Customization of DHIS 2 for Management of Drowning Information at Disaster Management Center

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Declaration

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Abstract

Introduction

Drowning is identified as a leading cause of death and injury in Sri Lanka. It is estimated that 855 people die by drowning in each year. Drowning is considered as a major water related hazard and Sri Lanka Disaster Management Centre involves in decision making and management. Establishment of The Disaster Management Centre (DMC) is under the control of National Council for Disaster Management. Functioning of the DMC is controlled by the Ministry of Disaster Management and Human Rights. It plays a major role when there are massive number of drowning deaths following disasters like Tsunami and floods. The main sources of collecting data are relevant police stations, royal lifesaving association and Registrar General Department. Due to the absence of drowning data surveillance system in Disaster Management Centre, there has been incidents of missing data. Limited information about deaths resulted in short comings in management of disaster preparedness planning and emergency operations during disasters.

Method

A solution has been proposed as an online drowning information system by customizing a globally recognized platform called District Health Information System 2 (DHIS 2). The software package is well designed to handle aggregated data of drowning death records by using event capture tools, extraction methods and data representation methods.

Results

A customized application was installed in DMC servers with hundred and thirty data samples reflecting number of drowning deaths across the country uploaded and tested on the system with feedback from users. Basic drowning details were further captured and analyzed by the system through a piloting project at a selected district of Sri Lanka. It was evident that the system can be used as a basic surveillance system for DMC. There are areas to improve on the information structure and the data flow, which however can be addressed as the application is rolled out across the country.

Conclusion

District Health Information system (DHIS 2) is one of the open source web based software which is free of charge. It consists of features such as GIS, charts and pivot tables that gives amazing visualization. Effective operation management, process monitoring and improvement of communication are added advantages of DHIS2. So this thesis is an attempt towards customization of DHIS 2 in Disaster Management Unit to meet the requirements of drowning information.

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Abbreviations

WHO-World Health organization

DHIS 2-District Health Information System

GIS-Geographic Information System

HISP-Health Information Systems Program

FOSS-Free and Open Source Software

NCIS-National Coronial Information System

UK –United Kingdom

IMS-Information Management System

DPRC- Drowning Prevention Research Centre Canada

RLSSA-Royal Life Saving Society of Australia

BHIS- Bangladesh Health and Injury Survey

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1. Introduction

1.1 Background

This section intends to set the context to the problem addressed by the thesis. Starts with a brief introduction to drowning to educate the reader of the scope of drowning considered and then discusses the economic impact and the relevance of addressing drowning as an adverse incident of human activity. According to the published literature, drowning is identified to cause a significant impact to global, regional and local economies hence policies and action plans are being put in place at each jurisdiction to prevent such events wherever possible. The impact to economy is fairly high for Sri Lanka compared to the south Asian region and even higher compared to globally. The mitigation plans heavily relies on the recorded data as the root causes can only be found through the data patterns and business intelligence done on the collected data. In contrary to the economic impact however, the level of details available on historical drowning incidents are fairly low in Sri Lanka compared to the data availability across the region and globally. This thesis is an attempts to find a solution to this problem using a technology offering.

Looking at the level of data available on drowning and performing a number of cross sectional analysis on it with the intent of defining a policy to prevent drowning, it was made quite clear that the weakness actually lies in the data collection process in Sri Lanka.

The local data collection process heavily depends on our legacy governance structure that revolves around Grama Niladari, who is fairly conversant to slow paperwork. Although being a main source of information, the Grama Niladari still needs to reports data through regional secretariat to perform integrity checks prior to sharing with a central disaster management body. This fairly a slow process with a very high vulnerability for errors and losses of data. The level of data collected through the paperwork is insufficient, less evolvable and prone to errors. It is an extremely slow process, especially in a disastrous situation like a Tsunami where drowning may have temporary social consequences that needs to be addressed immediately. Looking at the data collection processes put in place in the developed countries, it came out to be a prudent idea to fully automate the data collection process with enriched data forms and a user friendly workflows. A feasible solution would be a central web based application hosted in disaster management center accessible via mobile devices such as a smart phone or a laptop.

1.1.1 Scope of Drowning

"Drowning is the process of undergoing respiratory impairment due to submersion or immersion in liquid. Outcomes of drowning can be classified as death, morbidity and no morbidity". There are several types of drowning;

- Near drowning

Near drowning is when the patient is almost dying from suffocation under water. Which result in temporary survival or death. It is the last stage before fatal drowning and need medical attention to prevent health related complications.

- Dry drowning

Nearly 10% of drownings are dry drownings where little or no water entered to the lungs and death occurred mainly due to sustained laryngeal spasm.

- Freshwater drowning

Osmosis takes place across alveoli and the capillary in fresh water drowning. Water will enter the lung alveoli. Due to the osmolality in blood water is absorbed in to the blood through the capillary membrane. This results in heamodilution which result in quick cardiac arrest.

- Salt water drowning

When salt water enters and it filled up in the lungs, osmosis involves and cause draw water out of the blood stream and into the lungs (where opposite effect of fresh water). Then these liquid filled up air sacs interferes with oxygen transfer between alveoli and blood and ultimately results in drowning in self fluids.

- Secondary drowning

This is delayed onset drowning for approximately 1-72 hours. In this type the victim is successfully rescued after drowning, resuscitated and fully recovered but with a possibility to die. It is caused by deficient alveolar gas exchange due to alveolar membrane dysfunction and loss of surfactant. The death is due to brain damage, electrolyte disturbances, pulmonary edema and chemical pneumonitis.[1]

1.1.2 Drowning as a Global Burden

- Every day in every hour more than 40 people lose their lives due to drowning.[2]
- According to World health organization 2017 report show that the drowning is the leading cause of mortality.[3]
- Global death health estimate indicate it is the 3rd leading cause of unintentional injury.
- Approximately 360 000 annual drowning deaths worldwide.
- Frequently occur among those aged under 30 years mainly children aged 5-14 years.
- Children, males and individuals with increased access to water are most at risk of drowning. [4]
- Children drowning average per day: Australia 0.1 /USA 1.2 /Cambodia 6 /Bangladesh 50
- In Asia Pacific alone 250,000 – 450,000 children drown in each year [2]
- Nearly 90% of drowning deaths occur in low- and middle-income countries.[4]
- Drowning is one of the major causes of mortality reported in South-East Asian countries.[5]

1.1.3 Drowning in the South-East Asia.

Drowning is one of the major cause of unintentional deaths reported in the South-East Asia Region. In India particularly has high drowning mortality rate. The average drowning death rate was 6.6 per 100 000 population per year. It shows that in India one person drowns in every 8 minutes. Additionally, along with China contributes to 43% of world's drowning deaths and 41% from the total global daily lost lives related to drowning.

In Nepal, Health Research Council hospital-evidence based data in year 2008-2009 shows that drowning deaths constituted 0.07% of all injury deaths.

Myanmar's Health Management Information System has reported 1257-1511 drowning deaths in 2005. Surprisingly this number increased up to 7625 deaths in 2008. (15.97 deaths/100 000 population per year)[5]

In Maldives reported 1.9% of the total deaths were due to drowning and the age standardization death rate in 2011 was 7.33 per 100 000 of population.

According to World Health Organization Global Health report child fatality drowning death rate in the South-East Asia Region is 8.6/100 000 children per year. This rate is second only to the African Region.[5]

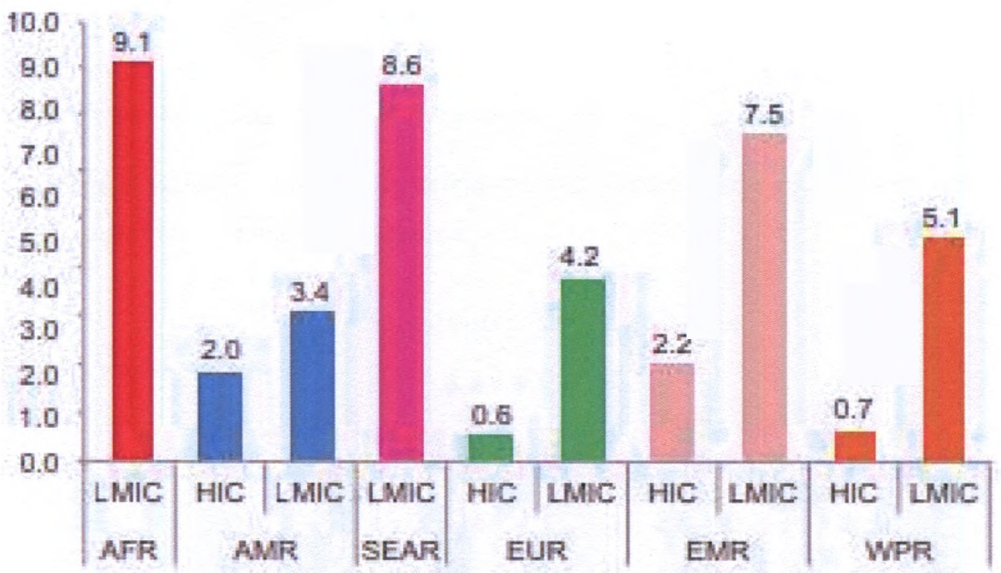

Figure 1. Fatal drowning rates per 100000 aged below 20 years with distribution of region and income of country level 2011.

"(Source: Who global health estimates, cause of death estimates for 2011. **age standardized death rate/100000 children aged less than 20 years. HIC = high income countries; LMIC = low income & middle income countries)"

1.1.4 The Burden of Drowning in Sri Lanka

Drowning is the one of major cause of death and injury in Sri Lanka[6]. Nearly 500 people sustain death annually, and in addition 1,300 injured with near drowning. Compared to sixty-one most drowning death countries Sri Lanka takes the twelfth place, and in addition Sri Lanka ranked tenth place amongst the countries which are low and middle in income (emerging economies). These records highlights how important public health problem this is. From 2012 to 2014, approximately 4.2 per 100,000 died due to drowning. As mentioned in the 2015 national lifesaving society report deaths due to drowning is around 1250.

Statistics of Drowning Deaths in Sri Lanka

Male deaths were four times more compared with female deaths and it's approximately 7.2:1.6 death rate among 10,000 people.

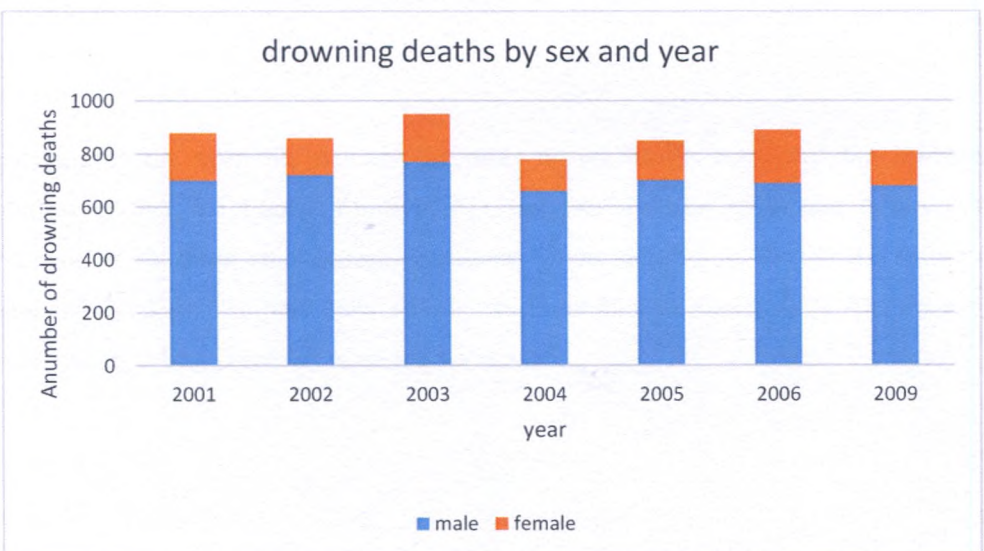

Figure 2. Drowning deaths by year and sex in Sri Lanka 2001-2006 &2009 [7]

Highest number of drowning deaths is recorded in the 25- 44year age group. However, those are above 65years has significant age specific drowning rate and it was 8.25 deaths per 100,000. The lowest drowning rate among 5-15years age group (1.94 deaths per 100 000).

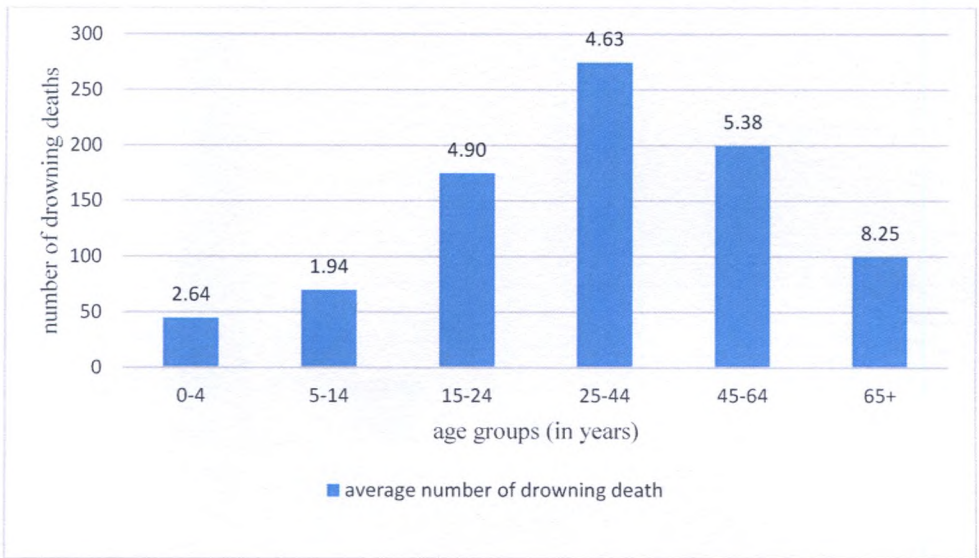

Figure 3. Age group distribution of drowning death in Sri Lanka 2001 to 2006 &2009 per 100 000 populations. [7]

According to the available records the most drown deaths are involving Sinhalese. Sinhalese (78%), Sri Lanka Tamil (12%), Sri Lanka Moor (5%) and others (4%). Provinces of Northern and Eastern provinces where majority is Tamils the respective deaths involved are also Sri Lanka Tamils. Northern 88% & Eastern40%. The drowning deaths seems to be a common issue across races.

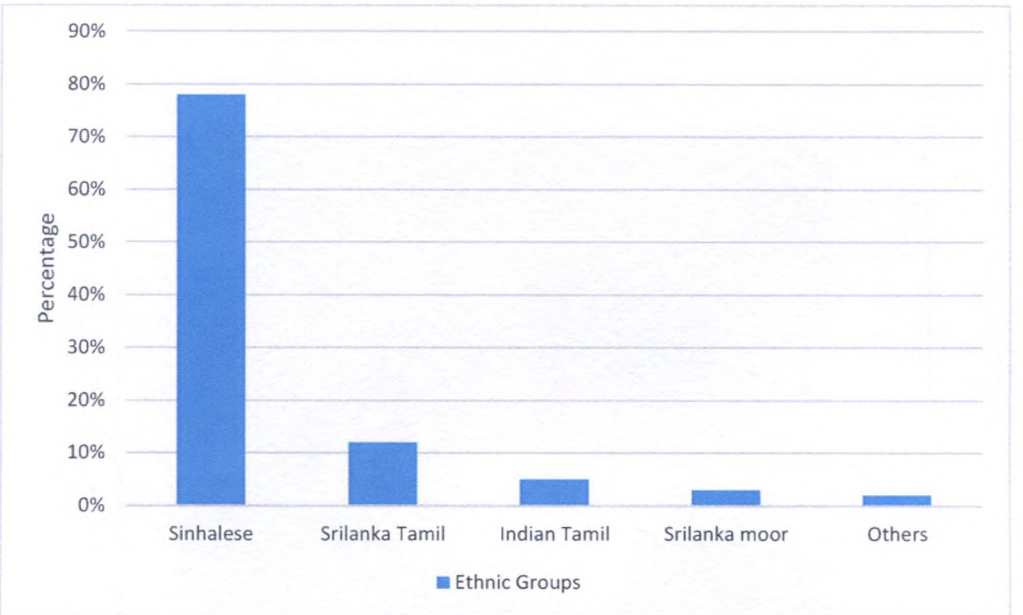

Figure 4. Proportion of drowning deaths 2001-2005&2009 by ethnic groups in Sri Lanka. [7]

Provincial Stats in Sri Lanka

Sri Lanka has nine provinces, out of which North Central is the largest (16%) compared to total country area and Western is the smallest (5.6% of total area). In contrary the highest proportion of the population (percentage wise is 28.6%) live in the Western province and the smallest proportion in the Northern Province (percentage wise is 5.6%). The estimated drowning death toll per annum in western province is 236 and the next highest of 44 reportedly die in the Uva and the Northern provinces. The highest death rate record in the North Western province (6.3 per 100, 000) while lowest in the Central province (3.4 per 100,000). Compared to the national average (4.4 per 100,000) the drowning death rate is recorded as North Western (6.3), North Central (5.4) and Southern (4.2). [8] When the drowning deaths analyzed by district wised Colombo was in the lead with 236 deaths per annum followed by Kurunagala, Kandy, Galle and Rathnapura with the numbers of 139,115, 85, 74 respectively.[9] These stats however don't talk about the reported place vs resident place distinction.

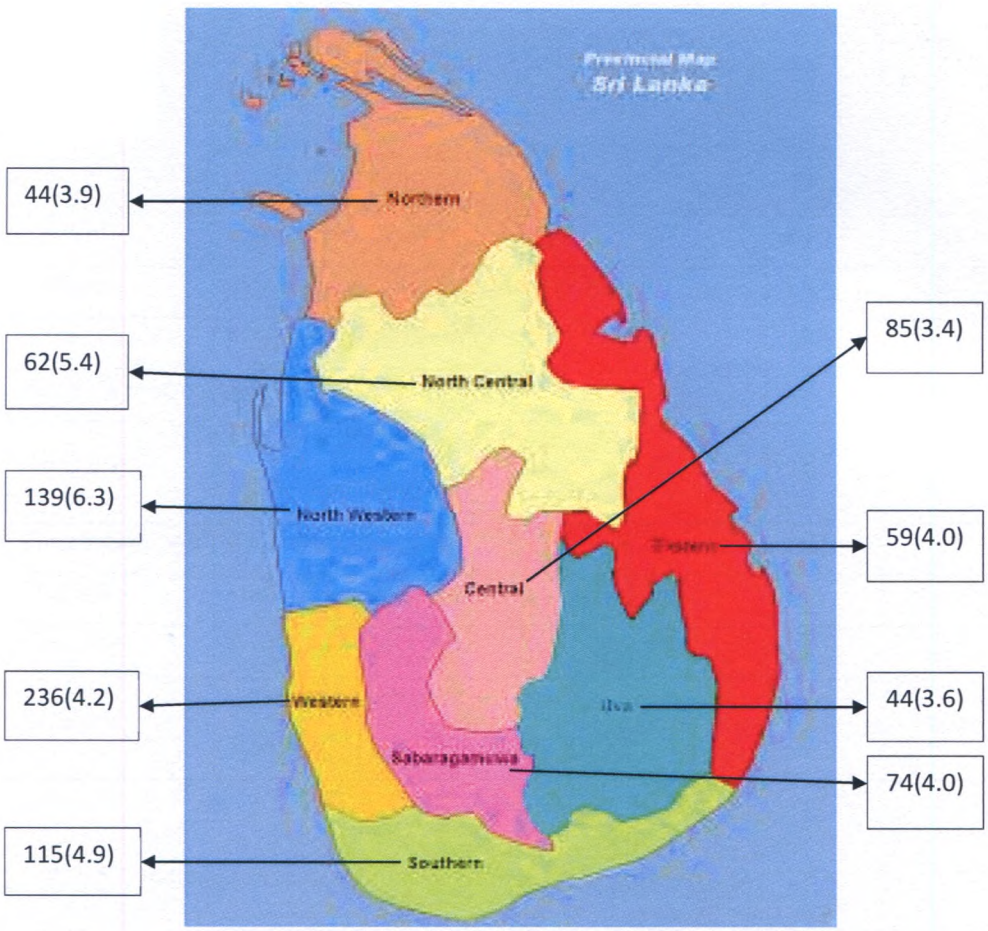

Figure 5. Provincial distribution of death due to drowning with frequency and rate (deaths per 100,000 population)
In Sri Lanka, 2001-2006 & 2009 [7]

Table 1. Statistics based on available data 2001-2014 [7]

Provinces	Districts	Downing frequency (per year)	Drowning rate (per 100,000 population)	Male: Female Drowning ratio
Central	Kandy,Matale,,Nuwara Eliya	85	3.4	3:2
Eastern	Trincomalee,,Ampara,Batticoloa	59	4.0	4:7
North Central	Anuradhapura,Polonnaruwa	62	5.4	4:5
North Western	Kurunegala,Puttalam	139	6.3	4:1
Northern	Jaffna, Kilinochchi, Mannar, Mullaitivu,Vavuniya	42	3.9	2:9
Sabaragamuwa	Ratnapura,Kegalle	74	4.0	4:1
Southern	Galle,Hambantota,Matara	115	4.9	4:0
Uva	Badulla,Monaragalla	44	3.6	2:5
Western	Colombo, Gampaha Kalutara	236	4.2	6:0

1.1.5 Identified Causes and risk factors for Drowning

Aquatic Activities

The places with common aquatic activities in the provinces are the most at risk. The list is as below;

1. Fishing
2. Tourism
3. Bathing and washing
4. Collecting water from open Wells
5. Recreating around waterfalls, lakes, reservoirs and beaches
6. Employment (rice paddies, brick making)
7. Water sports(swimming), Play in water holes, Whale watching
8. Religious reasons (pilgrims bathing)

Contributing Factors

The main contributing factors for deaths are alcohol consumption, poor swimming skills and escape techniques and not wearing life jacket while traveling in water. Governmental and non-governmental organization together conducting education and awareness programs to reduce these number of deaths.

1. Slips/falls around reservoirs
2. Flooding downstream of reservoirs/tanks
3. Lack of water safety knowledge
4. Lack of swimming ability
5. Alcohol
6. Tourists in unfamiliar area
7. Fishing and boating without lifejacket
8. Fishing in dangerous conditions
9. Bathing in river and ocean
10. Slips/falls around reservoirs/tanks
11. Difficulty accessing people
12. Unregulated tourism
13. Poor communities
14. Remote areas

1.1.6 Identified Top Drowning Locations

Key locations were reported for drowning incidents are mainly six out of nine provinces in Sri Lanka Mainly followed by oceans/beaches in eastern, North Western, Southern and Uva provinces; unprotected wells/open cisterns recorded in Southern Uva Western and North Central provinces; common rivers for drowning in Sabaragamuwa, Southern and Uva provinces; and reservoirs/tanks in Central, North Central and Northern provinces.

1. Beaches/Oceans
2. Reservoirs/tanks
3. Lakes
4. Wells/open cisterns
5. Rivers
6. Waterfalls

1.1.7 Identified Disasters/Causes for Drowning Deaths in Sri Lanka

- Flood
- Heavy rains
- Tsunami

Flood and Heavy Rains

The incidence of flooding and heavy rains seems to be most frequent in the latter part of the year, and the most flooding reported year were 2006 and 2008.The common flood occurring months are May and December. With respect to geographical distribution floods are most commonly reported in the districts of Jaffna, Kalutara, Rathnapura, Gampaha, Ampara and Batticaloa.

According available data in Disaster Management Centre disaster the below tables illustrate the distribution of deaths.

Table 2. Flood Disaster deaths report (2001-20018) [7]

Province	District	Deaths	Year
North Western	Puttalam	1	2002
	Kurunagala	2	2005
North Central	polonnaruwa	1	2004
Sabaragamuwa	Rathnapura	15	2003
	Kegalle	1	2008
		1	2005
Southern	Hambantota	21	2003

	Matara	1	2003
Uva	Moneragala Badulla	1 1 2 2 1	2006 2007 2008 2006 2008
Western	Colombo Kaluthara	1 11	2007 2008

Table 3. Deaths due to heavy rains [7]

Province	District	Deaths	Year
Central	Nuwara Eliya	1	2004
Eastern	Trincomalee Ampara	1 1	2009 2006
North Western	Puttalam	1	2006
Sabaragamuwa	Rathnapura	2	2009
Southern	Galle	1	2013
Uva	Badulla	1	2007
Western	Colombo Kaluthara	1 1 1	2008 2013 2011

Tsunami in 2004/12/26 - the Greatest Impact on Sri Lanka

The tsunami that struck Sri Lanka on 26th December 2004 killed about 35,000 people and made 900,000 people homeless. This is fairly an extreme amount for the nation that has only 19 million people, with a majority of them living in the coast area. Almost 40% of the dead were children. This has been Sri Lanka's worst natural disaster ever recorded in the history.[10]

Table 4. Tsunami Deaths in 26th December 2004 [7]

Province	District	Deaths
Northern	Jaffna	2640
	Killinochchi	560
	Mulativu	3000
Eastern	Trincomalee	1078
	Batticoloa	2840
	Ampara	10436
Western	Kaluthara	256
	colombo	79
	Gampaha	6
Southern	Hambantota	4500
	Matara	1342
	Galle	4218
North Western	Puttalum	4

1.1.8 Drowning Prevention in Sri Lanka

Intervention and Implementation Strategies:

Drowning is preventable injuries and it is important to have accurate detailed data for the establishment of prevention, active management and resolution of drowning related deaths.

