100
1	5294	2	5294	Pass	
		3	CAO 5294 CAO 5294	Pass	
1	KW0	1	KW0	Pass	100
2	678	2	678	Pass	
		3	KW0 678 KW0 678	Pass	
1	KQ1	1	KO1	Fail	33.33
3	556	2	556	Fail	
		3	KO1 556 KQ1 556	Pass	

Table 1: Test Result

The same vehicle number plate was captured three times and its number recognition accuracy was evaluated. In two out of three attempts, the app was able to detect the number. The quality of the captured picture, the lighting condition of the situation, the distance between the number plate and the mobile camera, and the quality of the mobile camera all influence this.

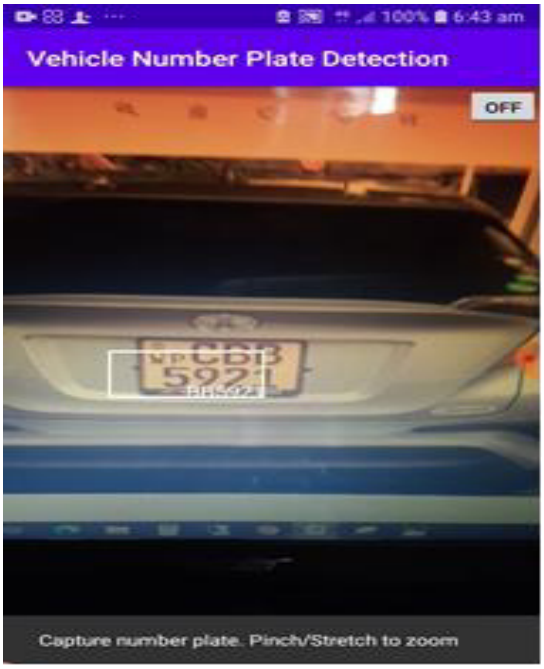

Figure 5 - BB5921-Fail

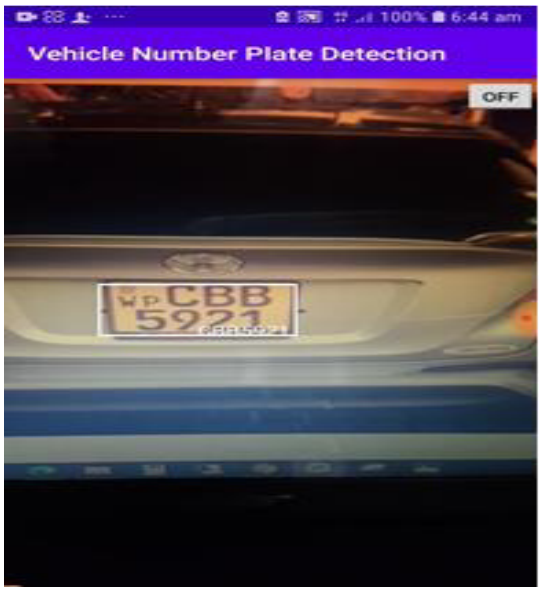

Figure 6 - CBB5921-Pass

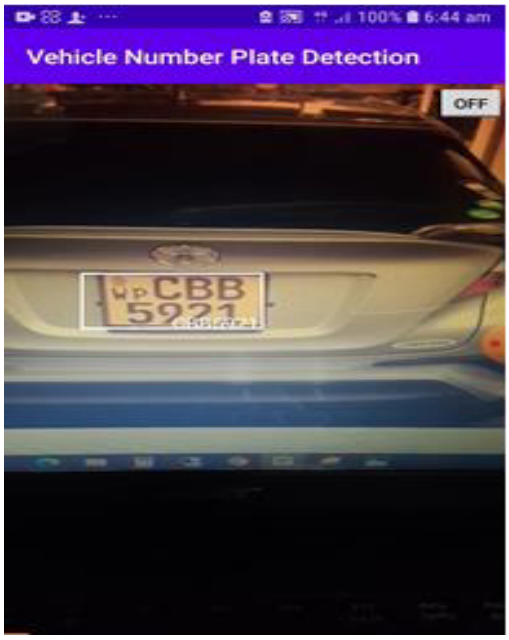

Figure 7 - CBB5921-Pass

Number plate recognition test was not 100% successful as there were some numbers and letters that Android OCR miss extracted and, the possible reasons for this inaccuracy should be due to image quality and the character format of the number plate as all the number plates are not in the same format. To do test, system used different sizes of number plate images. Sometimes letter Q was identified as O; also number 0 was identified as 6. And if a user face this problem he/she might use the manual enter function or can try changing the aiming distance from the number plate. Also there is a flash light option in the application to use flash light to detect a number plate at low light.

B. Stability and functional test of application

The screenshots below demonstrate how the system works in relation to the characteristics discussed in section IV.