According to the WHO guidelines there are six selected interventions and four implementation strategies [11]

Interventions:

- Safe barriers to control access to the water. Example: Covering wells and cisterns/four sided pool fencing with gates.
- Provide safe places away from water. Example, children in 1-4 age group in daycare Centre or in preschool: children are most vulnerable to drowning or they may fall into unobstructed water bodies which they cannot come out.do situational assessment first, identify risk factors, identify harmful water sources and give adequate supervision, find trained cares, share that information with parents.
- Training and teaching basic and advanced swimming skills to the school children and adults. Example: implement island wide swimming and water safety skills programs in schools.
- Safe rescue techniques and resuscitation training to the bystanders. Example: Develop training methodology for trainers and students.
- Implement safe boating, shipping and ferry regulations. Example; Well-trained, skillful and professional operators/improve search and rescue capabilities/safety rules and standards for the passengers.
- Build resilience and manage flood risks and other hazards locally and nationally. Example: Identify frequency, patterns and risk of flood disasters / identify common flood geographical areas/Establish early warning systems/ Develop disaster response and recovery plans.

Strategies

- Promote multisector collaboration. Deliberate to work with various stakeholder groups (e.g. government, private sector, civil) and sectors (health, economy, environment) to achieve a goal.
- Strengthen public awareness of drowning especially during pilgrimage season. Conduct programs to educate people and awareness to risk reduction, while massage can be disseminating by social and digital media, print, billboards, etc.
- Establish a national water safety (drowning prevention) plan. To reduce and prevent fatal drowning, develop a sustainable national water safety plan which

consist of four main principles: goals, objectives, actions and coordinate mechanisms.

- Improve research capability. Improve data collection systems by advance drowning prevention through well establish data collection and well-designed studies.

Challenges

As mention in the global drowning report these interventions and strategies are the best (evidence-based) way to prevent drowning but many of them commonly used in high-income countries rather than low income countries where the 90% of global drowning death lies.

Correct number of drowning deaths is not hundred percent accurate in the cause of death report. Some reported deaths were not well defined specially when it comes to measure mortality rate in all unintentional injury.

1.1.9 Usage of Technology for Drowning Prevention

Sri Lanka

When we look back at the drowning history in Sri Lanka, accurate statistics on the number of deaths and causes have not been analyzed and compiled. And there are significant missing data during 2006-2009 period.[7] Data gathering is done by many different ways but there is no proper linkage between these organizations (the main sources are Registrar General's Department, Department of censers and statistics, Sri Lanka Police, Naval forces and coast guard). The other way the technology in some organizations have not been applied, or at the simplest level (most of them using paper based information or either spread sheets). Top of that unavailable or lack of resources, untrained staff, inability to adapt for new systems are the problematic issues in the current situation. Although drowning is preventable but still Sri Lanka is not using any technology for preventing drowning as much as developed country does.

In Developed Countries

Australia

The National Drowning Report (also called Royal Life Saving drowning report) built with the collect and combine information from National Coronial Information System (NCIS), State and Territory Coronial offices and year round media monitoring. And they have very advanced technological sustainable system which uses a media. (uses mainly broadcast and online) The media services identify and report drowning death all year around. This information confirmed with the information from the NCIS, police reports and Royal Life Saving STMOs before being included in the National Drowning Report. So all these procedures taken to ensure that the information in this report is as accurate as possible.[12]

United Kingdom

In UK mainly concerned about detection drowning for public swimming pools, where most probable cause for drowning. This drowning detection system is highly technical which has made to assist with the surveillance of swimmers within the water of a swimming pool. Roughly up to date 30 systems already have been installed in public swimming pools.

Its consist with three general types: CCTV cameras (that give a underwater views) cameras with computer monitoring and automatic alarms (which detect swimmers in potential difficulty) Wristband tags with computer monitoring and automatic alarms (also helpful for the swimmers in potential difficulty). So these technology has prevented significant number of drowning cases.[13]

United States of America

They use Swim Safe band, a lightweight necklace for the swimmers. When submerged beyond a preset number of seconds (radio-frequency-controlled band and its corresponding control hub) will graduated alarms and strobe lights, alert the guardians or lifeguards. So it has been very useful for swimmers non swimmers and as well for children preventing drowning.[14]

These evidence prove that how the modern technology could be used to prevent drowning.

1.2 Literature Review

Drowning has become a significant cause of unintentional deaths worldwide. Sri Lanka is among the highest incident rate countries. The number of deaths could hike during disasters like floods and tsunami. Although Sri Lanka claims to have a Drowning Information Management System, it currently shows a number of short comings in terms of accuracy, coverage, access and usability.

There aren't many readymade solutions available to overcome the identified shortcomings. Number of custom solutions have been implemented in the developed countries with features and usability that are unique to them, hence are unlikely to be extended to emerging economies such as Sri Lanka due to the sheer social, literacy and financial capability differences. Number of other emerging economies have attempted to develop their own system, which has shown quite similar shorts comings as Sri Lanka, and have failed to evolve in the long run.

What was found to be feasible is to implement a solution on an open source Drowning Information Management System framework which is low cost and yet evolving along the lines of the maturity of systems in developed countries, and also allows necessary customizations to adapt to the Sri Lankan context. This approach was found to be the most suitable after considering all solutions used across developed and emerging countries and the circumstances, available resources and current technology context in Sri Lanka.

During the initial study a system referred to as DHIS 2 was found to be one of the best emerging Information Management System (IMS) platforms. It is currently recommended by the UN (United National) affiliated organisations and seemed to contain all the functions necessary to create drowning information system. The evolvability of the framework is quite high as the core platform is developed and maintained by industry experts who are volunteering for a good cause, but under the purview of an organization set up in a developed country.

In what follows is a brief introduction to IMS and its benefits to educate the reader with technical definitions followed by a section with a detailed analysis to discuss how developed countries use Drowning Information Management System to gather data and implemented actions via the findings to take precautionary actions for drowning. A similar analysis is also discussed across some peer emerging economies of Sri Lanka to discuss any disaster management IMSs that are being implemented and used with the

spirit of finding a feasible technology that has a validated implementation elsewhere. DHIS 2 is a finding that emerged in the analysis as a strong candidate that is being implemented and considered by many emerging economies. The chapter ends with a brief analysis of technology used by the disaster management center in Sri Lanka and the benefits of moving the current solutions on to DHIS 2, validating it as a feasible technology approach.

1.2.1 Information Management System (IMS)

IMS is a common term for software designed to promote the storage, organization and retrieval of information. Having introduced in 1968 by IBM, it is modified to novel programming tools and environments today.[15],[16]

Database Management in IMS

The main functions of an IMS consist of ability to store, manage and retrieve data. The type of database system depends on the use of information where IMS need to respond on request or queries. Two main types of data base are hierarchical database and relational database. In relational database it uses number of tables rather than using single large table. Database administer is able to connect different related tables each other once data is collected by using keys. These keys help to identify one table data with another table. Relational databases are quicker in response to queries than hierarchical databases. Additionally, they can store more information. Furthermore, data access in Hierarchical databases is most of the time from the top to down. The relationships between tables are not addressed in these databases

Reporting in IMS

Reporting is one of the main features of IMS. A good information system depends on quality of the report it generates, which helps in decision making. Majority of IMSs provide multiple report templates while others generate specific reports that can be used as templates later.

Open Access in IMS

IMS open access is free of limitations but it is monitored by regulations and requirements internally. This allows the institution to easy accommodation with IMS to the existing system. Being open access results in reduced maintenance cost.

Integration in IMS

IMS usually integrates with an organization's existing system. The challenges vary depend upon the internal and external resources in the organization. A good IMS can easily integrate with legacy systems. It helps the maintenance of equipment investments at the institution.

Scalability in IMS

Not all companies require the full offering, some IMSs focus mainly on purchasing scalability. Purchasing a scalable system gives an organization room to grow without losing its initial investment. For smaller organizations it may require a scaled-down version of an IMS. [17]

1.2.2 Drowning Information Management System

Drowning Information Management System is a process where all drowning deaths are systematically collected, processed, interprets, analyzed. The gained information will be providing to the relevant organizations, in correctly and timely manner. This information will help to identify how serious the injury problem is, its effects, the risk factors involved and the area prevention measures needed, and how to prevent such. A main contributor to the decision making process. [18]

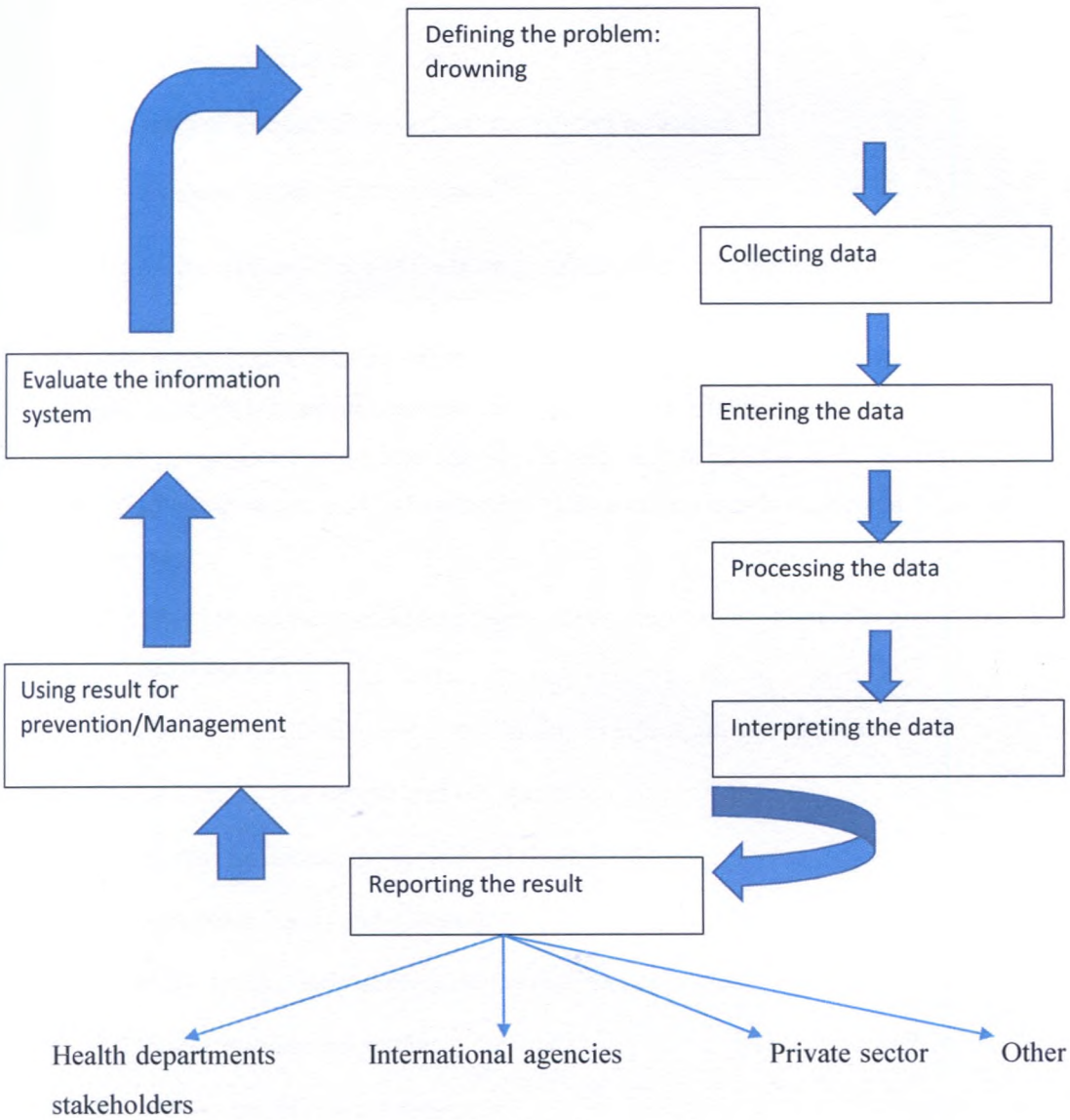

Figure 6. Drowning Information Management System

For optimum result of data gathering and analyzing and to interpret WHO guidelines has described as given below.

- identify trends in incidence.
- identify risk factors/ causes.
- develop successful preventive and control measures.
- evaluate the prevention impact.[19]

1.2.3 Benefit and Uses of Drowning Information Management System

Drowning Information Management System is a helping tool to analyze drowning deaths. Its main concern is to avoid hazards due to drowning specially in disasters. And for better prevention, mitigation and preparedness. As well as data can use in the decision making process to avoid deaths and risk reduction. There are various benefits which can gain in various ways.

1. Helps to monitor and analyze drowning events. This will help to plan prevention activities later.
2. Guides immediate action for emerging events .example.: disasters
3. To identify risk people and the places
4. Helps to estimate the severity of death burden.
5. Anticipate floods and disasters
6. Helps to take early actions for Prevention and control.
7. Proper resource allocation
8. Monitoring of control measures
9. To define priorities in policies and resources
10. To evaluate effectiveness of intervention program

1.2.4 Global Trends

Electronic information has evolved quickly, as it is not limited to databases, it extends globally and instantly. Presently disaster warnings are transmitted through social electronic medias or web within a short period of time. The technology which are used is up to date to match the global requirement.

Although there should be a separate Drowning Information Management System to collect data and plan drowning preventive measures, there are only a few countries have systems to meet these requirements. The most of developed and some under developed countries use fatal injury surveillance system to carry out their drowning information system purposes.

Example for drowning specific database systems are: Drowning surveillance system in Canada and the Royal Life Saving Drowning Data Base in Australia.

1.2.5 Drowning Information Management Systems in Developed Countries

The Canadian Surveillance System for Water-Related Fatalities

The Canadian surveillance system was developed by Canadian Red Cross, in collaboration with public health injury prevention professionals in the McGill Public Health, all provincial and territorial coroners, Medical Examiners, and other water-safety organizations (including the Canadian Coast Guard and the Lifesaving Society) in early 1990s.The database was included all unintentional drownings and other water-related injury deaths which have investigated by coroners or medical examiners in Canada.[20]

- Data collection

The surveillance database mainly relies upon annual water-related deaths report from the coroner and police. Obtained data for the surveillance system by using a questioner which consist of 48 questions. Mainly concern about cause of death, activity and purpose of activity, in addition personal, equipment and environment risk factors. The volunteer project manager collects data in every province. The deaths which is associated a crime (homicide/suicide/which need second investigation) Will be fallen to next year after gone through full investigations.[21]

- Data verification

Verification mainly done by well-trained Health injury researches including an epidemiologist and public health physicians. By this trained group all collected data verified corrected and entered to the surveillance. This verification is highly structured and well developed, and include issues like admissibility, completeness, internal consistency of responses, and consistency from year to year. The data entry is doing with appropriate quality control, including double entry and compare.

- Data analysis

The mortality rate for year were calculated by using an average of two censes estimates, example: 1996-2000 were calculated using an average of the 1996 and 2001 censuses, multiplied by five to represent 5 years of person-time. And age specific rates also calculated in same manner. Aboriginal Peoples Survey data and all census data and were obtained from the Computing in the Humanities and Social Sciences (CHASS) Data Centre at the University of Toronto. Those days has been used (2001-2010) to perform analysis by using SAS version 9.3and Microsoft Excel spreadsheets, but the technology using now a days are more developed and smart than that.[20]

- Drowning Prevention Research Centre Canada

Drowning Prevention Research Centre Canada (DPRC) is one of the leading agency for drowning and water incident research, they and have introduced a new web-based database. This database can create link between the data current year media, internet sports and the data collected from all provinces (provincial and territorial coroner's offices). Meanwhile the program report will facilitate the identification of high risk groups for drowning and provide data which required to create campaigns targeting risky behavior.[22]

- Non-fatal drowning surveillance system in Canada

DPRC has announced creation of same level of sophistication in the development of a comprehensive database on non-fatal drowning, they are doing research on that and working with experts in Canada and in other countries. By following WHO guidelines and with expert's knowledge and experience in non-fatal drowning data collection.[23]

Australian Fatal Drowning Database: The Royal Life Saving National Drowning Data Base

The Royal Life Saving National Fatal Drowning Database is a database in Australia founded by Royal Life Saving Society. The database consists of detailed information on the circumstances of all unintentional fatal drowning deaths, with the collaboration of Coroners, Federal, State and Local Governments. Meanwhile it has been great source for valuable resource for drowning prevention research and advocacy efforts in Australia. The database was made with possible ethical access to gain information from various authorities. (for example: The National Coronial Information System and State and Territory Coronial Offices, The Queensland Family and Child Commission and Surf Life Saving Australia). [24]

- Drowning Report

With the help of database, the royal lifesaving society producing an annual National Drowning Report in each year, National Drowning Report mainly concerned unintentional drowning deaths consist of the age, gender, geographic location, category of aquatic location and associated activity immediately prior to unintentional fatal drowning. [25]

- Royal Life Saving Society of Australia

The Royal Life Saving Society of Australia (RLSSA) is the major authority (is supported by the Australian Government) of data collection. It is established 120 years ago and continues its service to Australia. It provides services like education about water safety, proper swimming skills. It is also engaged in providing lifesaving education in Australia.

The Royal Life Saving National drowning data base aims are:

- Provision of a data set that can be managed easily, can respond quickly to enquiries.
- Keeping the records of all unintentional drowning deaths.

- Data collection analyze and interpretation

Data collected through annual drowning reports then after conformation it was fed in to the system. All cases in the in the database were checked regularly with the national coronial system and update as cases close within the coronial system. Data is fed to the data base after confirmation annually. Cross checking of all RLS cases against NCIS and

will be updated regularly. The coding manual which has been developed helps the researcher regarding coding and data entry.

Results

There were 3500 individual cases over 12 years in RLS data base. There were 103 variables in each case to be entered. The entered data include information about deceased, medical conditions, drug and alcohol involvement, location, season, etc.[26]

Water Incident Database UK – WAID

"WAID is a service developed by the Forum to bring together water-related incident data from a wide range of sources within the UK search and rescue region". Main objectives are:

- Providing idea about water related hazards and risk acceptability.
- Establishing coordinated efforts to make better national data.
- Providing high quality data.
- Provision of cost effective data collection.

National Water Safety Forum in UK

The Forum was established in 2005 to provide a single point of contact for water safety advice, expertise and information. The National Water Safety Forum (NWSF) is a UK-wide association of organizations that have interests in and responsibilities for water safety. This includes wide range of institutions that engage in water related activities. The Royal Society for the Prevention of Accidents (RoSPA) provides the technical and administrative support which needed. The National Fire Chiefs Council (NFCC) is a member of the NWSF, as are some 80 local authorities.

The NWSF also provides the Water Incident Database (WAID) designed to provide comprehensive information on risks from water-based activities. WAID collects data across the UK from different sources and categorize them accordingly

- Collecting data

This collects wide range of data through direct entry via Internet or uploads in large numbers.

- Analysis and reporting

The analysis is done in different levels. It is done in own data, all national data or data sets over several years. It can provide different reports respectively.

Electronic Injury Surveillance in United States

Electronic Injury Surveillance in United States was started in very early stages when compare with other countries, it was first establish in 1971. The primary purpose of the surveillance is to collect data on consumer product-related injuries occurring in the United States. [28]

The National Electronic Injury Surveillance System (NEISS) is a statistically valid, injury surveillance system operated by the U.S. Consumer Product Safety Commission (CPSC). NEISS monitors injuries treated in selected emergency departments nationally. Ninety-three representative hospitals across the country contribute data to NEISS.[29]

CDC's WISQARS™ (Web-based Injury Statistics Query and Reporting System) is an interactive, online database that provides fatal and nonfatal injury, violent death, and cost of injury data from a variety of trusted sources. Researchers, the media, public health professionals, and the public can use WISQARS™ data to learn more about the public health and economic burden associated with unintentional and violence-related injury in the United States [30]

1.2.6 Drowning Information Management Systems in Developing Countries.

There was no separate drowning data collection process in the under develop countries the drowning data was collected through Fatal injury surveillance as a sub injury category.

1.2.7 Disaster IMS in Sri Lanka

This is mainly used to collect drowning death data following flood /heavy rains. The Disaster IMS is a sustainable option inside the department. It helps in well-organized data gathering, documentation and analysis of data about losses due to disasters.

Benefit: The Disaster IMS is a systematic analytical tool which is used in the analysis of the disaster trend and its impact. As a result, this helps for better understanding of a disaster and its management.

Data availability: The Disaster Management Centre (DMC)is under the control of Ministry of Disaster Management and Human Rights (M/DM&HR). Disaster Risk Management program(DRM) of United Nations Development Program(UNDP) provides the necessary technical and financial aid

Technology used for Disaster IMS in Sri Lanka

The Disaster IMS (DesInventar methodology) is composed of two major components.

- The DesInventar module can be considered as a relational and structural database. It is fed by filling the different fields.
- The DesConsultar module permits access of the database. The queries include types of events, causes, sites, dates, etc. The results can be presented tables, graphics and thematic maps.

Information gathered was categorized into district and national level in the organization..[31]

Technology Suitable for Emerging Economies such as Sri Lanka

Poverty has deepened the crisis in health-care delivery in developing countries, particularly sub-Saharan Africa, which is a region facing a disease burden that is unmatched in the world. Whether access to proven and powerful information and communication technologies (ICTs) can improve health indicators is an ongoing debate. However, this brief review shows that in the last decade there has been significant growth in Internet access in urban areas; health-care workers now use it for communication, access to relevant health-care information, and international collaboration. The central message learned during this period about the application of ICTs is that infrastructural

and cultural contexts vary and require different models and approaches. Thus, to harness the full potential of ICTs to the benefit of health systems, health workers, and patients will demand an intricate mix of old and new technologies. [32]

1.2.8 Health Information Systems in Developing Countries

Health Information Systems (HIS) are critical not only for assessing the health needs of populations, but also for planning, administration, and financial management of health interventions. The contributions of HIS are especially important in global health for low-income countries where inadequate health infrastructure, political uncertainty, and economic disruption require careful stewardship of valuable resources.

Information and communication technologies (ICTs) are the foundation of electronic health (eHealth). As the field is propelled forward by the expansion of open-sourced software, better accessibility to hardware, and the standardization and promotion of eHealth agendas, developing nations are becoming better equipped to tackle the unique health challenges of today.

Although a considerable volume of electronic health data exists worldwide, the data is often fragmented and unable to be used in health-related decision-making. National eHealth managers at health ministry often struggle with how to link discordant information systems and integrate primary care projects. Those projects are subsidized outside of the official health system and collect data in different ways, using different code sets and communication formats. One of the crucial ways this problem is being overcome is by the establishment of standards for the collection, management, and transformation of data for its eventual dissemination and use.

- Recommended framework

The World Bank, United Nations, the World Health Organization, and other international organizations have been advocating for framework for the development and sustainability of health information technology through the use of eHealth agendas in the developing world for more than a decade.

Interoperability, or the ability of different information technology systems and software applications to communicate, exchange, and interpret the data that has been shared, is

vital to the success of eHealth systems and a critical component to eHealth agendas. The challenge for governments and stakeholders is advocating for the consistent use of standard content, coding, and communication formats that can be used regardless of technology.

- Open source and low cost

The implementation of eHealth systems in resource-limited countries has also been aided by the expansion of open-sourced software. Two well-known examples are OpenMRS, a software platform that enables customized design of Electronic Health Records with no programming knowledge or experience, and PostgreSQL, an object-relational database system that is able to run all major operating systems and has a strong reputation for reliability and data integrity.

Information and communication technologies for development are supported by various initiatives of the United Nations and USAID. They are helping to provide low-cost solutions for hardware acquisitions that allow low-income countries to have better access to technology.

The potential of eHealth to enhance health systems and to improve the quality, safety, and access to care has long been recognized as an indispensable tool for supporting health system management and planning in resource-poor settings. As health care managers, policy makers, and program leaders strive to develop an information system that meets the unique health needs of every population, efforts should made to establish a clear framework for evaluating performance and ensuring sustainable use of ICT solutions in eHealth.[33]

Feasible technology available for emerging economic countries such as Sri Lanka

DHIS 2 is a software platform that the University of Oslo developed in 2006 to manage health information systems (HIS). The first implementation was in India in 2006 and the first national rollout was in Kenya in 2010. Since then, low- and middle-income countries (LMICs) worldwide have adopted the software. DHIS 2 is flexible, adaptable, and extendable through web application program interfaces (APIs), which are useful for building software applications (apps). It can be customized to suit many purposes for health information management and for non-health sectors, too. Example of DHIS 2 using countries for improve health and non-health related information systems.

Uganda

DHIS 2 was adopted at the national level in January 2011. The system was initially piloted in 4 districts, before it was rolled out to all the 112 districts by July 2012. As part of the roll-out process, 35 training workshops targeting 972 users were conducted throughout the country. Those trained included Records Assistants (168, 17.3%), District Health Officers (112, 11.5%), Health Management Information System Focal Persons (HMIS-FPs) (112, 11.5%), District Biostatisticians (107, 11%) and other health workers (473, 48.7%). To assess improvements in health reporting, we compared data on completeness and timeliness of outpatient and inpatient reporting for the period before (2011/12) and after (2012/13) the introduction of DHIS 2. We reviewed data on the reporting of selected health service coverage indicators as a proxy for improved health reporting, and documented implementation challenges and lessons learned during the DHIS 2 roll-out process

Implementation of DHIS 2 resulted in improved timeliness and completeness in reporting of routine outpatient, inpatient and health service usage data from the district to the national level. Continued onsite support supervision and mentorship and additional system/infrastructure enhancements, including internet connectivity, are needed to further enhance the performance of DHIS 2. [35]

Mali

National Directorate of Health, other government agencies, working with implementing partners to transition the country's legacy HIS into DHIS 2. Data on HIV, infectious diseases, epidemic surveillance, and logistics management integrated with the new system. Significantly, for the first time, the indicators and surveillance data for Ebola were integrated in the HIS, which will provide good-quality data to ensure that potential Ebola cases are quickly identified so the country can take action. Other customizations have reduced the data collection burden on health workers. Ongoing work will integrate customized tracking for client retention on antiretroviral treatment, electronic registers for maternal health and child immunization programs, and logistics management. So far, 70 percent of health facilities now use DHIS 2 and 100 percent of health regions and districts use it. As a result, emphasis on data quality has increased in Mali, generating confidence in the data and fostering a culture of data use.

The Democratic Republic of the Congo (DRC)

World Bank, the Global Fund to Fight AIDS, Tuberculosis and Malaria, the European Union, and the British government's UKaid, together have provided technical assistance for DHIS 2 deployment. The project worked with technical experts from the HIS division and the National Malaria Control Program in three provinces to update malaria indicators and migrate the malaria database to DHIS 2, integrating it with the national HIS. The integration of medicine management, HIV data, and epidemiological surveillance is in progress. The process of adding data is not yet complete and health facilities are not yet covered. In addition, the country is contending with poor Internet connectivity, inadequate financing, and lack of tools and equipment. However, the achievements so far have laid a foundation for capturing health data that are timely and of high quality. [36]

1.2.9 Features of DHIS 2

District Health Information Software 2 (DHIS 2) is a free and open source health management data platform for collection, validation, analysis, and presentation of aggregate and patient-based statistical data, tailored (but not limited) to integrated health information management activities. It's completely web-based with well visualization features and the ability to create analysis from live data in seconds. DHIS 2 handles Aggregate, Event and Patient data, also allows additional functionality through open APIs and app development. It was developed by Health Information System Programme (HISP) and used in forty-seven countries including the European Union (EU), and governments worldwide.[37],[38]

When it comes to public health information management DHIS 2 plays major role, it has various benefits which can fit well with low income countries like Sri Lanka. The main benefits and features described in below.

1 DHIS 2 provide a complete data management solution based on data warehousing principles and a modular structure its more reliable and flexible which can be easily customize depend on requirements of management information systems at different level organizational hierarchy. [39]

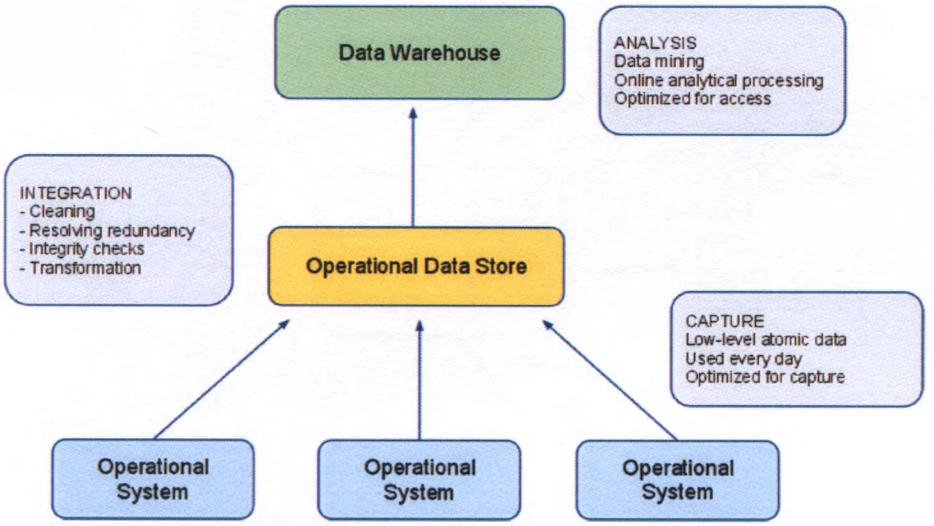

Figure 7. DHIS 2 data warehouse, Source DHIS 2 user manual

2 DHIS 2 is more reliable, in the data store in ware house and it is not directly connected to the sources where the data originated from and is hence not affected if data in the operational systems is purged or lost.

3 DHIS 2 Provide different kinds of validation tools to improve data quality, mainly are data input validation, validation rules, data range and outlier analysis. By using those validation rules user can make sure the data collected in correct format within the accepted range(the validation rules are defined with mathematical relationships between the data being captured for e.g. subtotals vs totals) [40]

4 Provide a comprehensive data management solution based on data warehousing principles and a modular structure which can easily be customized to the different requirements of a management information system, supporting analysis at different levels of the organizational hierarchy.

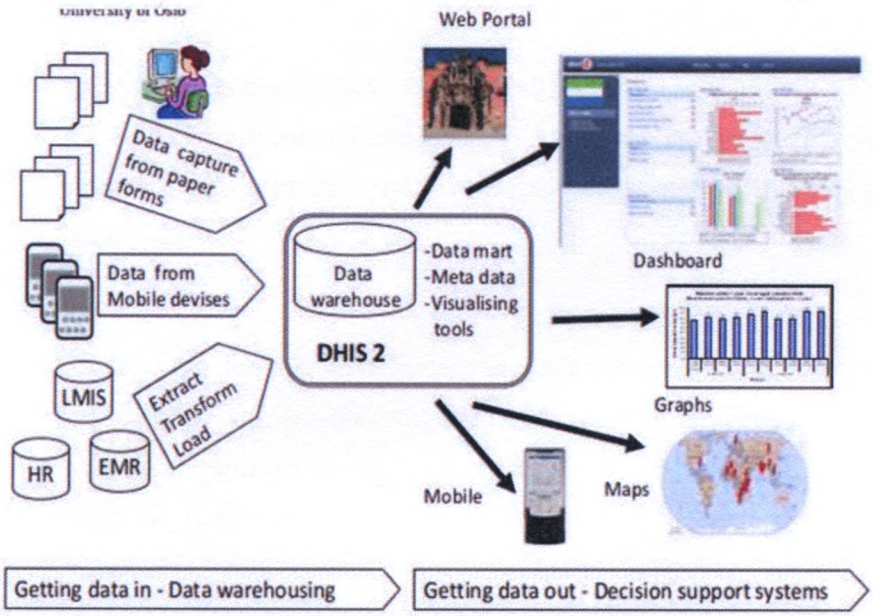

Figure 8.Features of DHIS 2, Source :DHIS 2 User Manual

5 Given the information needs for the health sector are constantly changing and evolving, there is a need for the user to have the freedom to make the changes as per the user requirements, this is often limited in proprietary software. But DHIS 2 is a free and open source software where people are free to use, copy, study, and change in every way. And it was released under BSD license, does not involve paying for prohibitive license cost. This open source software code can easily design depending on their purpose and needs, for example: customization and local adaptation. So it will be a better solution for the low economical countries like Sri Lanka.[41]

6 Another function great function of DHIS 2 is interoperability, it plays major role in the health sector by able to communicate and exchange information between two or more different systems. But his availability is often not possible in the case of proprietary software. And when it is, it comes at a high cost and contractual obligations. Functionalities of export-import of data and metadata, supporting synchronization of offline installations as well as interoperability with other applications.

7 DHIS 2 is a database which consist of all the database qualities include accuracy, it's unlikely to have data redundancy. And if the user entered wrong value the system quickly identifies and give a response, so that will help to avoid saving wrong values.

8 Provide user friendly environment to work with easy accessibility analysis and visualization with various tools and functions. Data can be analyze and visualize with more options it could be Reports, Pivot Tables, Charts and Graphs, GIS Maps or even more further it could customize in attractive ways by allow integration with other popular report designing tools (e.g. Jasper reports)[42].Meanwhile for the quick access DHIS 2 could use for user specific dashboard for the relevant monitoring and evaluation.

9 In the health sector personal details are bound to protect and keep in secure. This work much easier by using DHIS 2, by accessing the system with user roles password for the relevant responsible person. (from user to the system administrator).

10 Suitable This software is specially developed for managing public health data flow.

11 Highly Scalable- can have thousands of concurrent users and hundreds of millions of data records using only a single standard web-server.

12 Social Analytics DHIS 2 enables people to communicate and share interpretations of data.

13 Performance could monitor using in-built performance monitoring tools

14 Customizable Everything can be configured through user interface

15 Depend on custom need and demand DHIS 2 developers usually release a new version in every 3 months with newer system with more facilities.

16 Manage Individual Data Records DHIS 2 allows to collect, manage and analyze transactional, case-based data records.

17 DHIS 2 user interface can be manage in eight different languages, English, Chinese, Spanish, French, Russian, Portuguese, Vietnamese, and Tajik

18 Extensible through APIs and apps.

Figure 9. Pivot table/graph/GIS, Source: DHIS 2 User Manual

1.3 Rationale

Sri Lanka has significant death and injuries due to downing. According to WHO reports related to drowning published in year 2001 to 2009, shows 855deaths per year and the death rate was 4.4 percent among 10000people.Affected across all ages and around the country occurred under diverse circumstances. The economic impact due to drowning is significant [7].

However, the non-accurate statistics, missing data, inaccurate characteristics of drowning victims and the inadequate information on the activities they were undertaking at the time, are standing against rolling out counter mechanisms for drowning at nation-wide level. Even at the time of most terrible situations like 2004 tsunami and recurrent heavy floods that impact families, friends, and the entire community with immeasurable economic impact, have failed to gain any traction on a sophisticated information management system for drowning.

From institutional standpoint, disaster management center(DMC) has a major role during emergency situations in national wide-level. They have to be actively responding, participating and providing where necessary through distribution of resources on time, communication with other organizations to provide needs, and making early warnings accurately to minimize risk. They are also responsible for effective post disaster activities but unavailability of drowning data, poor quality of data sources and incomplete information have been affecting the operations of DMC quite significantly.

DMC is also the institution responsible to coordinate and collaborate with the respective ministries, departments, agencies, authorities and local authorities at national, intermediate, and Grama Niladhari levels. They are given constitutional authority to interact with the armed forces, police, international and national NGOs in managing national disaster situations for the purpose of country wide risk reduction. In the current process and workflow, the main source of information and data collecting point is registrar general's department and Sri Lankan police but the chain of data flow is not yet established and premature[43]. The data collection process is also mainly paper based prone to incomplete, incorrect or redundant data. Moreover, the data collection process is long and time consuming. The privacy and data security aspect is also completely ignored.

The aim of this research is to tighten all the lose ends in the current (Information Management System) IMS process/workflow and replace it with a state of the art drowning information management system that is to capture all drowning deaths/injuries

and analyze/visualize all such information in real-time. It will also be used as the main tool in a national disaster situation to provide maximum services during the three phases of response, rehabilitation, and recovery by compiling credible executive reports to share with national executives and world-wide organizations such as WHO.

As proven to be feasible in the literature study, DHIS 2 is the strongest candidate to use as the application framework for the solution. DHIS 2 is FOSS and it can fulfill the urge need in DMC [44]. It will be an electronic information management system hosted centrally and accessed across the nation by number of users with designated workflows depending on their role in the process. DHIS 2 is developed by Health Information Systems Programme (HISP) coordinate by Department of Informatics, University of Oslo and supported by NORAD, Research Council of Norway. Its credibility gained through number of deployments across globe speaks for its suitability for the drowning information management system needed by DMC.

1.4 Objectives

Research Question: How to customize DHIS 2 for drowning information management system

1.4.1 General Objective

To customize and implement a Drowning Information Management system for disaster management center based on the free and open source public health software frame work DHIS 2.

1.4.2 Specific Objectives

- To identify the requirements of drowning information management system.
- To identify and analyze relevant stakeholders.
- To gather software requirement specification
- To customize DHIS 2 to accommodate the identified requirements.
- To pilot the drowning information management system at the National Disaster management Centre.
- To develop a user manual.
- To rollout amongst a selected audience of a selected geographic location

2. Materials and Methods

This chapter discusses the requirements discovery, customization process and implementation of drowning information management system at Disaster Management Centre. The first two parts of the chapter discuss the DHIS 2 design work flow and the advantages of using such a guided framework for information management solutions. The subsequent sections attempt to explain the solution methodology to the granular details by elaborating the requirements gathering process, data modelling, and list of customizations made to meet the requirements and also the live deployment of the software solution at disaster management center. The underlying core principles of the implementation as well as the rollout process to the focus user group through trainings and workshops were ensured to be in line with WHO drowning prevention implementation guidelines and WHO injury surveillance guidelines.

2.2 DHIS 2 Design Workflow

2.2.1 Using DHIS 2 in health information cycle

The wider context of Health Information System in DHIS 2 can be comprehensively described through the data information cycle as given in figure 10. The information cycle consists of various stages from data collection to the use of data. In these processes DHIS 2 supports the collecting of data, quality checks, accessing data at multiple levels, reporting, analysis using graphs maps and GIS, enabling comparison between different data elements or time scale (for example, previous months) and measure trends (use data series to see their min and max levels).

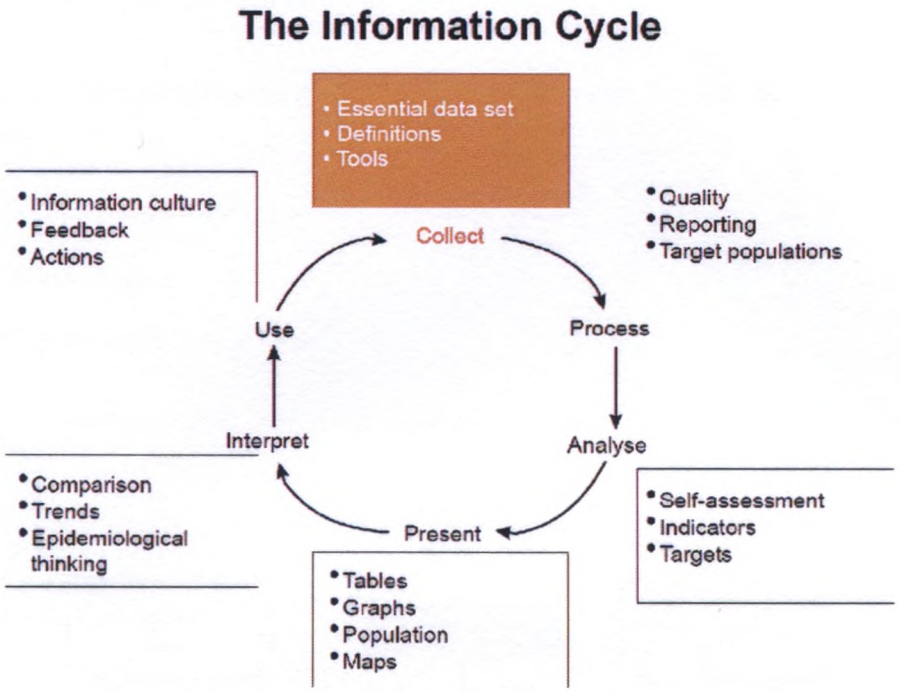

Figure 10. The health information cycle (source: DHIS 2 user guide)

The first step of the information cycle is data collection, recording and processing. This is mainly done through data entry in software forms which could be created with data elements and customized user defined forms. All types of data needed are entered into the system by software forms in this solution however the framework supports number of plugins and APIs to integrate non-human equipment such as scanners, barcode readers etc.

Second step of information cycle is to ensure the integrity of data. The data quality can be improved by assigning each data a minimum and maximum level, eligible list, bounded list etc. so that the users are no allowed to make fat finger errors. Any sophisticated quality errors can be further reduced through four eyed verification steps such as entry user and approval user provided through user roles.

At the last stage all collected data will be processed to generate analytical reports with the help of indicators. The analytical report could view in various ways, as graphs, as charts or as profiles.

2.2.2 The Data Model of DHIS 2

The DHIS 2 data model consists of three dimensions which are flexible and connected each other

- What: data elements
- When: Period
- Where: organization unit

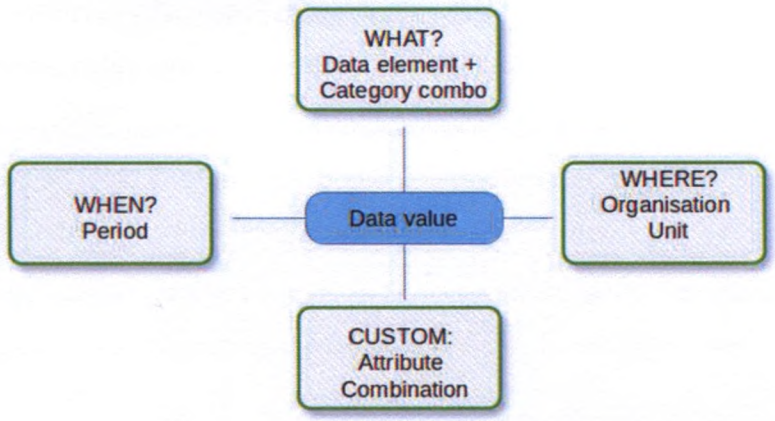

Figure 11. Data Dimensions of DHIS 2 (source: DHIS 2 user guide)

2.1.3 The Event Capture Module

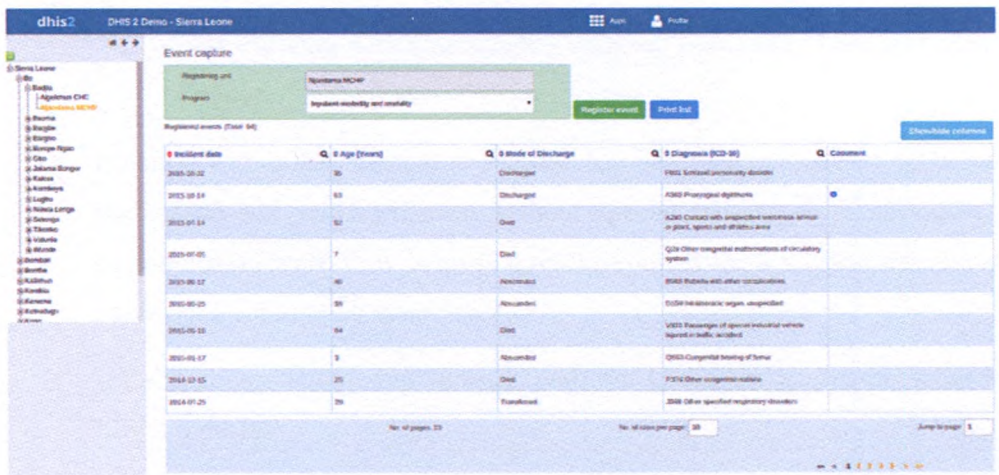

Figure 12 Event Capture Module

In DHIS 2, event capture module will allow to register any events at given time and place. Sometimes these events call records. In the DHIS 2 platform events are linked to a program. The event capture module will allow to select the program stages in order to enter data in information form by selecting the appropriate organization unit and the date when an event happened.

The Event Capture application could work online and even offline. Even when the internet connectivity drops the data will be saved locally and when connectivity re-established it will upload to the database in the server.

The access of data for view, edit and approval are being done through user roles in DHIS 2. There are also validations and warning massages to streamline registration.

DHIS 2 has a quite comprehensive functionality around indicators. When a program has indicators and all related values related to the indicator expression is filled, the system will calculate indicator and display the output.

Graphical user interface (GUI) supports an enriched functionality. For example, sorting and filtering data could be done by the selecting the icon in column header.

2.3 Advantage of Using DHIS 2 for Drowning IMS

- Main benefit is it being free and open source so that;
    - the cost becomes very low and affordable for immerging countries like Sri Lanka
    - fast evolving with functionality enriched with state of the art technology support
- It comes with a user manual and online learning material that are quite easy to understand and self-learn even without special training from an expert. The customization work flow is quite intuitive enough for a medical practitioner to carve out a solution by themselves.
- It has a strong and proven versatile platform to support any requirement in the health industry

- It has a strong extensibility (for example, can use mobile app later on rather than entering data through computers) to fasten the time to get information and react instantly.
- Because its work online it could use to disseminate the data to the relevant organizations (which associated to disaster e.g. S.L. Navy, Health Ministry, etc.) same time as well as collecting data.
- And it could use to trace all drowning risk zones in S.L by using GIS map and to locate risk area geographically

2.4 Identify Stake Holders

Any individual or organization who is interested in drowning information could be considered a stake holder. It is imperative that the drowning IMS consider the interests of all such parties. The key stakeholders are those who work for the government with specific job descriptions/roles attached to the collection, communication and action tasks related to drowning incidents. For the purpose of the project implementation such stakeholders were identified in a specific geographic region, and can be extended to the entire country with a significant level of generalization as the government service is fairly uniform.

Followings are the key stakeholders who we directly involved in the project as requirements owners or end users of the system.

- Staff members in National Disaster Management Unit who relevant to the project including technical staff.
- Health ministry Disaster management unit.
- District secretariat at Bingiriya.
- Administrative officer of Grama Niladari at Bingiriya.
- All Grama Niladaries.
- Development officers at Bingiriya Disaster management unit

There were certain number of potential stakeholders, such as those who are not directly involving but has an interest or attach to the part of the process. To ensure the project contains the interest of such parties a number of random participants were also involved

across police, legal institutions, policy makers, insurance companies, social welfare organizations, political leadership and NGOs.

2.5 Establish Project Goal and System Objectives

The IMS mainly considers the drowning deaths as well as water disaster deaths which are valuable information for DMC to proactively act on all four phases (1) mitigation; 2) preparedness; 3) response; and 4) recovery). The system should be able to identify common causes of drowning, water source, location and risk factors and high risk people and the age groups.

Data collection to be done by Grama Niladari of every division and hand such over to the officer in charge at Grama Niladari division resided in the district secretaries. Those collected data would be entered to the system by accessing web application. As the data are entered any respective visual analytics and reports in the DMC will get updated in real-time.

Although the current scope is to limit system access through a browser based application, a possible further enhancement would be to provide a mobile application such that data entering Grama Niladari and data accessing users will have the capability to perform their tasks in mobility and fast.

2.6 Identify the Data Need

The data elements of the drowning information form were designed according to the WHO drowning prevention guidelines and fatal injury guidelines. Any specific variations and localizations were identified through dependent user requirements and objectives of the information system.

Majority of system user requirements were gathered from the users involved in the current process/workflow and their data forms, mostly a translation from a paper based process to a paperless process;

- Identification of data sources for the system: The main data source is the drowning information form.
- Assessment of available resources: Resources are mainly from the DMC which are already allocated for disaster information system in the DMC (e.g. Technical equipment, well trained staff).

- Collecting data: Initial plan is to collect data of 2017 from the pilot study in a selected place –Bingiriya, and to expand further on to the rest of the country.

2.7 Requirements Analysis

Requirement analysis is the basis for establishing a stable system. It has three main steps:

- Feasibility Study
- Requirement Gathering
- Software Requirement Specification

2.7.1 Feasibility Study

Feasibility study is an assessment, which requires to assess viability of the target information system and its expected final result to help decide whether project need to be carry out or not.

There are 4 main components that could be concern of.

1. Economic Feasibility

The economic feasibility is done to analyze whether expected benefits are equal or exceed the expected costs in the information system. The main cost factors which are contribute to the information system expenditure are as given below:

- Hardware cost– web server, laptop computers for data entry, mobile devices for data entry,
- Software cost– licensing cost will be free of charge if FOSS is used
- Hardware and software implementation cost– its free of charge if use by local expertise.
- Maintenance cost –initially there's no maintenance cost
- Network management expenses –using local expertise so it's free of charge.
- Software licensing cost – using FOSS so it's free of charge
- Cost of electricity and maintenance of web server – fairly bearable

- Cost data entry – using DMC currently available disaster management system resources and computers to the pilot project were purchased from ministry of health.
- Cost for training of end users –initially there is no cost.

2. Technical feasibility

The technical feasibility is done to identify the availability of required technology and further resources. The factors taken into consideration are;

- Availability of resources- currently the resources are manageable, using mainly from DMC.
- Availability of technology-by using DHIS 2 which is free and open source and it suits with the current technology.
- Familiarity with Technology: It will support by Health Informatics Society of Sri Lanka (HISSL) for technical expertise, as well as health informatics experts in Sri Lanka with experience on open source customization, adaptation and project management. And the team undertaking the project would be rich in technical familiarity.

3. Operational feasibility

The proposed system will resolve the concerns in the current process (further elaborated in project objectives and goals) of national DMC. The technology has to be cost effective compared to other proprietary systems, however if the system is not well received by the users the software will fail in its rollout for daily usage. What is critical for roll out therefore is the ability to integrate with existing workflows and the power of influencing effective changes to the current process. It can be achieved when the software (and the related information) forms for drowning IMS are created following global guidelines and also considering end uses responses.