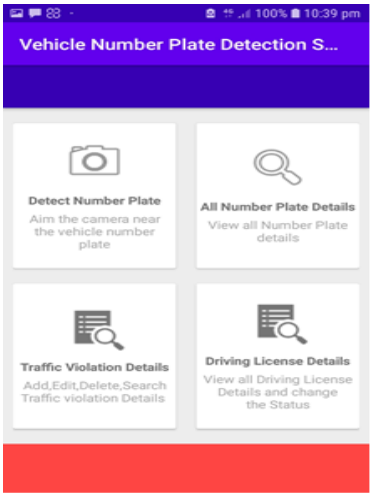

Figure 8: Main Menu page

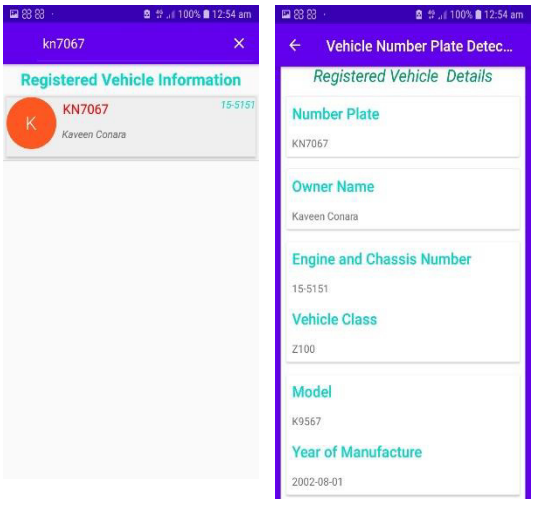

Figure 9: Search & view vehicle registration details

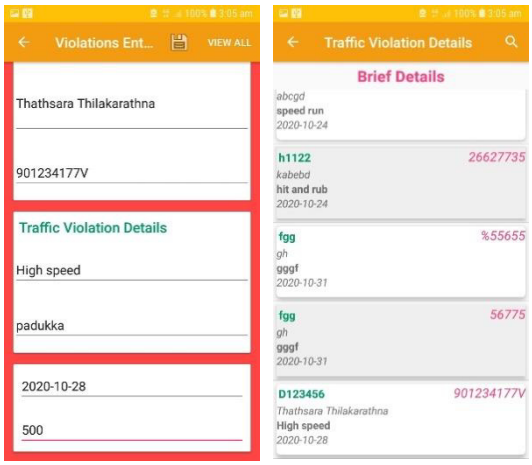

Figure 10: Entered violation details

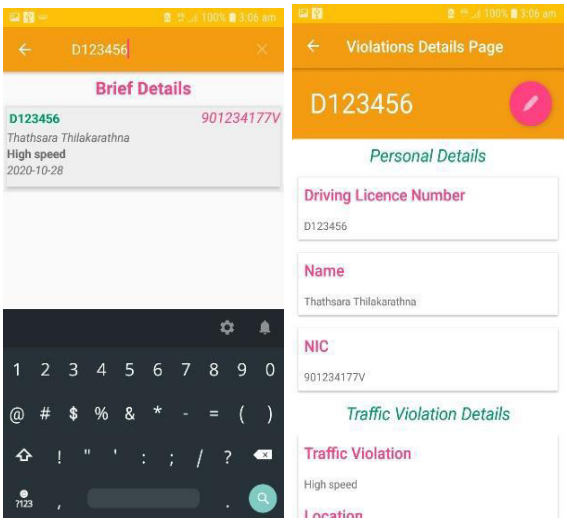

Figure 11: Search & view traffic violation details

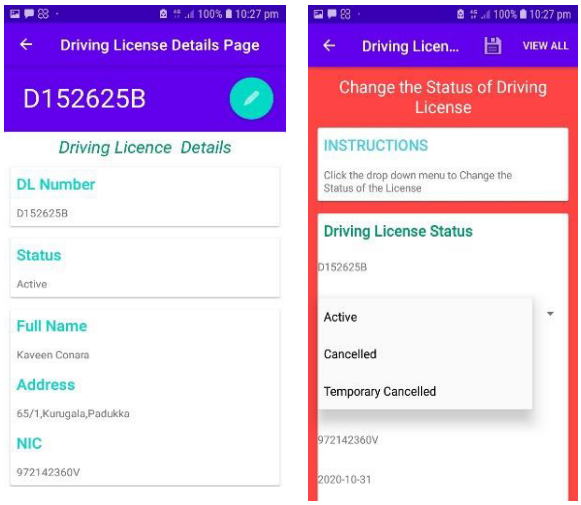

Figure 12: Driving license details & status

II. Future works

Number plate detection is currently achievable in portrait mode, which is one of the system's limitations. In the future, the landscape mode may be introduced for a more compatible user interface. Also at this stage, this software detect only modern number plate formats such as ""“AA-1234, AAA-1234”. It should be improved to identify older number plate formats such as “12-1234, 123-1234", " 4 ශ්‍රී - 4756". Furthermore number plate identification should be possible by video processing as well.

Conclusion

With the support of Android OCR and vision APIs, this proposed application detect the number plate and extract the appropriate character with an average degree of accuracy.

The observed characters were validated and the final output was fixed using regular expressions. Then this application search relevant vehicle number plate and retrieve registration details from the Google Firebase Real-time database. It can also keep computerized past traffic violation entry record and a driving license detail log. Those records may also be edited or deleted by the traffic officer. According to the traffic infringement, the officer may change status of the driver's license either to active or cancelled.

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