4. Ethical Feasibility

The piloting project has been done in the local server which is not connected to outside and can only be accessed by government authorized users hence the personal details of the affected individuals are protected. Even when it is accessible publicly all necessary precautions are needed to protect data privacy. The information forms will be kept within

the responsible organizations or with the person who in charge, and any disclosure to outside parties will require approval. In terms of project execution, the data protection and misuse of personal details are protected and relevant Ethics approval is also taken from the ERC of PGIM.

2.7.2 Requirement Gathering

Drowning information management system requirement gathered from the DMC and from their stake holders, to study the existing process and identified further requirements to be done in Bingiriya divisional secretory where most frequent flood and drowning deaths was recorded in Sri Lanka.

A series of discussions were conducted with Gama Niladari, Gama Niladari in charge officer, developing officers at disaster unit in Bingiriya, and captured their requirements, ideas and opinion for further improvements for the information management system to provide information on timely and accurate manner. The feedback was helpful to improve the data collection form, identify areas of current resources and the suitable technology.

At a very high level following are the areas of their highest concern to address through the new drowning IMS.

- Full fill the objectives
- Advance collection data collection form
- Accurate information
- Timeliness of data
- Gain adequate data from all the data sources
- Establish access
- Control and verification of different level hierarchy

2.7.3 Software Requirement Specification

Gathered information can be categorized under functional, non-functional and system requirements when diving deep in to the granular requirement capturing.

1. Functional Requirements

The functional requirements are the inputs, behavior, and outputs of the information system expected by the stakeholders and the functionality it would provide to satisfy the requirements.

General system requirements

- Should manage users and user roles.
- Should capture all data in every divisional secretariat.
- Should be able to handle null values according to set criteria.
- Should be able to validate entered data.
- Should be able to identify duplicate records.
- Should be able capture individual event capture records according to set criteria.
- Would be able to generate customized event capture reports.
- Reports should visualize as chart or tables and could be able to export or print.

The system Administrator/Program manager

- Has authority to log in to the system.
- Can generate, modify and delete users.
- Can manage user roles.
- Can allocate users to organization units and Programs.
- Has authority in data element generation, update and deletion.
- Can create, update and delete datasets at any stage.
- Can generate and modify data entry forms.
- Able to create and modify individual patient records.

- Able to search patient records for relevant reasons.
- Can generate customized reports after analysis.
- Has authority to share custom reports.
- Able to modify dashboard
- Able to block or unblock users.
- Edit own profile details.
- Ability to add new roles.
- Add new user to the system.
- Edit details of any user.
- Reset or generate login details to users.
- Add new option to the system.
- View reports.
- Print reports.
- Back up data from the system when needed.
- Remove option from the system
- Update option.

The data Entry user

- Has the authority to log in to the system.
- Able to create, retrieve and update individual death person records.
- Should be able to search relevant area person records.

The view user

- Can log in to the system.
- Able to view the report dashboard.
- Able to view custom reports.

2. Non-functional Requirements.

Nonfunctional requirements are the properties which are not directly associated to the function of the system, but are necessary for the usability, reliability, maintainability, scalability and security of the system.

- The system shall be run on any server.
- The system should run on any browser.
- The system should allow data entry using multiple users.
- The system should be able to secure user data
- The system should be able to protect patient data
- System response time should be minimal during logging and saving data entry forms.
- System shall be developed by free and open source.

3. System Requirements

System requirements are the platform and hardware requirements of the information system which are needed to support the function and nonfunctional requirements to the expected levels.

2.8 Data Modelling and Design

Data modeling is the process of documenting a complex software system in to a simple understandable diagrams with the involvement of synthetic entity definitions. This will be baseline structure that drives the solution when performing customizations. All information will be summarized to make it easier to understand the requirements.

2.8.1 Context Diagram

Context diagram will help to illustrate the components of the Drowning Information System.

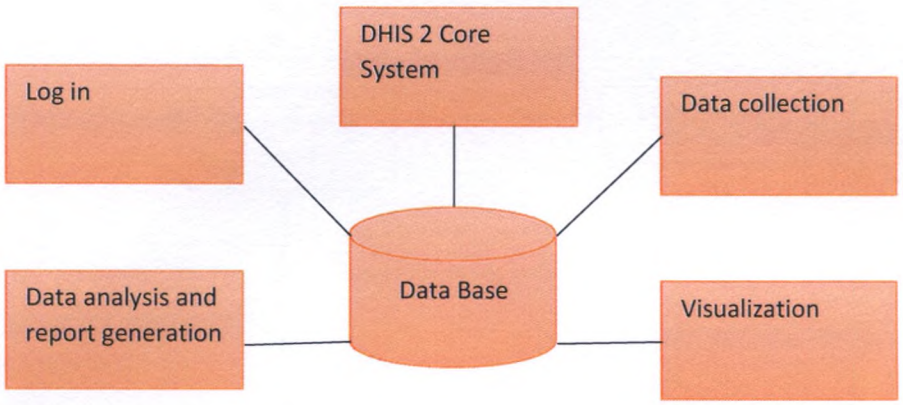

Figure 13, The context diagram

2.8.2 Activity Diagram

Activity diagrams are flow charts which represent the dynamic aspects of the system. Some of the main parts are described below.

User login

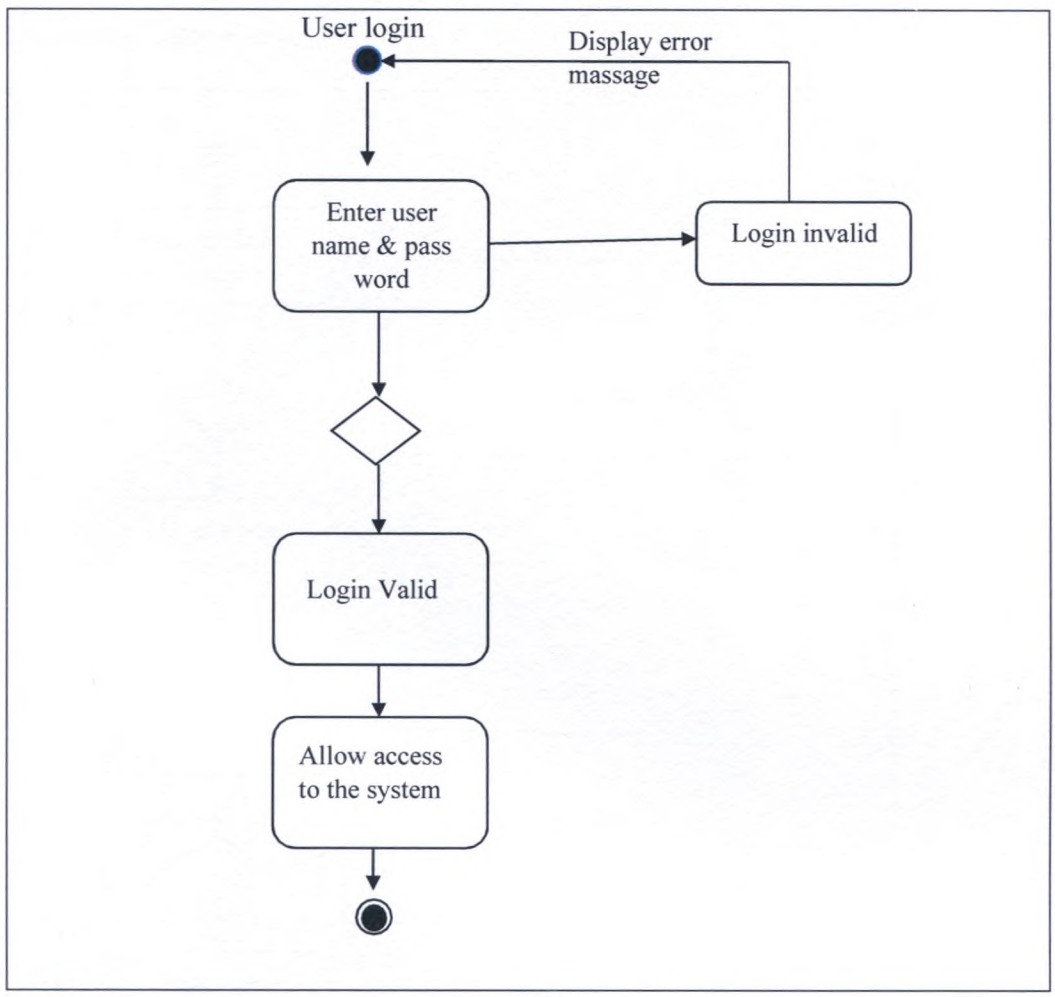

Figure 14. User Login

Create new death record

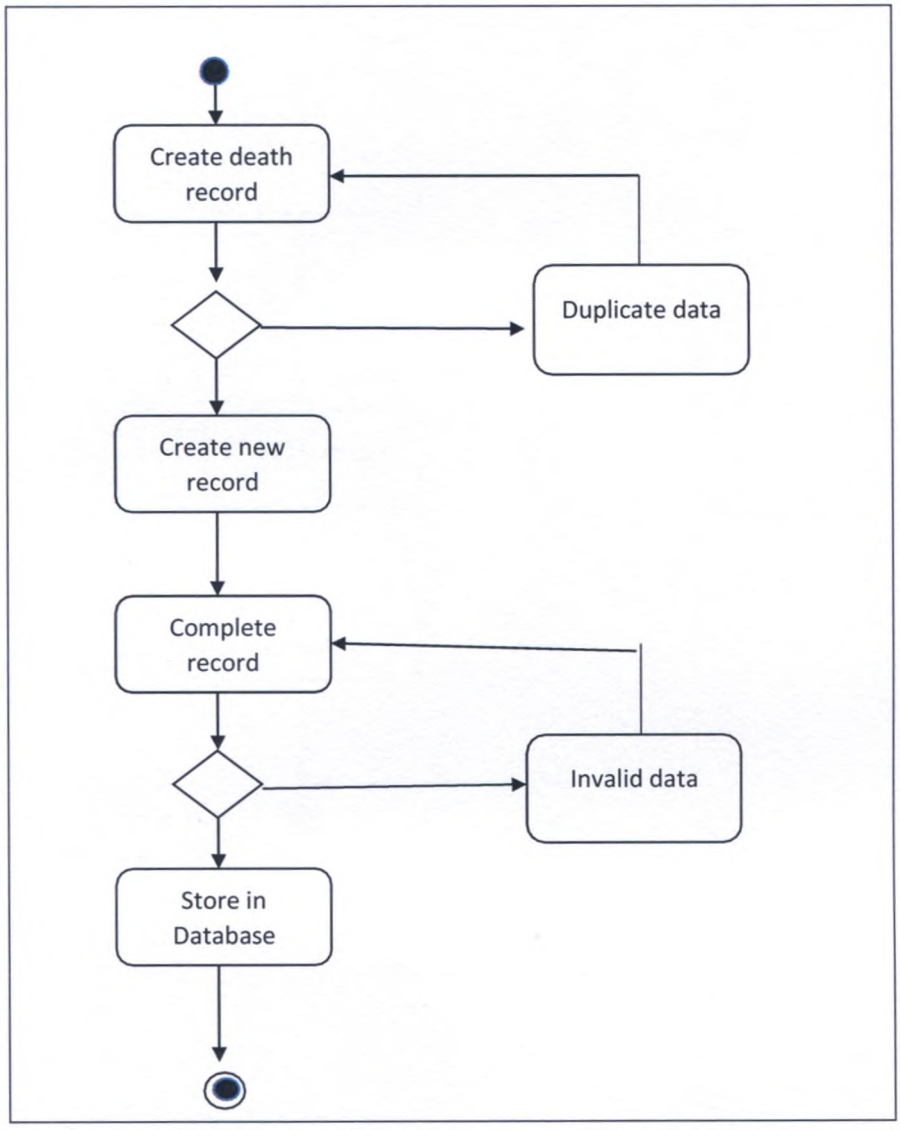

Figure 15. Creation of individual report

Delete Individual death record

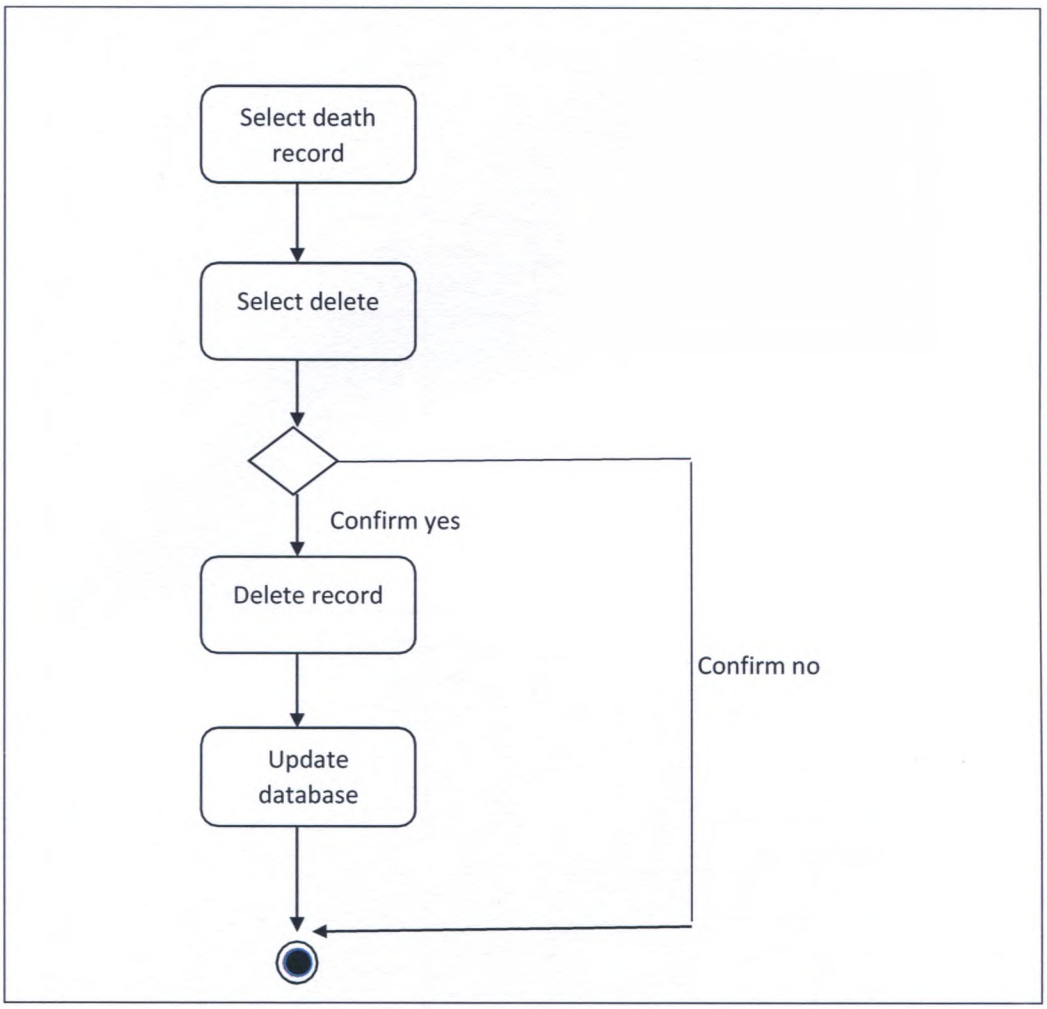

Figure 16. Delete Record

Generate report

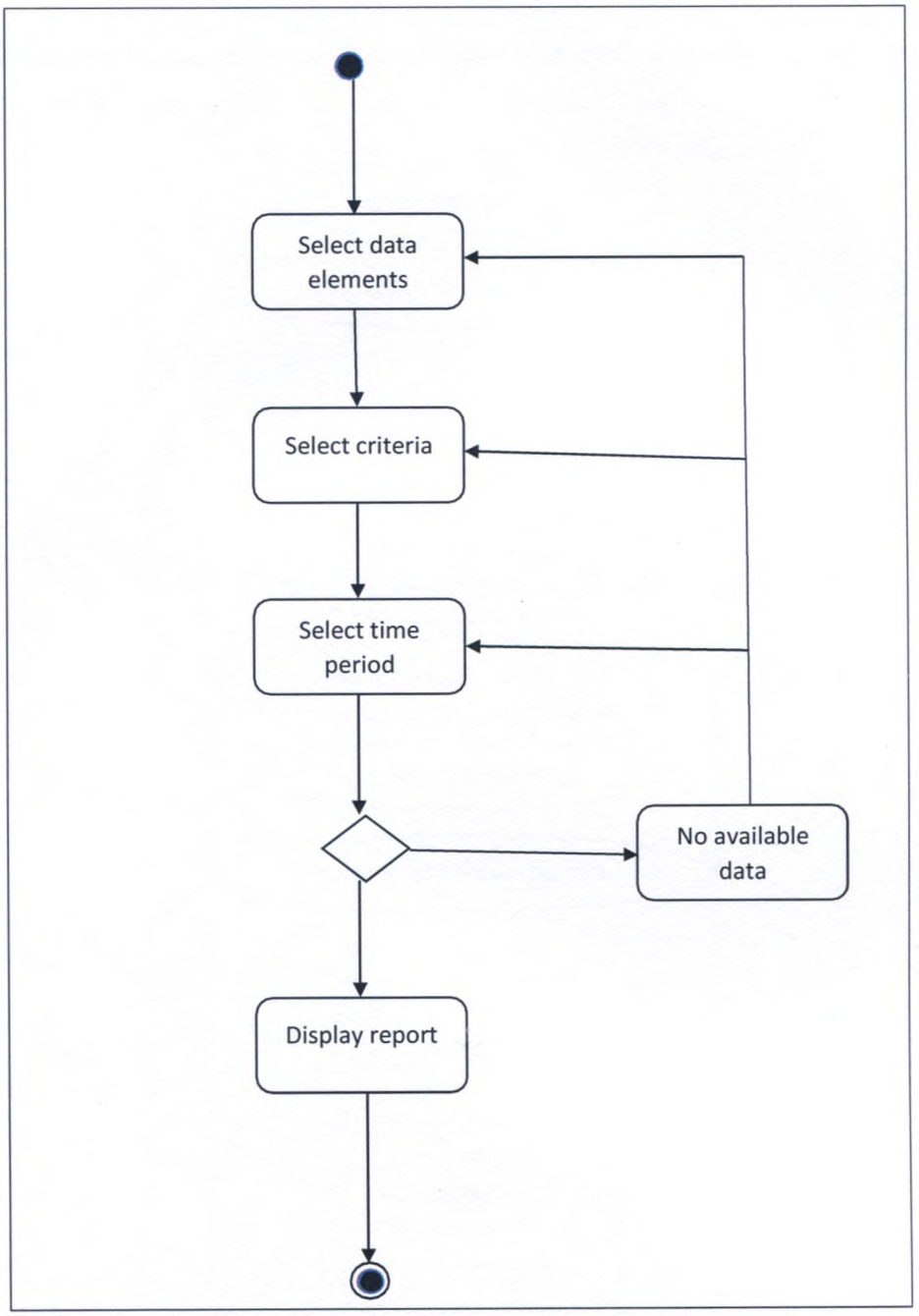

Figure 17 Generate report

2.8.2 Use Case Diagram

A use case diagram is a graphical picture which illustrates the interaction among elements of a system. It is described in Figure 18 below.

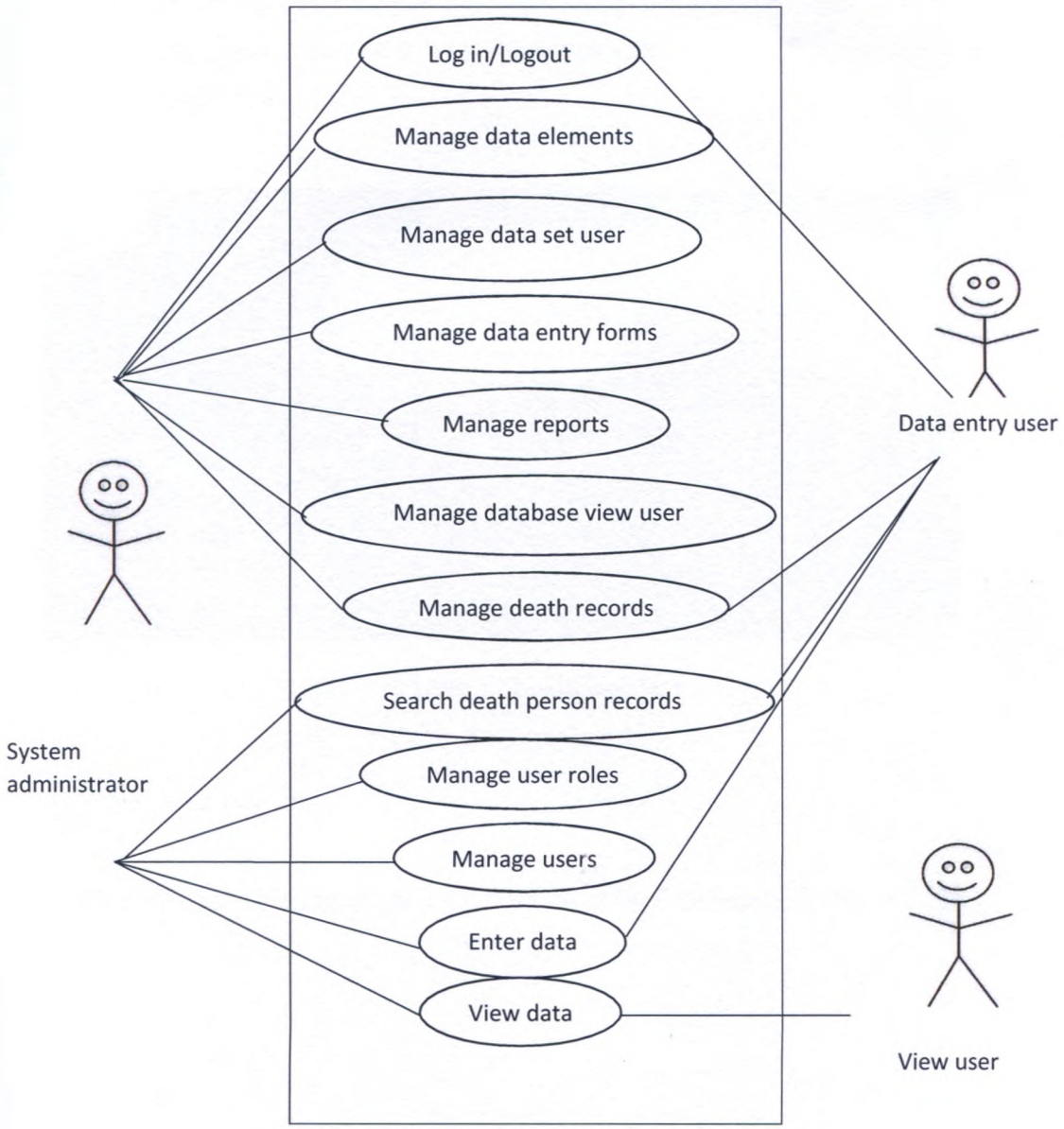

Figure 18. Drowning information system use case diagram

2.9 Customization of DHIS 2

2.9.1 System Login

System login was customized with Sri Lanka flag as the logo and with a suitable name. Access to the system should be through a user name and a password, pre-assigned by the system administrator.

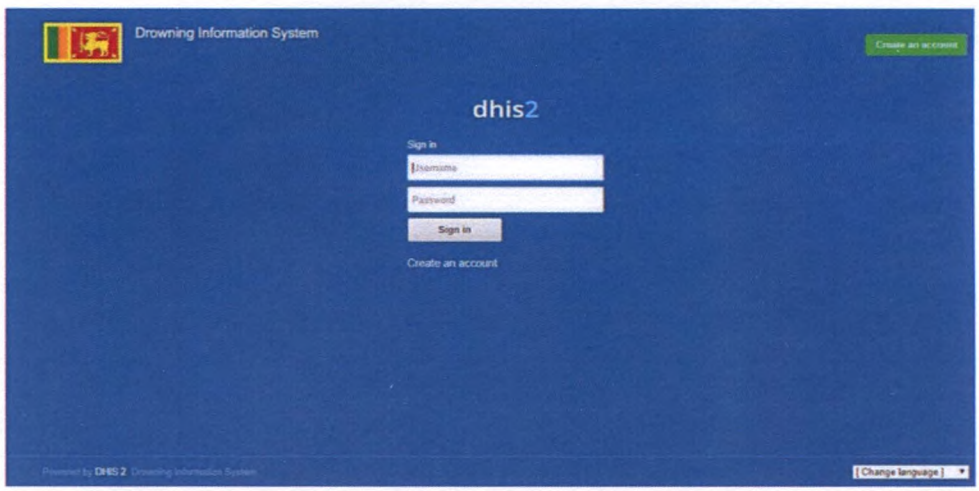

Figure 19 Login Interface

2.9.2 Log Out

Can log out by clicking admin or log out button in the right upper corner.

2.9.3 DHIS 2 Navigation

Drowning information system navigation can be used for the fast access for different modules. It has two menus, the main menu is at top of the page and the second menu is at the left side.

Top menu is for apps and user profiles and left side menu modules are to navigate between features inside each module.

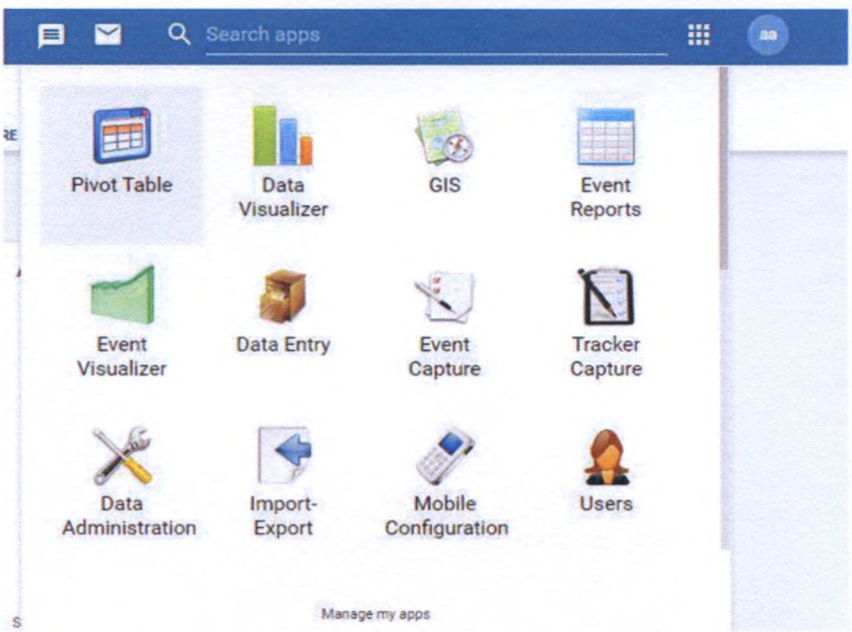

Figure 20 DIS navigation

2.9.4 Organizational Hierarchy Levels

Organizational hierarchy units are built with the convenient framework support in DHIS 2 platform. For the drowning information system there are five levels: National, Provinces, District, District Secretariat and Gama Niladari division. By using such hierarchical levels system can easily collect data across Sri Lanka with the ability to dissect further down on demand.

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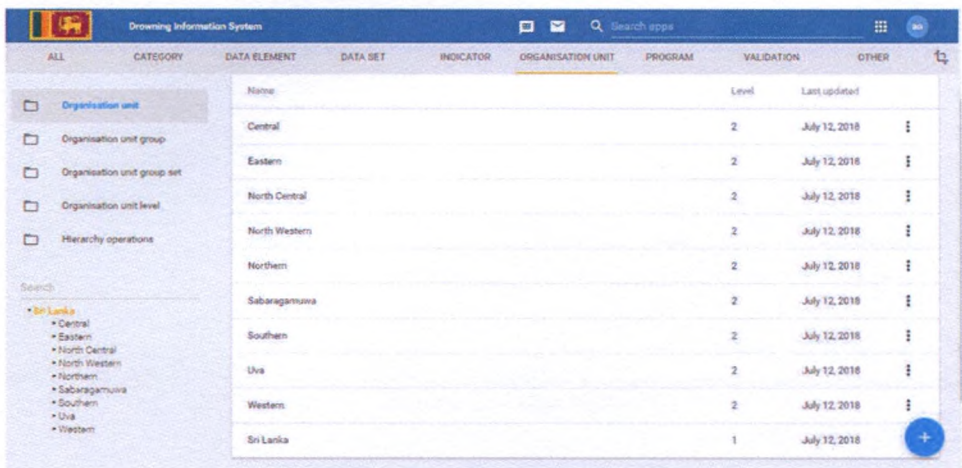

Figure 21 Organizational Hierarchy

2.9.5 User Roles

The DIS the system would be used by four users. Administer, Super User, Manager and Grama Niladari.

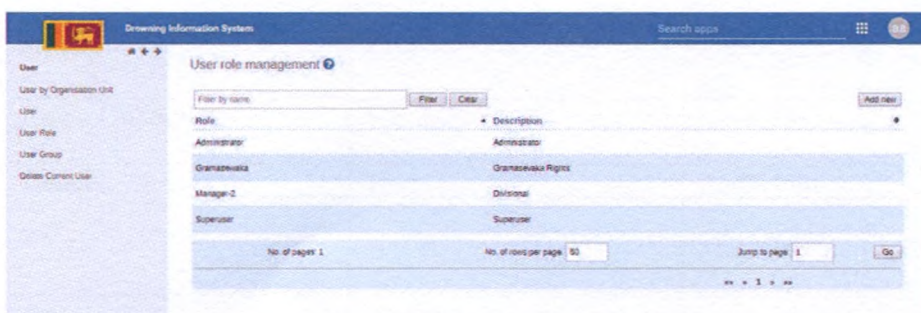

Figure 22 User Roles

2.9.6 Data Elements

The data elements are identified based on the information intended to capture through information forms of drowning deaths. It mainly consists of text fields, numeric field, and option set.

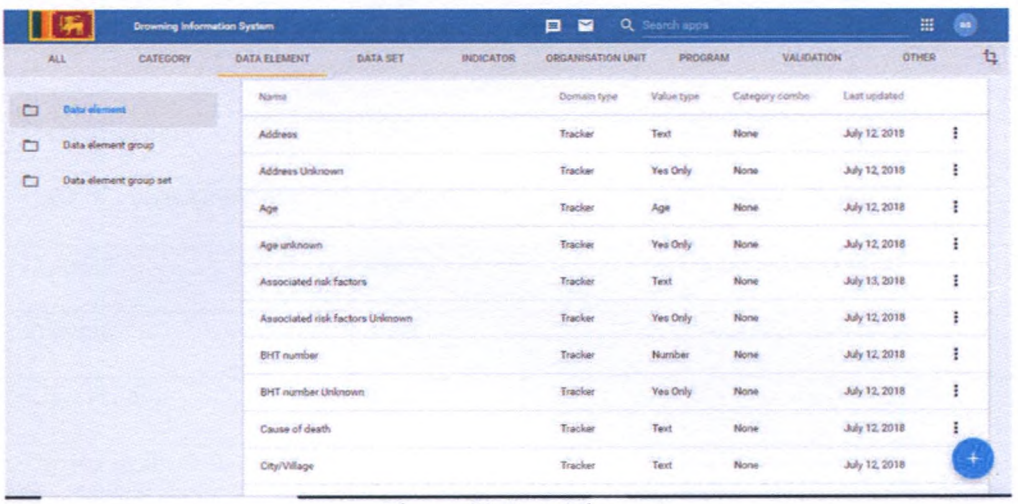

Figure 23 Data Elements

Table 5. Data Types

Name	Value type	option
Basic Information of Victim		
Unique reference number	Number	----------
Name	Text	----------
Name Unknown	Yes only	----------
Gender	Text	Radio button Male/Female/Unknown
Age	Number	----------
Age Unknown	Yes only	----------

Address	Text	----------
Address Unknown	Yes only	----------
Nationality	Text	----------
Date of death	Date	----------
Date of death Unknown	Yes only	----------
Facility name	Text	----------
Event		
Date of event	Date	----------
Date of event Unknown	Yes only	----------
District	Text	Select-Drop box
Province	Text	----------
City/Village	Text	----------
Drown in fresh water	Yes/No	----------
Drown in salt water	Yes/No	----------
Source-fresh water	Text	Radio button - Swimming pool lake/River/Well/Other
Injury occurrence Residential	Text	Dropbox Home/Yard/Other
Injury occurrence Non Residential	Text	Dropbox Picnic/Leisure/School/ University/Accident
Flood disaster	Yes/No	----------
Travel on water	Yes/No	----------
Occupational	Yes/No	----------
Associated risk factors	Text	Dropbox Alcohol/Drugs/Fits/Trauma/ Stroke/CVS/Carelessness/

		Lack of Swimming ability
Associated risk factor Unknown	Yes only	----------
Life support given	Yes/No	----------
Life support Successful or not	Text	Dropbox Successful/Unsuccessful
Time lapsed to recovery	Text	----------
Time lapsed to recovery Unknown	Yes only	----------
No life on recovery	Yes only	----------
Hospital Information		
Hospital admission	Text	Dropbox Yes/No/Unknown
BHT Number	Number	----------
BHT Number Unknown	Yes only	----------
Died before admission	Yes Only	----------
Died in Hospital	Yes/No	----------
Length of Hospital stay	Text	----------
Postmortem examination number	Number	----------
Postmortem examination number Unknown	Yes only	----------
Cause of Death		
Cause of death	Text	----------
Incident Summery narrative	Text	----------

2.9.7 Data Element Group

Data elements were selected into groups so that it can easily identify the categories in the form.

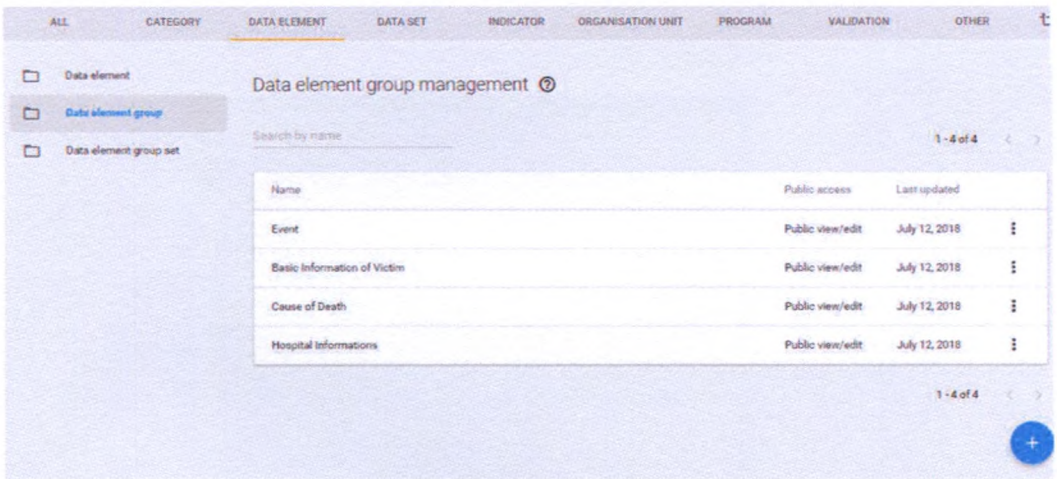

Figure 24 Data Element group

2.9.8 Data Set Management

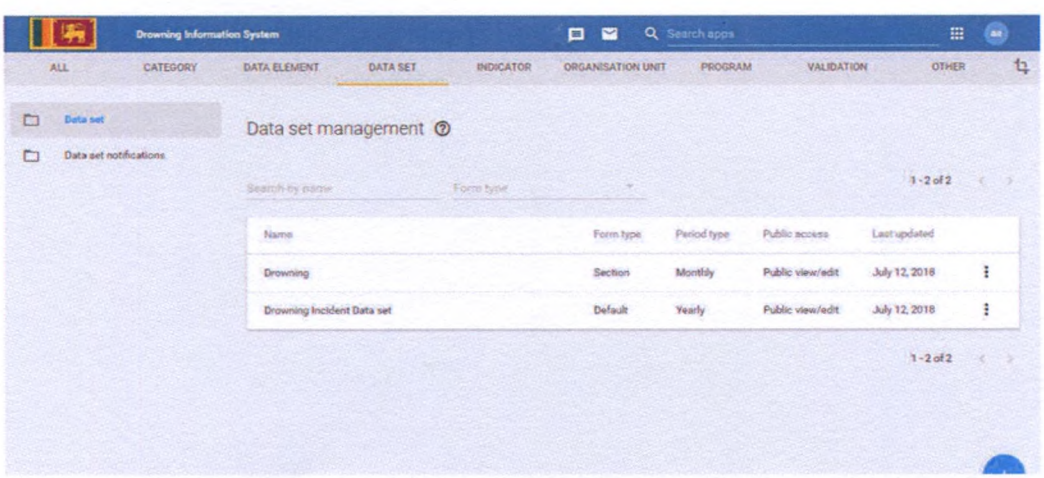

Figure 25 Data set Management

2.9.1 Create Data Entry Form

Data entry form is created by using DHIS 2 section form which is simple and easy to design. All data elements will be categorizing and assigning in to tables. It will generate the form automatically.

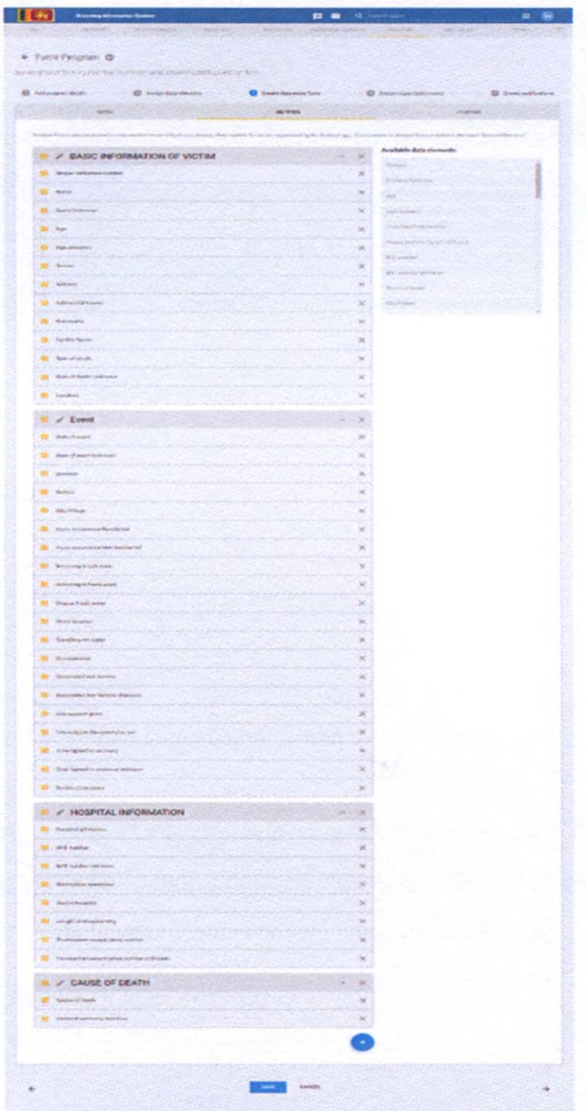

Figure 26 Creating Data Entry Form

2.9.2 Capturing Drowning Death Event

Drowning information system is built using event capture module. First step is to select event capture data entry form and assign an organization (the lowest level is Gama Niladari Division) from the organization unit then register the incident. It allows to capture single event of drowning death data. The second step is to select the organization unit and program, and then to enter the date of which the event has happened. Finally, the information form will appear to fill.

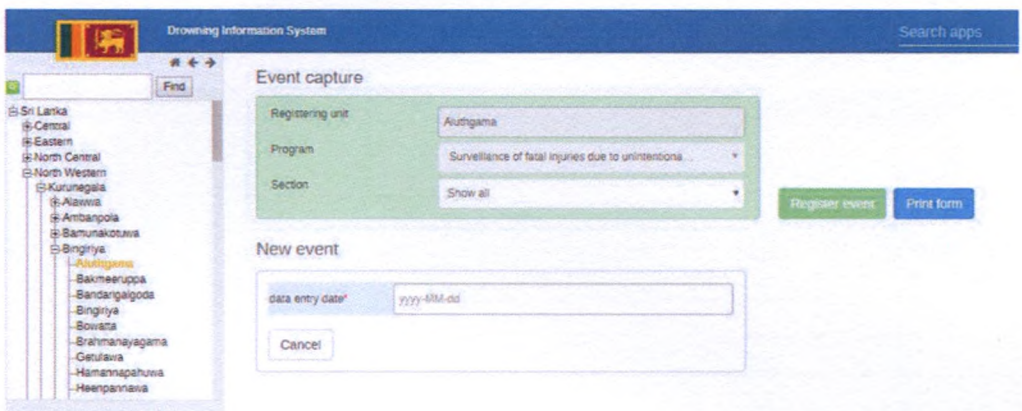

Figure 27 DIS Register New event

2.9.3 Event Capture Data Entry Form

After registering a new event and selecting an event date, the full form will appear. The data entry form is made up using data elements, and designed customizing program stage data entry form. This is much quicker and simpler to design.

(The form snap shots in appendix D)

2.9.4 Data Approval

The current situation at Bingiriya, is the data which was collected from Grama Niladari will be entered in into the system by appointed developing officer at District secretariat at Bingiriya. The data will be then accepted and approved by district secretary. If it's not verified, the system will not accept the data for analyze and generate the report. Therefore, the verification step plays a main role to generate accurate report from the data sources. Finally, this accurate and verified data will become accessible at DMC.

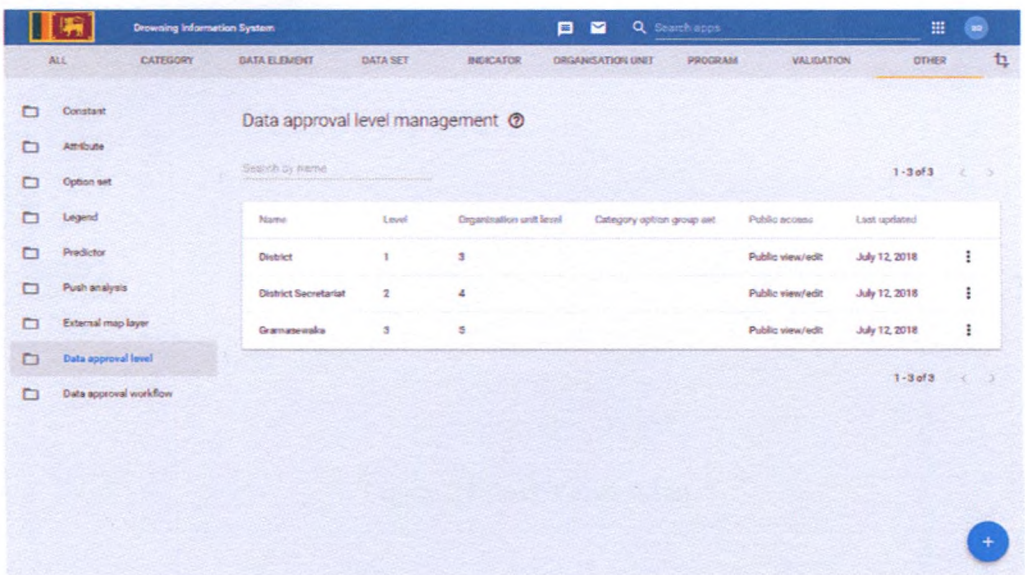

Figure 28 Data Approval

2.9.5 Verification of Data

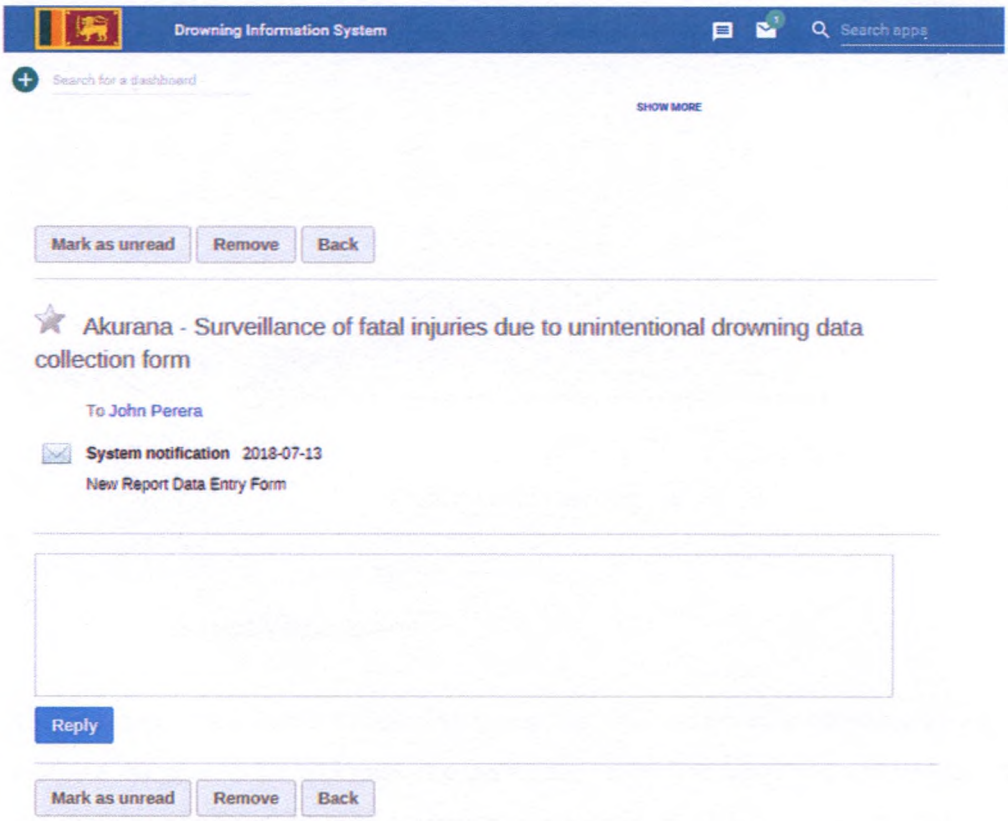

Figure 29 Data Verification

2.9.6 Custom Reports Generation

Custom reports are generated using data Visualizer or Event Repots applications. Those contain flexible visualizations for data as charts and data tables. It can include large number of indicators and data elements and generate any types of charts with configurable columns, lines, stacked columns, area and pie charts. The charts could further be changed in to another layer of charts or tables. The generated reports could be exported as images or pdfs and can email or share directly with the users. It also provides an option to modify chart axes, titles and layout. The selected charts or tables can be added to 'Favorite' to view later for a better user experience.

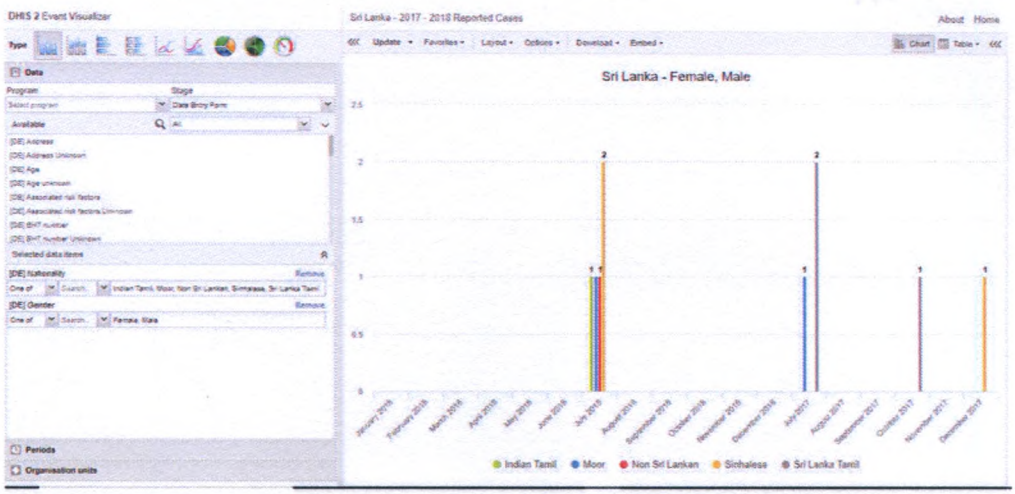

Figure 30 Custom report

2.9.7 GIS Data Visualization

The data entry form has the capability to capture the location of a drowning incident by marking the area in the GIS map or entering the respective longitude and latitude. Such information can them be used to generate a reports as GIS locations overlaid on Sri Lankan map. The map can be provided via that GIS application or the native map application of the DHIS 2 platform. Maps are adding an enhanced visualization for data analysis. Any precooked data representation on the maps can either be added to Favorites or displayed on the dashboard for an enhanced user experience.

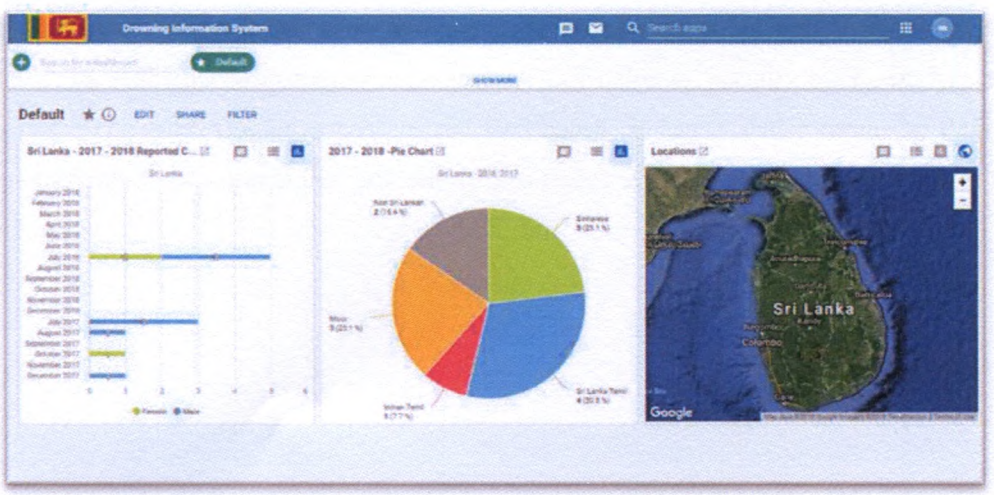

Figure 31 GIS Data Visualization

2.9.8 Event Table

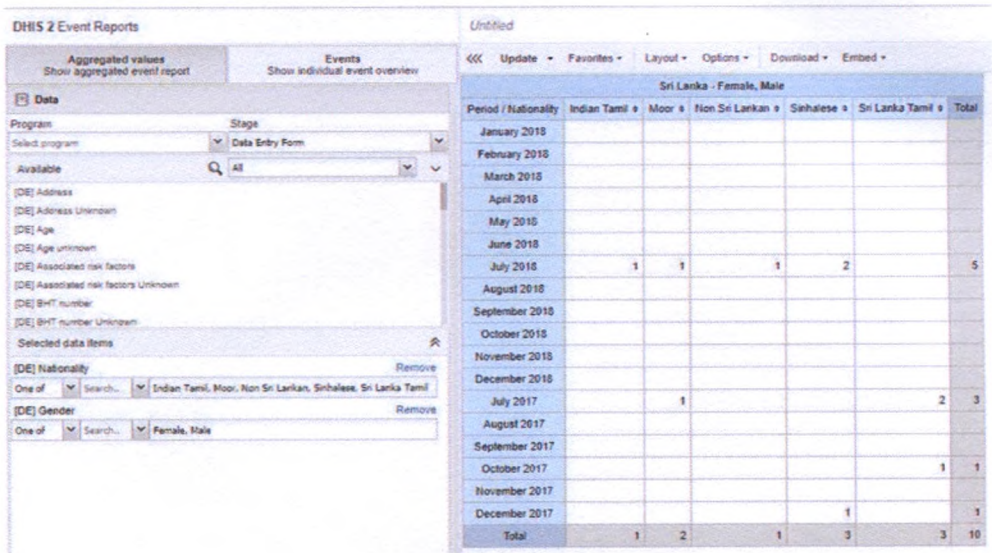

Figure 32 Event Table

2.9.9 Event Report Dash Board

The report dashboard gives a real-time summary of all available data in a preconfigured representation. It could be set up in various visualizing forms such as reports, tables or charts. Its real time information management tool helps to visually track, analyze and display. The following is a customized dashboard. It has a wider range of flexible functionality to customize the look and feel to match with the desired experience of the end users.

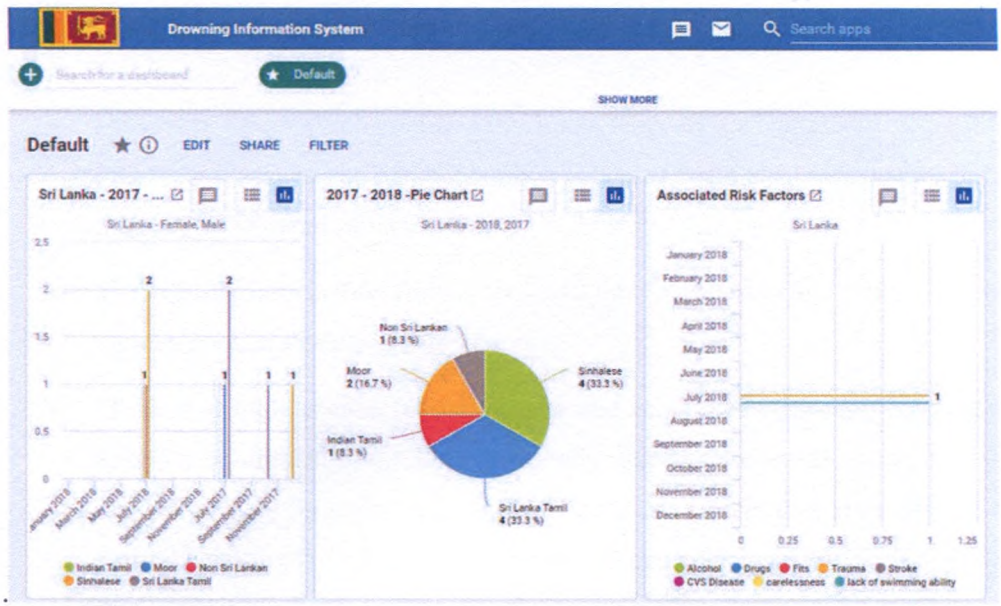

Figure 33 DIS Dash Board

2.9.10 Data Entry Workflows

Ground level data feed to drowning IMS implemented for DMC is done by Grama Niladari. They will first fill the drowning death information form and then hand over to the administrative officer at Divisional Secretariat Once approved by Divisional Secretary then the entered data in soft form are sent directly to the DMC database such that the information is made available to all users more accurately and in timely manner.

As it has been evident in the recent past, in almost all the disasters the country has faced up to now the data availability has become a serious issue. Government reaction times have been proportionately slowing down when accurate information takes a long time to reach DMC and in more cases than not the collected data carries fault and repetitive data. The suggested workflow will resolve all these issues.

2.10 Problems in Existing System

- Data entry forms which are filled by Grama Niladari is a common form applicable for all the disasters and captures only a subset of basic attributes needed to cover a drowning incident in its full form.
- The existing information flow is long and time consuming and causes systematic problems when managing disasters.
- There is a high chance of data losses and redundancy through long distance information transmission flow especially during a disaster when a massive number of data throughput is manually processed (data that are collected from ground level send to divisional level verified and goes to provisional level before finally reaching DMC in paper form)
- Work load of field level workers increase due to the demand of maintenance of registries and paper work.
- Unavailability of water sources for tracking, reporting and decision making.
- Inadequate number of risk factors of drowning identified so far.
- Inadequate interventions and progress of drowning prevention due to lack of information.
- Lack of knowledge to record keep detail information of drowning incidents when further interrogation is needed with field level workers.
- Minimum input from other organizations regarding information and interventions.
- Location based information is not taken which could have been a valuable source of information for decision making and prevention.
- Lack of efficient and effective utilization of collected data.
- Inability to perform a country level data analysis due to lack of depth and categorization of information submitted at field level.

Given the high literacy in mobile phone usage, it is also suggested to introduce a mobile application for data entering tasks. This is currently noted as a future enhancement due to the lack of resources in all aspects of funding, expertise, time and infrastructure support such as smart phones with data packages.

2.11 Deployment and Access

2.11.1 Testing of Drowning IMS using Sample Data

The drowning IMS was initially implemented on DHIS 2 2.29 framework version deployed on a personal computer and customized the relevant data entry module and report generation. It was then fed with sample data, mimicking real world incidents received from DMC but anonymizing identities. The data was then extracted and analyzed through the graphs, charts and reports to ensure the integrity of data and workflow accuracy. The system was also given to a Grama Niladari, an officer in a district secretariat, and a few colleagues to do mock testing to ensure the system accuracy and usability aspects have been addressed. There were number of issues and bugs raised during this period which were fixed successfully. After a successful testing phase, the IMS system was installed in a DMC server, to make it available through online for the piloting system users

2.11.1 Installation Guidelines for Drowning Information Management System

Drowning Information Management System has been installed in DMC server as per the guidelines given in appendix B.

2.11.2 Piloting System at Bingiriya

The online drowning IMS installed at DMC was rolled out as a pilot project at Bingiriya GN Area. It is an area with high drowning incidents but with minimum resources available to counter act. With the use of one desktop machine set up with a mobile broadband connection the system was introduced to the administrative community.

A couple of noticeable blocks in the roll out process, the poor internet connection due to weak mobile coverage and computer literacy of a number of Grama Niladaries. On a positive note there were number of Grama Niladaris who has joined the service as graduate appointments hence are of high computer literacy.

2.11.3 User Training

User training has been done in DMC and Bingiriya. The training at Bingiriya, required multiple follow up sessions since majority of staff in Bingiriya had only basic knowledge of ICT. They were hardly aware of DHIS 2. So the introduction session took a bit of time to instill the basic concepts and rationale of an IMS and its importance. This was done initially with the help of material produced by DHIS 2 colleagues and the user manual prepared for the project. The training session were conducted quite successfully. The developing officers and selected Grama Niladari were able to interact with the system and perform data entry and visualization.

The training on data analyzing and viewer point was conducted at DMC, the staff on the other hand had heard of DHIS 2 and had good knowledge and skills of ICT to receive the training well and fast.

2.11.4 Drowning Information System User Manual

User manual was created with the help of DHIS 2 user guidance manual and DHIS 2 user guidance videos. It was helpful during the user training and later on to reiterate the knowledge.

2.11.5 Backing up the Database

One of the critical requirements of an IMS is data retention such that all important information could be recovered in an unlikely scenarios of systematic destruction of hosted location or servers. In order to face such failure scenarios, an operational procedure has been introduced at DMC to back up the data base on regular basis, such that in a catastrophic failure the entire system can be implemented and hosted without losing data significant data.

Every data item that is used in the DHIS 2 system is stored in the PostgreSQL Database server in the database named "dev". It contains both system (DHIS 2) and input data in its tables. When an event is registered with the DHIS 2 system, all data element fields gets saved into the database. Therefore, when a database is exported (to be deployed elsewhere) all such data could be exported as well. Once a database export file (db_export.pgsql) is created on to the disk, new events that are registered post-export is not going to be included in the export, hence should be exported again.

3. Results

The Drowning Information Management System was developed and tested using real test data with all private information of previous deaths records which is available in DMC made anonymous. According to the previous records from all the data sources it is believed to have captured only 80% of all incidents. The rest of 20% data are believed to have misplaced or not reported as the previous system is paper based and lengthy in processing times to reach DMC. When the data belonging to year 2017 was analyzed it was made evident that all drowning records had some values either incomplete or missing.

The IMS supports data collection analysis and report generation functions that can be used to exploit event reports, data visualizer and event visualizer modules. Event report module helped to generate custom report table for the given data. The Event visualizer has been used to generate graph and charts. The Drowning IMS data capture, analysis and reporting was made according to WHO injury surveillance guidelines and WHO drowning prevention guidelines, to ensure the results and observations can be presented in a credible form. The findings of 2016-2017 data are as follows. Note that the graphical extracts are screen caps from the Drowning Information Management System.

3.2 Generated Results

All the reported death cases due to drowning in the period of 2016-2017 are given below. The data was gathered from several categories: flood deaths, drowning due to heavy rain and fresh water and salt water drowning. According to the all nationality in Sri Lanka the deaths number and the percentages are

1. Sinhalese: 120 (77.9%)
2. Sri Lankan Tamil: 20 (13%)
3. Moor: 8 (5.2%)
4. Indian Tamil: 5 (3.2%)
5. Non Sri Lankan: 1 (0.6%)

Drowning deaths in Sri Lanka 2017 January 1st to 2018 January 1st

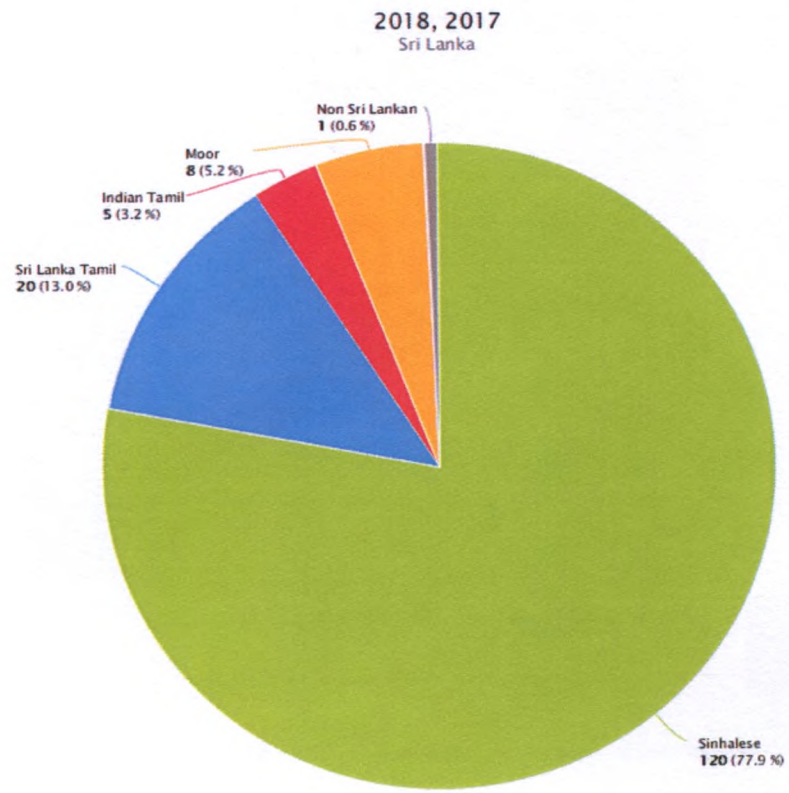

Figure 34 Drowning deaths in 2017,Sri Lanka(2017. 01.01-2018.01.01)

In figure 36 describe the total flood deaths during 2017 in Sri Lanka according to Nationality.The total number of deaths are 114.

1. Sinhalese :93 deaths
2. Sri Lankan Tamil :15 deaths
3. Moor :4 deaths
4. Indian Tamil :2 deaths
5. Non Sri Lankan : no deaths recorded

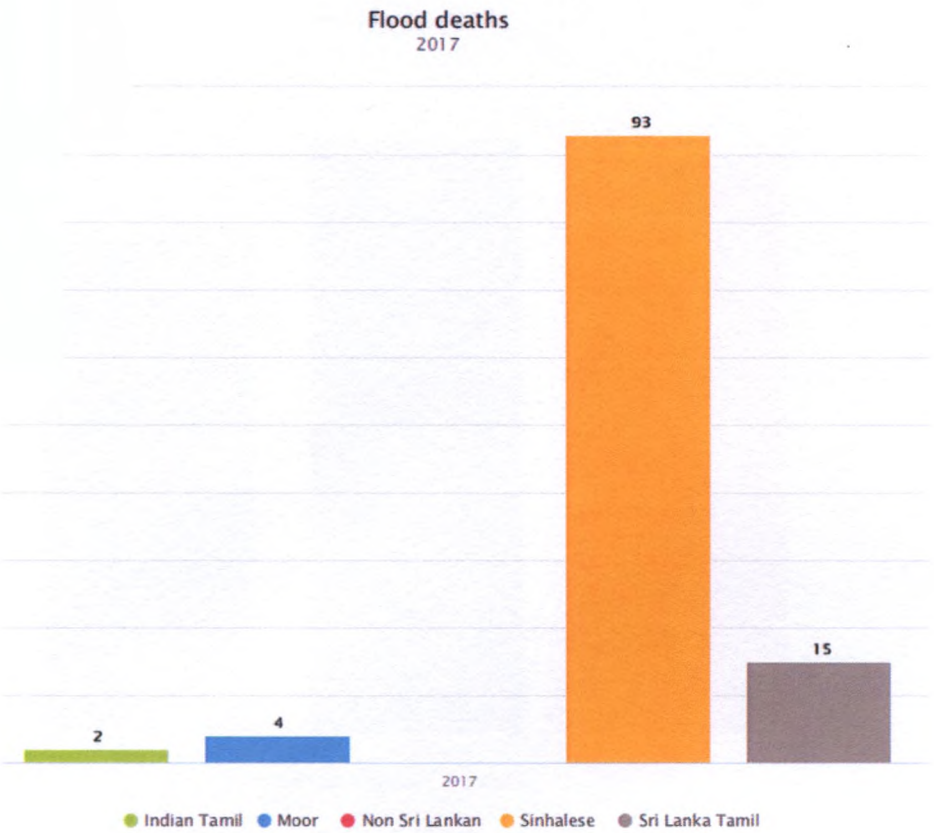

Figure 35 Flood deaths, 2017(according to Nationality)

Flood deaths in 2017 according to the gender shows in figure 37.The data from DMC by gender were not well defined hence those undefined data has fallen into unknown catagory.

Male deaths 40

Female deaths 34

Unknown deaths 39

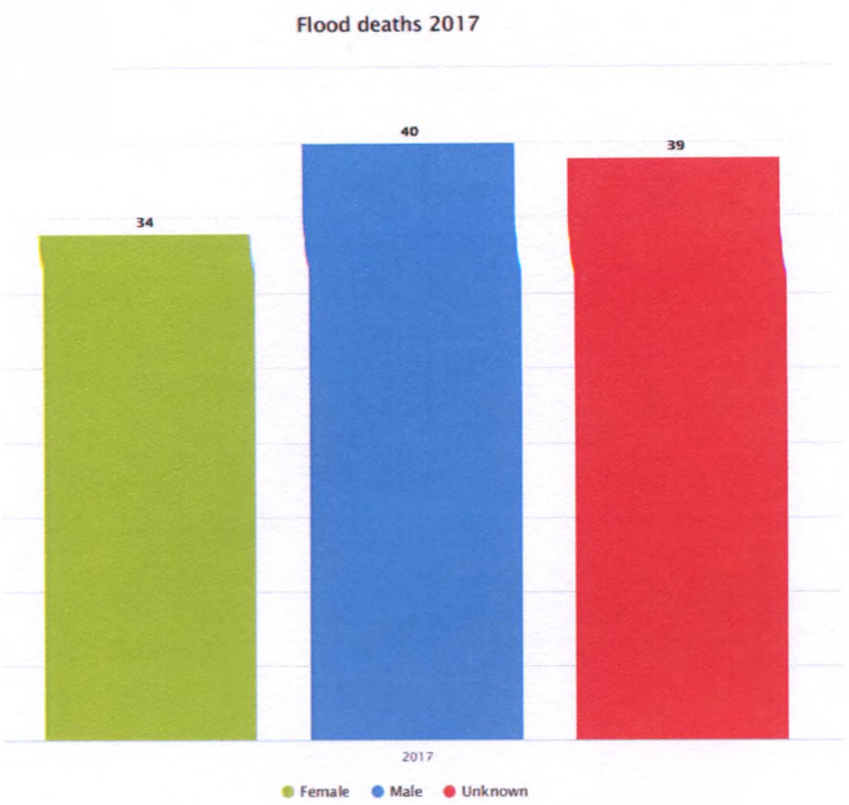

Figure 36 Flood deaths 2017(Gender)

All the flood data in 2017 in Sri Lanka analyzed and can be shown as different organizational levels as given below. It can be shown as provinces and districts district secretory levels and Gama Niladari Divisions level seperately.But the data which was available from DMC was mentioned only provincial and District levels.

Those are described and shown in below figures.

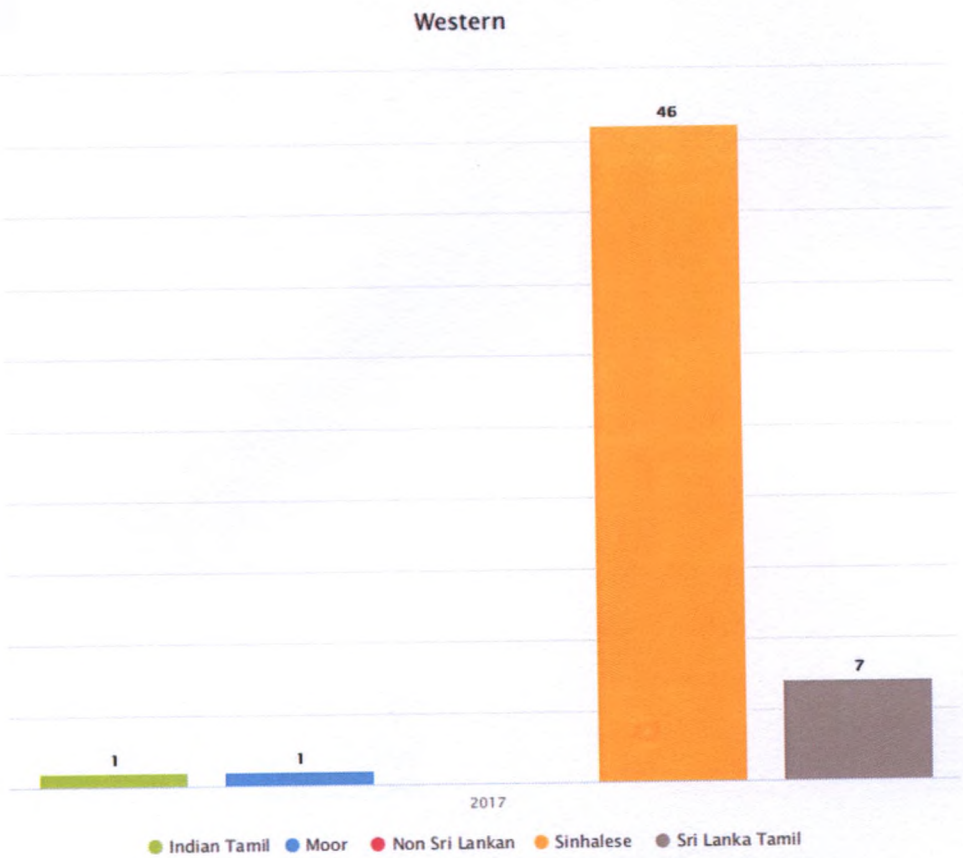

Figure 37 Western Province Flood Deaths, 2017

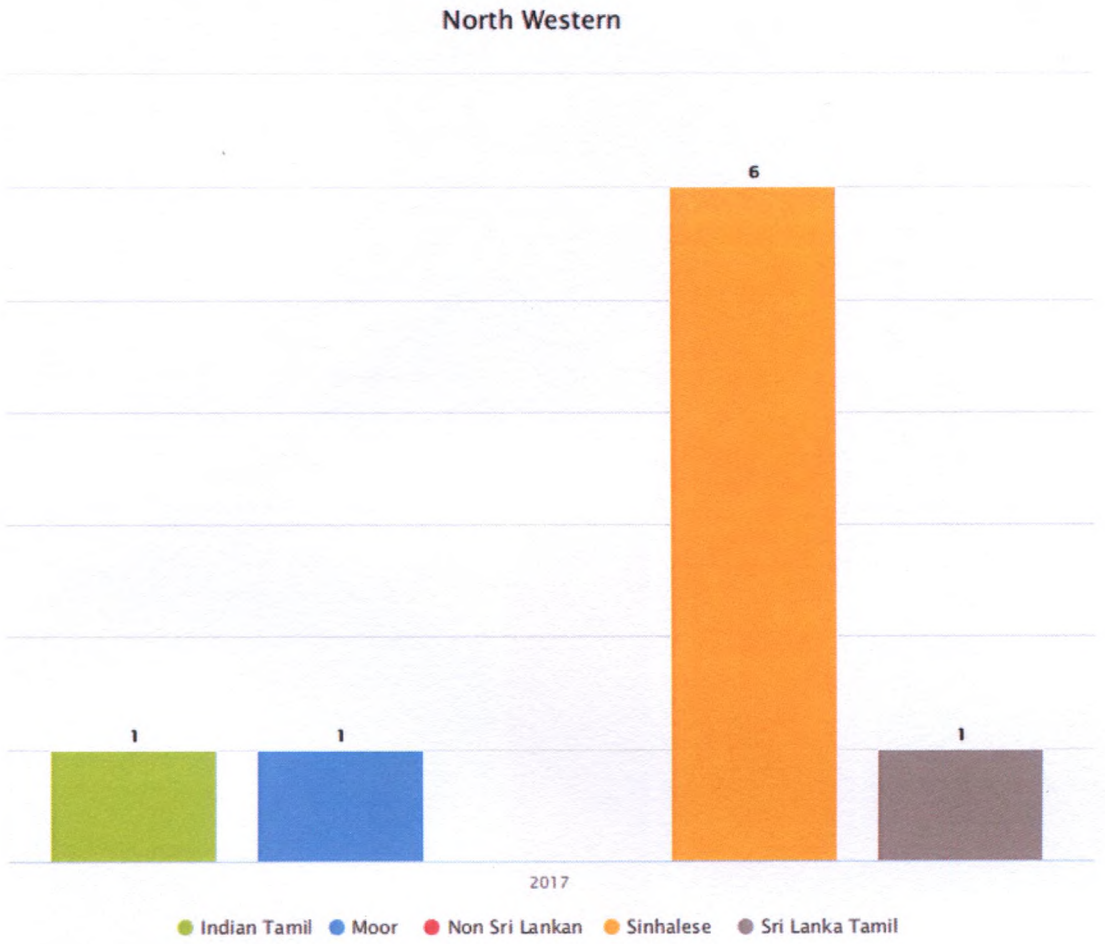

Figure 38 North Western Province Flood Deaths, 2017

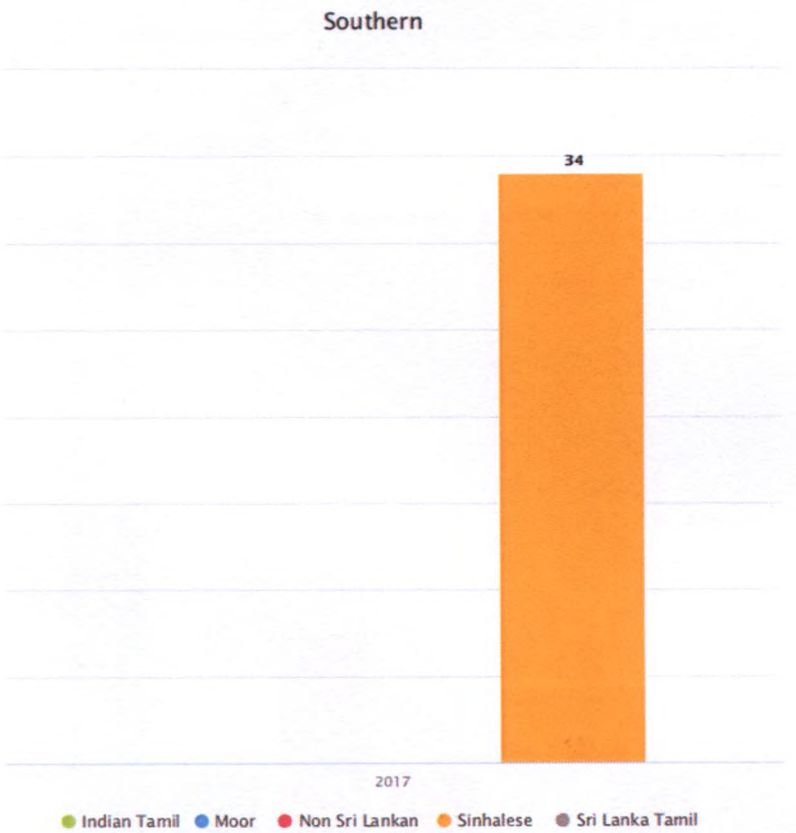

Figure 39 Southern Province Flood Deaths, 2017

Data gather from Bingiriya Grama Niladari division according to the past records in 2016-2017.Common risk factors identified are given below.

In figure 40 reveals most common risk factor is Alcohol.

1. Alcohol 4 deaths
2. Carelessness, lack of swimming, trauma: 2 deaths
3. Stroke and drugs: 1 death
4. CVS diseases no deaths recorded

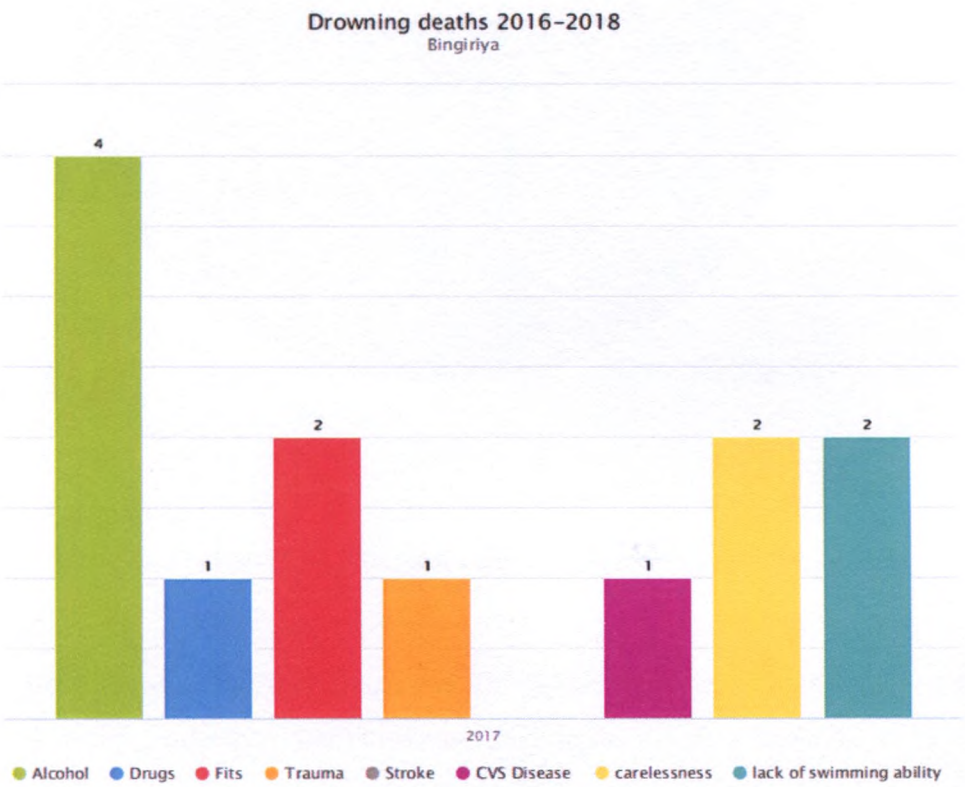

Figure 40 Risk factors for drowning in Bingiriya

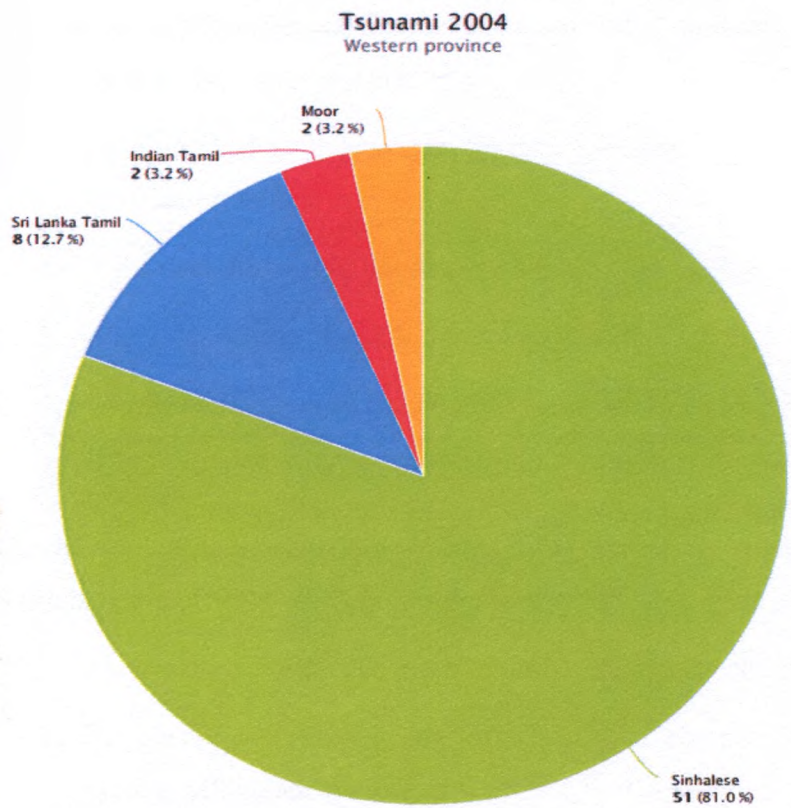

Figure 41 Tsunami Deaths in Western Province 2014.12.26

Great Tsunami in 2014 December 26th killed more than 30,000 of people among them estimated deaths in western province are describe in below figure 41.

1. According to figure 41
2. Sinhalese: 51 deaths (81%)
3. Sri Lankan Tamil: 8 deaths (12.7%)
4. Moor: 2 (3.2%)
5. Indian Tamil: 2 deaths (3.2%)
6. Non Sri Lankans: not reported

3.3 Feedback from the Users

The Drowning IMS previous records data entered analyzed and taken feedback from the users in the Disaster Management Centre. The open ended questions were made to improve the current system. The questions are:

1. Opinion for the whole system for data collection analyze and interpretation whether satisfied or not?
2. Is the data quality has improved when compare with the previous systems?
3. Is this new system flexible and easy to use?
4. Whether data security and confidentiality satisfied?

The answers which gained from DMC was as below. Answers are given by from 2 administrative officers and 2 from Information officers branch (IT Unit) in DMC.

1. They were well satisfied with the new system and custom requirement were fulfilled.
2. They were satisfied with the data quality as compare with the previous data new system will gained more details.
3. Satisfied with the new system as its flexible and simple usability some videos can be follow through web videos. (not system complex to understand).
4. Satisfied with the User roles and password which are defined to the different
5. Organizational hierarchy level.

In additionally:

6. They have given further opinion to collect injuries as well as collecting only deaths.
7. Suggested to develop the system to all other disaster categories without limiting only to drowning.
8. Suggested to add mobile data feeding to the system in the future purpose.

4. Discussion

4.1 Discussion

One of the major cause of unintentional deaths in the world are drowning. Among all drowning deaths 90% are recorded in low and middle income countries (LMIC). When compared with sixty-one most drowning countries Sri Lanka rank the twelfth place and tenth place amongst LMIC respectively. The highest contribution is due to the significant death recorded during flood and tsunami in Sri Lanka.

Drowning is a predictable and preventable unintentional injury. According to world health organization (WHO) drowning prevention guidelines it's essential to have national water safety plan along with a proper data collection system. Therefore, it is crucial that a county like Sri Lanka have a data collection system for drowning information. Most of the developed countries use fatal injury surveillance to enter drowning data but for a country like Sri Lanka who is prone to significant drowning incidents need to have a separate information system for the management and decision making process. During disasters such as Tsunami and floods the requirement becomes much more prominent.

And there are only a few developed countries who have rolled out a national drowning surveillance by using high technology. They are for example Australia and Canada. Sri Lanka is a LMIC hence can be crunched by resources and technology when seeking for such a solution. It was therefore crucial to consider cost factor of using high technology and advance resources.

An application cost depends on hardware (infrastructure), software and maintenance. The numbers can be very high if the application is proprietary since the functionality is offered with a premium. Considering all the factors it was quite clear that using DHIS 2 software application can resolve most of the issues. It functions as a sustainable system since it is a free and open source application and can use free without license. There may be a cost for further customization depending on the need, but at the same time DHIS 2 has good coverage of community expertise. It has become increasingly popular among LMIC countries as well as develop countries due to rich functionality and flexible framework.

Implementing a new information system has to have the function of disseminating information among other stake holders. It may also require certain information to interact together for example communication and dissemination between DMC and Health ministry. That requires proper interoperability. DHIS 2 can easily made interoperable by using HL7. Such interoperable capabilities will help a DHIS 2 based solutions to get absorbed by a large scale ecosystems allowing stakeholders to work together on their own unique systems for decision making and management process at the time of a critical disaster.

The current paper based system where data are collected and analyzed manually can lead to incorrect data and false analysis. It is quite difficult scale in its basic form during a disaster or during drowning deaths following a disaster as data has to be filled with own words. There aren't any specifications or previous data options selectable with minimum details to input. A manual form takes a significant space to write the incident by own words without specifying analyzable data.

The current information flow is to collect data by manually filling a common form to capture all drowning information by each Grama Niladari division and then send it to divisional secretariat by entering data in to another paper based system. Sending information is done through telephone messages or by fax or by a letter to the district secretariat. Given that data has to travel a long path there is a high chance of redundancy and loses. The proposed application is unarguably a better solution as it shortens time and increases quality of data.

The new information system has made data entering form a quite intuitive simple process and has made it easier to analyze data without any complications and confusions. The online form also includes expert opinion, WHO guidelines plus and feedback from Grama Niladaris to make it a versatile data capturing format. In addition, the form is more evolvable than that of paper based.

Although the application is a better solution, its rolling out across the district secretory level could be a challenge given their lack of basic ICT infrastructure facilities and knowledge. It is therefore essential to provide all basic resources and trainings prior to implementing the solution across the island. In terms of trainings, it is crucial that high caliber individuals are identified to play the designated system user roles and train them enough to enter drowning data to the electronic system at divisional secretory level.

As means of finding a solid approach for the rolling out, a piloting implementation was carried out at the Bingiriya divisional secretory area. At the piloting stage there was a responsible person (with basic ICT knowledge) allocated to enter data and a couple of other users to authorize entries and view relevant data reports. The exercise was successful and the data was reviewed at DMC. The next phase of the implementation would be to extend this model island wide assigning a trained person to every division in Sri Lanka.

The application (with database) was installed in DMC severs where the server facility is available and well-functioning within ICT resources. Given their trained staff the maintenance cost can be kept at manageable levels.

Ground level data are collected by Grama Niladari on a paper based detailed drowning information forms. This is because Grama Niladari of the selected division showed lack of ICT technology knowledge and difficulty to adapt to the new system. This is an initial weakness and typical human resistance to change that can to be resolved over time. It has to be overcome so that the time taken by entering operator at divisional secretory level can be avoided. A better solution in the future would be Grama Niladari be given a mobile application to enter data via mobile access with DHIS 2 mobile application method.

There is no reliable sustained database for drowning information in Sri Lanka and no previous attempts to even resolve according to the recorded literature. Some of the organizations are involved in data collection but there's no proper collection analysis, reporting and dissemination mechanism. They are mostly paper based systems with paper based persistence mechanisms.

Given that a drowning information system is a long standing urge that was never resolved in Sri Lanka and it is expected the that the proposed solution will get more traction for further enhancements through government authorities once system gets implemented across the country.

4.2 Recommendation

The Sri Lankan Government health sector and all non-health should prioritize drowning prevention as it is the 3rd leading cause for the unintentional injuries in Sri Lanka. To solve this ongoing problem all the government and non-government sector should work together and develop a national drowning prevention plan along with well-established drowning information system.

Resources should be allocated by all responsible government organizations as well as nongovernmental organizations. The resources should allocate at least all divisional secretaries in Sri Lanka to establish sustainable drowning information system.

Drowning information system should be well organized and centralized and provide basic ICT facility including connectivity and human resources for all divisional secretaries.

Staff training should be done initially and thoroughly under regular supervision. System should be well maintained and should follow quality standards. In additional information system periodically evaluation should be done to maintain quality and standards.

Drowning data collection form should be update according to new WHO fatal and injury surveillance guidelines, WHO drowning prevention interventions, strategies and policies. Data collection forms should be use electronic form rather than paper based an in future mobile application data entering mode could be applicable to collect data in more efficient way.

Drowning information should be full detailed which cover all issues with the associated risk factors. And also island wide data collection centers covering all the areas will collect and transfer all the data to DMC. These data will be used for management and decision making.

4.2 Conclusions

Free and open source software DHIS 2 platform has been used to successfully develop a sustainable drowning information system. It has come out to be the best solution attempted so far as a systematic application for data collection, analysis, reporting and dissemination. For emerging countries like Sri Lanka, where the drowning incidence were high, this application will be far reaching and cost efficient as well.

A pilot version of the drowning information system was successfully implemented in National Disaster Centre and a pilot project has been rolled out Bingiriya division, where high drowning deaths were recorded in Sri Lanka. By using minimum resources and people involvement, this system was very well received by the community and has shown a great potential in coming a successful application that could be rolled out across all the divisions in Sri Lanka. DHIS 2 health information platform is not limited to health sector and could be used even for non-health sector data information management. DHIS 2 could be used in such scenarios by modifying or further developing the application workflows depending on their need with the minimum resources. It is also easy to link between the organization for management purposes and for decision making during critical situations. (e.g. share drowning information between DMC and health ministry disaster management unit)

Developing a mobile application in the future to gain information in more efficiently and timely can improve the visibility of events more accurately and real-time.

Any weaknesses or errors which could arise while functioning system can be solve by frequent evaluation and regular staff training.

There is no drowning database system in Sri Lanka. National drowning prevention and water safety plan in 2017 has been emphasizing the need for a drowning surveillance system to support the national plan. The proposed solution in this thesis could be the most feasible solution to move forward and establish a drowning information system across Sri Lanka.

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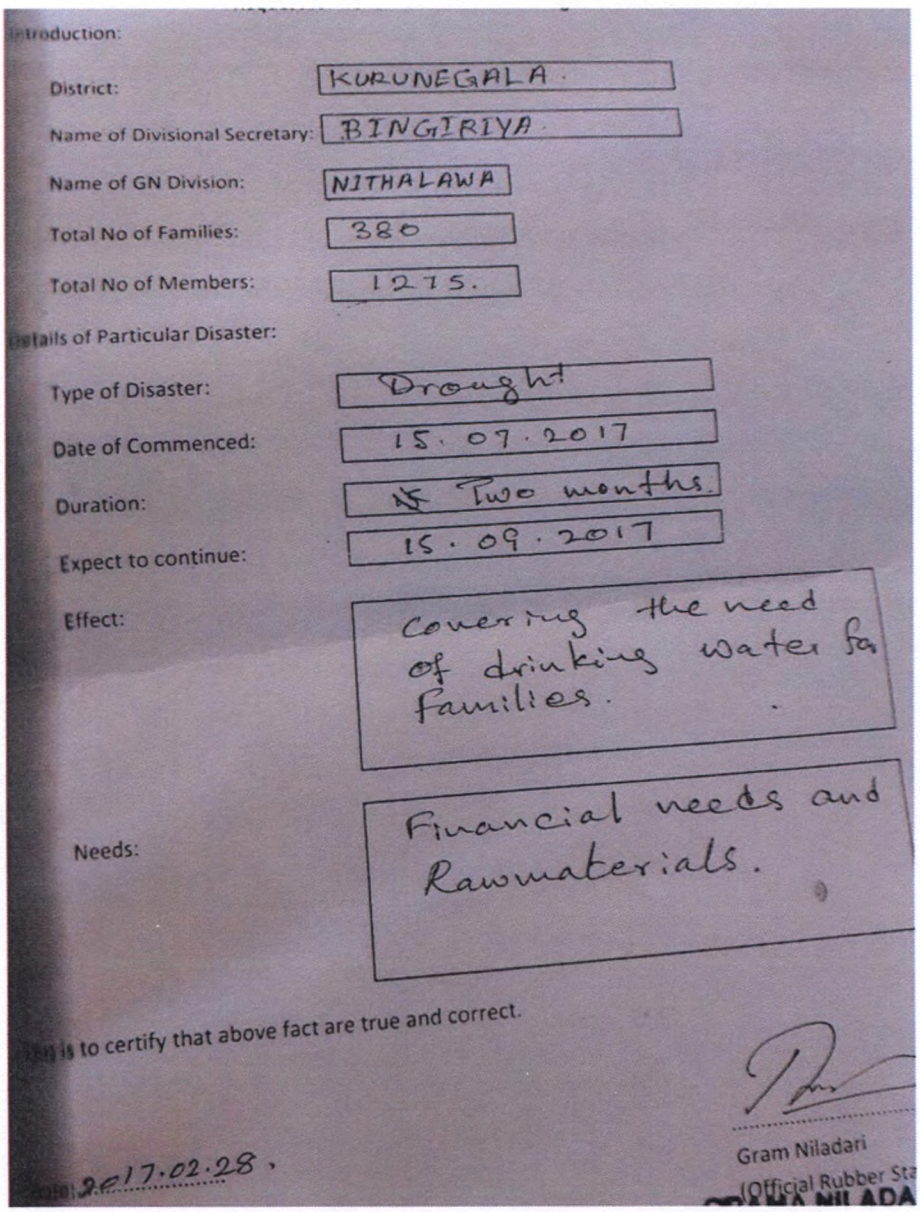
Appendix A – Disaster Information (common) form.



troduction:

District: KURUNEGALA

Name of Divisional Secretary: BINGIRIYA

Name of GN Division: NITHALAWA

Total No of Families: 380

Total No of Members: 1275.

tails of Particular Disaster:

Type of Disaster: Drought

Date of Commenced: 15.07.2017

Duration: Two months.

Expect to continue: 15.09.2017

Effect: Covering the need of drinking water for families.

Needs: Financial needs and Rawmaterials.

is to certify that above fact are true and correct.

2017.02.28.

Gram Niladari

(Official Rubber Sta

NILADA

Appendix B –DIS installation guide.

STEP 1 - Install Database Engine

1. Install PostgreSQL as the database engine on the windows machine using the given installer (postgresql-9.6.9-1-windows-x64.exe)

2. Use All the default options when installing. Give a default password for the "postgres" user that the database engine is using.

Therefore, the default locations for PostgreSQL would be,

install_dir - C:\Program Files\PostgreSQL\9.6

bin_dir - C:\Program Files\PostgreSQL\9.6\bin

data_dir - C:\Program Files\PostgreSQL\9.6\data

3. After installing PostgreSQL, type "pgadmin" in the start menu and click on it when it appears.

4. A browser window will open, type in the password given at installation time for the superuser "postgres"

5. It'll prompt to say that pgadmin4 version 3 is to be used instead of pgadmin4 version 4, simply click ok.

6. The pgadmin dashboard will now be visible.

7. On the left-hand side "Browser" tab, expand,

Servers

----PostgreSQL 9.6

----Databases

----Login/Group Roles

----Tablespaces

8. Right click on "Login/Group Roles" and "Create" > "Create Login/Group Role"

9. Set the role name as "dhis" in the General tab and password as "dhis" in the Definition tab.

10. Grant all privileges for this user in the Privileges tab (exclude the final option - Can initiate streaming replication and backups)

11. User/Role creation is complete, now, create a database for DHIS 2 to use.

12. Right click on "Databases" and "Create" > "Database"

13. In the "General" tab, set,

Database - dev

Owner - dhis

14. Click "save" to create the database.

15. Now, copy the "dbexport_latest.pgsql" to the bin_dir.

16. Open Command Prompt/Powershell from the bin_dir by pressing Shift and right clicking.

17. Execute the following command (from the bin_dir) to import the pgsql file into the database. Use password "dhis" when prompted.

psql.exe -U dhis dev < dbexport_latest.pgsql

(https://www.a2hosting.com/kb/developer-corner/postgresql/import-and-export-a-postgresql-database)

Server room in DMC

Appendix C-DIS backup script

The syntax of the export command is as follows. This should be executed in the PostgreSQL bin directory on a Command Shell with administrative rights.

pg_dump.exe -U username dbname > dbexport.pgsql

eg: pg_dump.exe -U dhis dev > dbexport.pgsql

1. Search for "cmd" on the start menu.
2. Right click on "cmd" and select "Run as Administrator"
3. enter the following commands on the Command Prompt.

   cd ../../"Program Files"/PostgreSQL/9.6/bin

   pg_dump.exe -U dhis dev > db_export.pgsql
4. copy the created db_export.pgsql file.
5. Use it to restore a fresh DHIS 2 installation using the previous guide.

Appendix D-DIS data information form

DIS information form in English

BASIC INFORMATION OF VICTIM		
Unique Reference Number	case number	
Name		
Age		Unknown ●
Sex	Drop down: Male / Female	Unknown ●
Address		Unknown ●
Nationality		Unknown ●
Facility name	(drop down list of hospitals) (place where death was examined and recorded)	
Date of death (date picker)		Unknown ●

EVENT			
Date(drowning)(date picker)			● Unknown
Site of injury occurrence: Province	District	City/village	Unknown ●
Injury occurrence Resident area(drop down-)-(Home/yard/other)		Injury occurrence Remote from home (drop down) (While on a picnic /school/university/other)	
Drown in salt water – yes/no		Drown in fresh water (yes/no) drop down swimming pool/lake/river/well/Reservoirs/water falls/ other own all category	
Flood disaster - yes/no	Travelling on water - yes /no	Occupational – yes/ no	

Associated risk factors (drop down) Alcohol/Drugs/Fits/carelessness/lack of swimming ability/Trauma/stroke/CVS Disease Unknown	
Life support not given-yes or no	Life support given :(drop down) unsuccessful and successful
Time lapsed to recovery Unknown	No life on recovery Unknown

HOSPITAL INFORMATIONS	
hospital admission-(drop down) yes/no/unknown	BHT number(if available) Unknown
Died before admission	Died in hospital
Length of Hospital stay (days)	Postmortem examination number Unknown

CAUSE OF DEATH
Cause of death _____ Incident summary narrative_____ (from the autopsy reports, police reports, police record, inquest data& bystander reports) Describe the cause the, nature &circumstance of the injury)
Documented by Name-_____ Designation- _____

DIS Data entry form Sinhala format

දියේ ගිලීම නිසා සිදුවූ මරණ පිළිබඳ තොරතුරු එකතු කිරීමේ පත්‍රිකාව

මියගිය තැනැත්තාගේ මූලික තොරතුරු		
හඳුනා ගැනීමේ අංකය	හඳු අංකය	
වයස	අ වූ මා ස	නොදනී
ස්ත්‍රී/පුරුෂ භාවය	ස්ත්‍රී පුරුෂ	නොදනී
ලිපිනය		නොදනී
ජාතිය	ශ්‍රී ලාංකික ශ්‍රී ලාංකික නොවන සිංහල/දෙමළ/මුස්ලිම්/බර්ගර්/වෙනත්	නොදනී
අතුලත් කළ රෝහල		
මියගිය දිනය		නොදනී

සිදුවීම.			
දියේ ගිලුනු දිනය	අ මා දි		නොදනී
සිදුවූ ස්ථානය පළාත	දිස්ත්‍රික්කය	නගරය	නොදනී
දියේ ගිලීම සිදුවූයේ (නිවස තුළ, ගෙවත්ත තුළ, වෙනත්)	දියේ ගිලීම සිදුවූයේ නිවසින් බැහැර (විනෝද චාරිකා, පාසල, විශ්ව විද්‍යාලය,වෙනත්)		
ගිලීම සිදුවූ මූලාශ්‍රය : මුහුදු ජලය ඔව් නැත	මිරිදිය ජලය ඔව් නැත (පිහිනුම් තටාක,විල,ගංගා,ළිං,ජලාශ,දියඇලි,වෙනත්)		
ගංවතුර	ජාලාශ්‍රිත ගමක්	ජාලාශ්‍රිත වැස්තිය	
ගිලීම සම්බන්ධ අවධානම් සාධක(මත්පැන්, මත්ද්‍රව්‍ය,අපස්මාර,අනතුරු,ආඝාතය,හෘදාබාධ, නොසිලිකිසිමත්කම, පිහිනීමට නොහැකි වීම නොදනී			
හදිසි මූලික ප්‍රතිකාර ලබා නොදුනි.	හදිසි මූලික ප්‍රතිකාර ලබාදුනි සාර්ථක අසාර්ථක		
ජීවිත ආධාර දීමට පෙ වූ සාලය නොදනී	සොයාගත්තා විට මිය ගිය බව නොදනී		

අදාළ රෝහල පිළිබඳ තොරතුරු	
රෝහල් ගත වුනි/නොවුනි/නොදනී	අද ඉතිපත් අංකය
රෝහල් ගතවීමට පෙර මිය ගිය බව	රෝහලේදී මිය ගිය බව

රෝහලේදී ගත කළ කාල සීමාව (දින) ☐☐	පශ්චාත් මරණ පරීක්ෂණ අංකය නොදනී ☐

මරණයට හේතුව
මරණයට හේතුව ____________________ මරණයට අදාළ අනෙකුත් කරුණු____________________ (සාක්ෂි,පොලිස් වාර්තා)
තොරතුරු සටහන් කළේ නම-____________________ තනතුර -____________________

DIS information form in Tamil format

தற்செயலாக நீரில் மூழ்குவதால் நிகழும் உயிராபத்து உண்டுபன்னும் காயங்களைக் கண்காணிப்பதற்கான தரவு சேகரித்தல் படிவம்.

திகதி ▀ நேரம் ▀

வசதிப்பெயர் ▀ (மரண விசாரணையும் பதிவும் நடைபெற்ற இடம்)

தனித்த தொடர்பு இல.(பிரேதப் பரிசோதனை இல.) ▀

சம்பவம் நிகழ்ந்த திகதி தெரியாது ▀ மரணம் சம்பவித்த திகதி தெரியாது ▀ பிரேதப் பரிசோதனை நிகழ்ந்த திகதி	நோய்வாய்ப்பட்ட வயது ▀▀ தெரியாது ▀ பால் ஆண் ● பெண் ● தெரியாது ●
மீட்சி பெறுவதற்குரிய காலக்கெடு ▀ தெரியாது ▀ மீட்சியில் உயிர் பிளைக்கவில்லை ● வைத்தியசாலையில் உயிரிழப்பு ● வைத்தியசாலையில் தங்கியிருந்த காலம் ▀	ஆயுள் ஆதரவு அளிக்கப்பட்டது ● ஆயுள் ஆதரவு அளிக்கப்படவில்லை ●

காயம் விளைந்த இடம் மாகாணம் மாவட்டம் நகரம் வசிக்கும் பிரதேசம் - (வீடு / முற்றம் / ஏனையவை) வீட்டிலிருந்து தூரம் - (கற்றுலா/பொழுதுபோக்கு/பாடசாலை/பல்கலைக்கழகம் ஆகியவற்றில் நிகழ்ந்த ஒரு விபத்து)	மூலம் உவர் நீர் ● நன்னீர் ● நீச்சல் தடாகம் /குளம் /ஆறு/கினறு/ஏனையவை வெள்ள அனர்த்தம் ● நீரில் பிரயாணம் செய்யும் போது ●

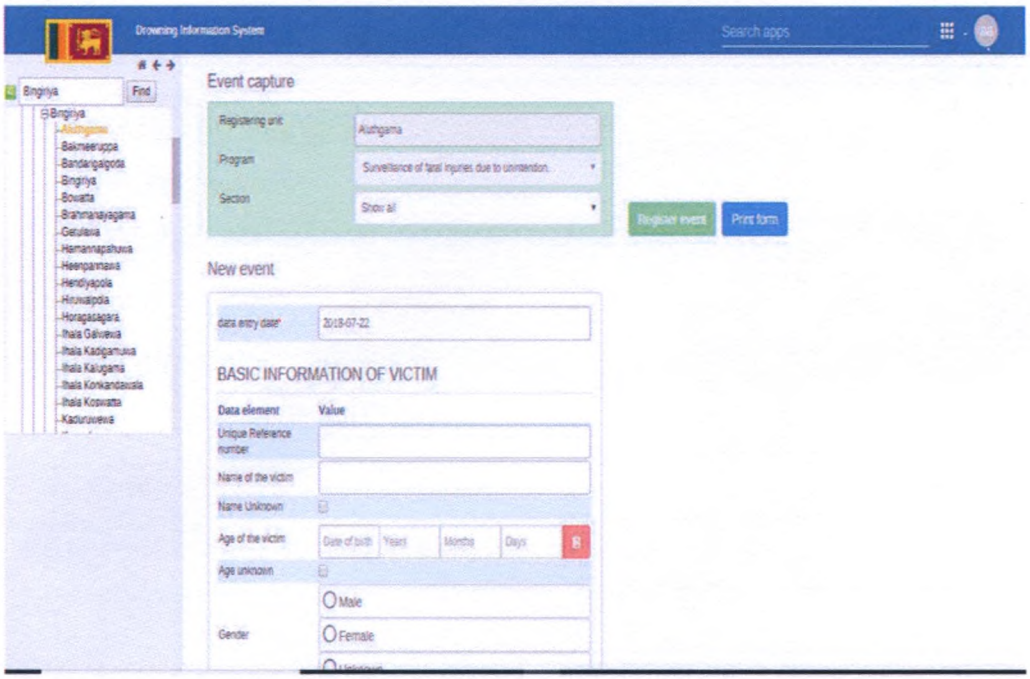
மரணத்திற்கான காரணம் -_____

சம்பவத்தின் சுருக்க விபரம் _____ (விபத்து பற்றிய அறிக்கைகள், பொலிஸ் அறிக்கைகள், பொலிஸ் பதிவுகள், விசாரணைத் தரவுகள் மற்றும் நேரில் கண்டவர்களின் அறிக்கைகள்) காயத்தின் தன்மை மற்றும் காரணம் ஆகியவற்றை விளக்கவும்)

ஆவணப்படுத்தல்

பெயர் -_____ பதவி -_____

DHIS 2: Drowning information system Data entry form (clear view)



BASIC INFORMATION OF VICTIM

Data element	Value
Unique Reference number	
Name of the victim	
Name Unknown	☐
Age of the victim	Date of birth | Years | Months | Days
Age unknown	☐
Gender	○ Male ○ Female ○ Unknown
Address *	
Address Unknown	☐
Nationality *	Select or search from the list
Facility Name	
Date of death	yyyy-MM-dd
Date of Death Unknown	☐
Location	Latitude | Longitude

Event

Data element	Value
Date of event	yyyy-MM-dd
Date of event Unknown	☐
province	
District *	[Please Select] ⊞
City/Village	
Injury occurrence-Residental	Select or search from the list ▾
Injury occurrence-Non Residental	Select or search from the list ▾
Drowning in salt water	◯ Yes ◯ No
Drowning in fresh water	◯ Yes ◯ No
Source-Fresh water	◯ Swimming pool ◯ Lake ◯ River ◯ Well ◯ Other
Flood disaster	◯ Yes ◯ No

Flood disaster	◯ Yes ◯ No
Travelling on water	◯ Yes ◯ No
Occupational	◯ Yes ◯ No
Associated risk factors	Select or search from the list
Associated risk factors Unknown	☐
Life support given	◯ Yes ◯ No
Life support - Successful or not	Select or search from the list
Time lapsed to recovery	
Time lapsed to recovery Unknown	☐
No life on recovery	☐

HOSPITAL INFORMATION

Data element	Value
Hospital admission	Select or search from the list
BHT number	
BHT number Unknown	☐
Died before admission	☐
Died in hospital	◯ Yes ◯ No

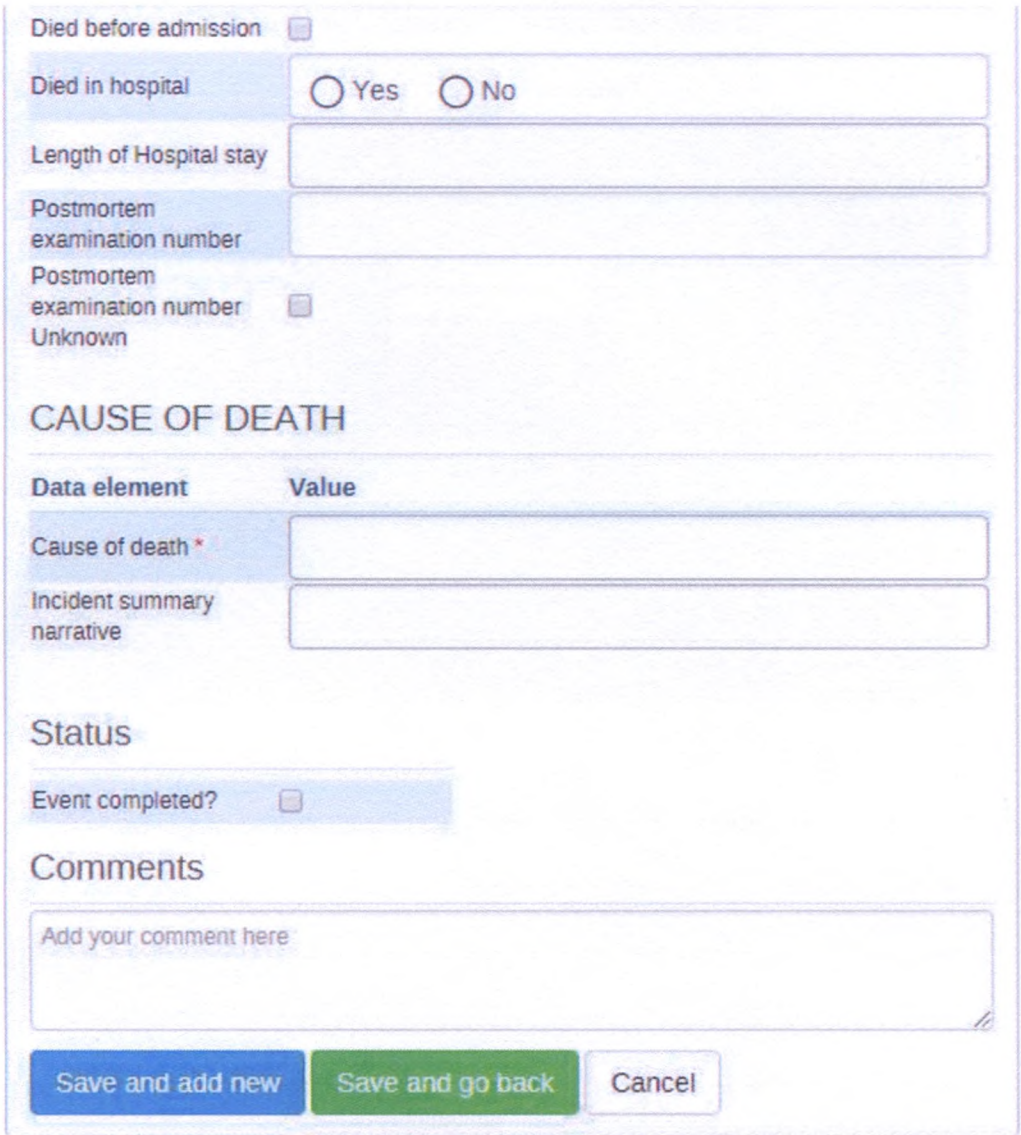
recovery Unknown	☐
No life on recovery	☐

HOSPITAL INFORMATION

Data element	Value
Hospital admission	Select or search from the list
BHT number	
BHT number Unknown	☐
Died before admission	☐
Died in hospital	◯ Yes ◯ No
Length of Hospital stay	
Postmortem examination number	
Postmortem examination number Unknown	☐

CAUSE OF DEATH

Data element	Value
Cause of death *	
Incident summary narrative	


Died before admission
Died in hospital
Yes
No
Length of Hospital stay
Postmortem examination number
Postmortem examination number Unknown
CAUSE OF DEATH
Data element
Value
Cause of death *
Incident summary narrative
Status
Event completed?
Comments
Add your comment here
Save and add new
Save and go back
Cancel

Appendix E- Drowning information system User Manual

End User Manual

Contents

Introduction

The Drowning Information System that runs on top of DHIS 2 is implemented to report, collect and store drowning related fatalities / incidents in the Sri Lankan locale. As an end-user of the system, your obligation is to report these incidents to the national database via the DHIS 2 system interface. This manual aims to discuss the process / procedure as to how these incidents are reported.

Procedure

Creating an Account

Based on the administration requirements of the implementation, account creation will be accessible from time to time for Gama Niladari individuals to register with the system. They will be automatically assigned with the "Grama Niladhari" Role with limited rights until a system administrator elevates / modifies individual privileges.

To Create an account, click on the Create Account button in the login page. This will

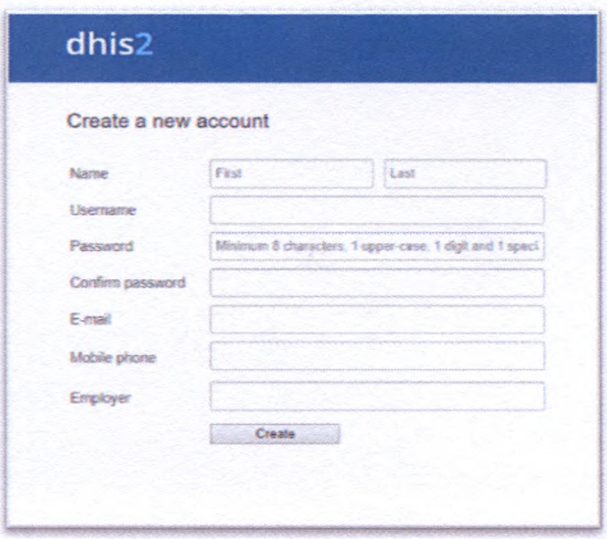


Figure 42: Create new Account

redirect you to the account creation page as shown below. Enter necessary details and click create.

Logging in

You will need to use a web-browser (Google Chrome, Firefox etc.) to log on to the application. DHIS 2 should be compatible with most modern web-browsers, although you will need to ensure that Java Script is enabled.

To log on to the application just enter the domain name (e.g. http://www.dhis.nhsl.lk.gov) or the IP address of the server where the server version is installed.

Once you have navigated to the application through your web browser, the displayed screen will prompt you to enter your registered user-name and password. After entering the required information click on Sign in button to log into the application.

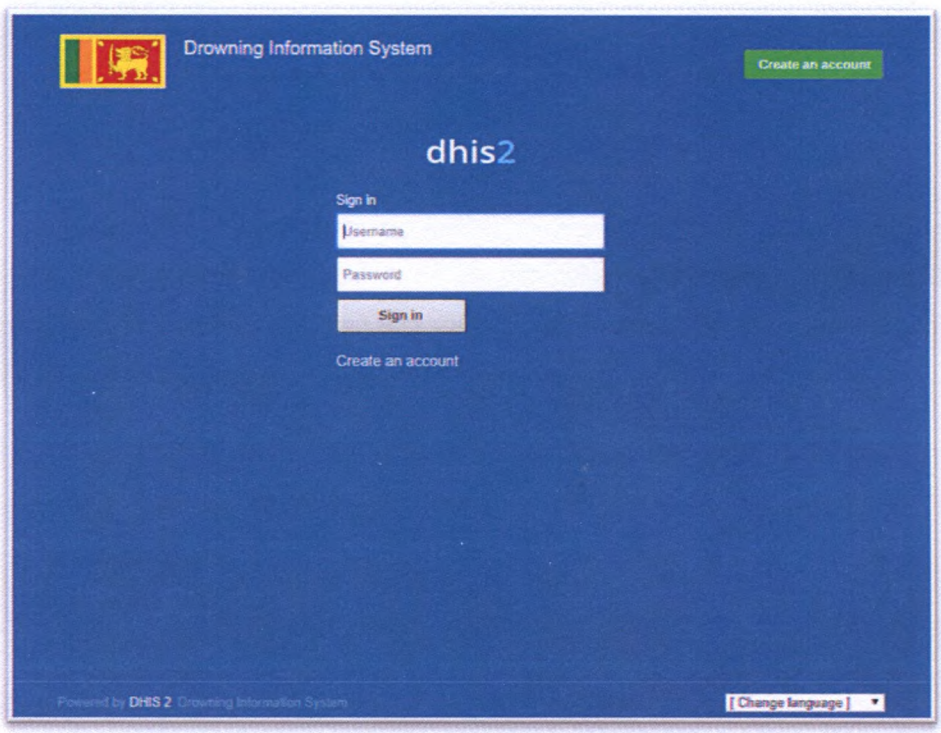


Figure 43: Login landing

Dashboard

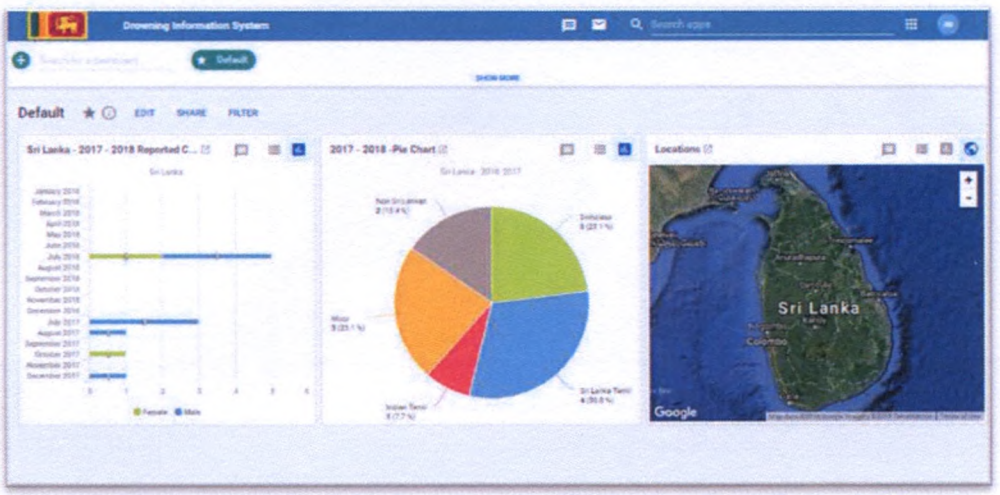


Figure 44: Dashboard after login

After a successful login, you will be presented with a highly customizable dashboard interface. This could be populated with graphs, tables, charts, maps etc. according to your needs and access rights as granted by the system.

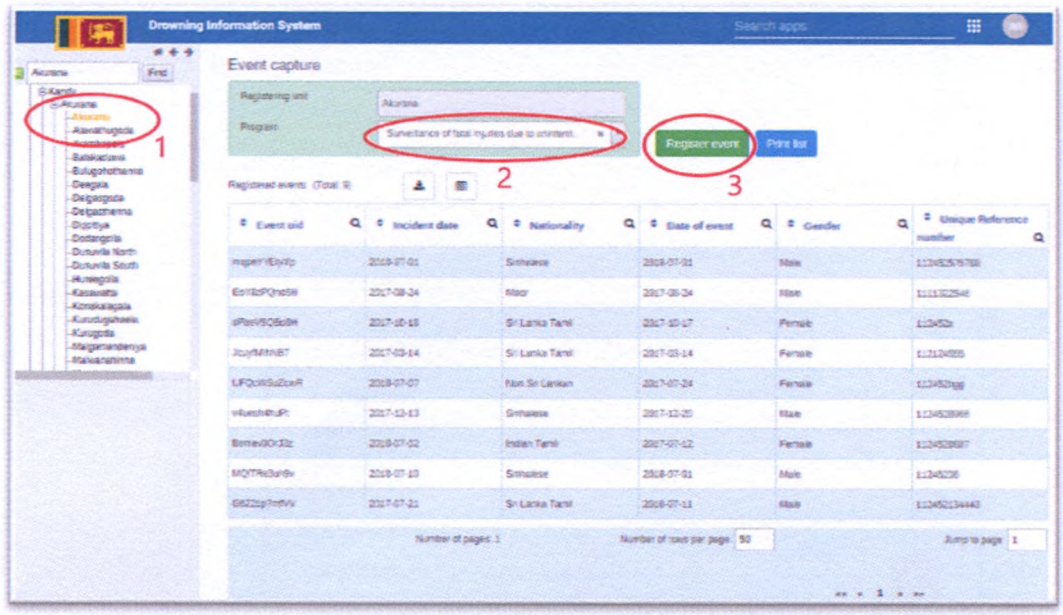
The purpose of the dashboard is to provide a quick overview of the analytics of the system as a whole. The aggregation and presentation of data inserted to the system is easily exposed via this interface.

Reporting Drowning Incidents

Reporting drowning incidents must be reported via the **Event Capture App** which is accessible via the navigation menu.

Figure 45 Menu > Event capture

Simply find the Event Capture App from the menu or search for it in the search bar and click on it. This will redirect you to the event registration page.



1. Select the Organization Unit where the report is registered with, in this case, a

Figure 46: Event Capture for Akurana GN Division

Gama Niladari Division.

2. Select the reporting program. E.g. *Surveillance of Fatal Injuries due to unintentional drowning*
3. Click on *Register Event* to register a new event.

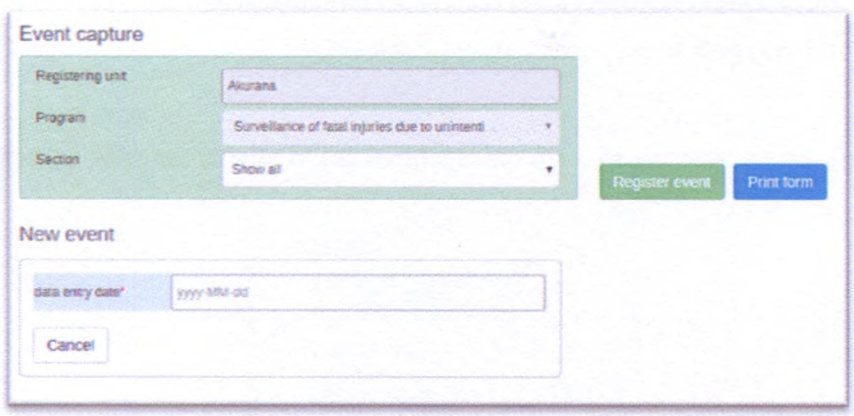


Figure 47: Capture form

Select the reporting date to begin the reporting process. (Note that this step is mandatory for the rest of the form to load.)

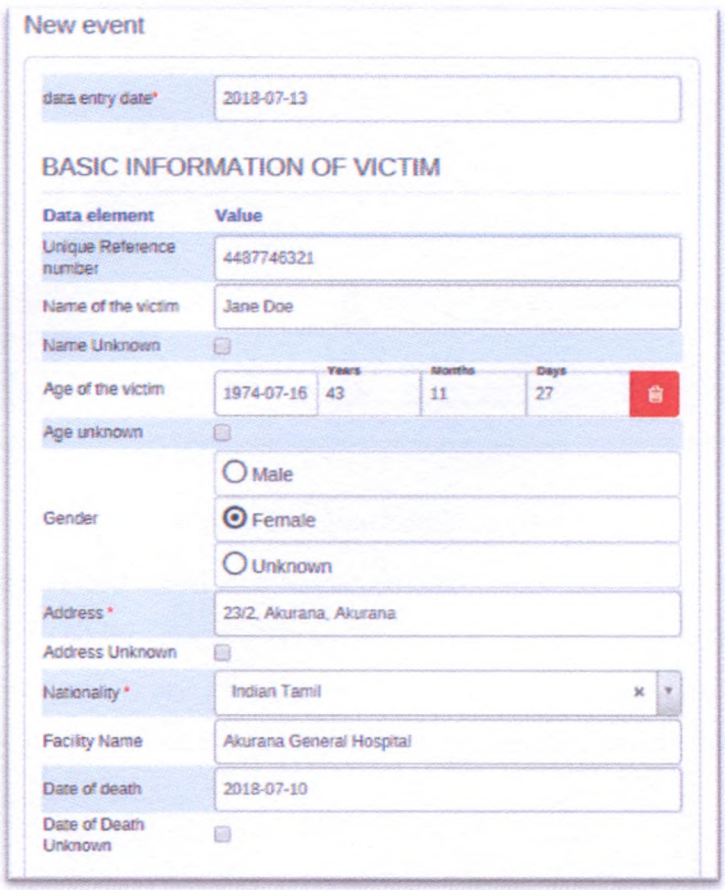


Figure 48: Capture form - Event Registration

Enter the relevant details of the incident into the corresponding form fields.

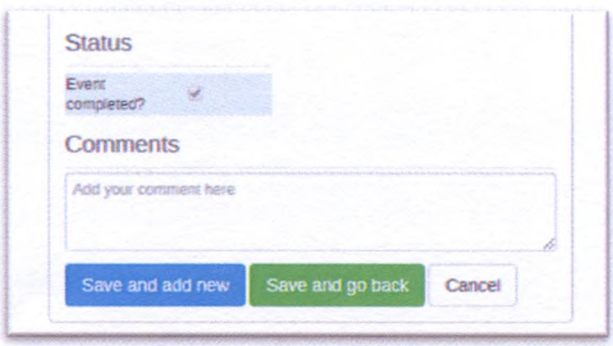


Figure 49: Capture form - Completion

Once the data entry process is completed, click on "Save and add new" to save the current form and add a new event, click on "Save and go back" to save record and quit the recording step.

Administration

User Management

Figure 50: User Administration App

Individual Users are created based upon organizational needs where their access to system resources are constrained by "Roles". These 'Roles' are assigned to a user at the account creation step which ultimately describes the users' activity on the system. (Access to the User administration module is allowed if and only if such permissions are granted by the system administrator)

The Drowning Information System has the following Roles.

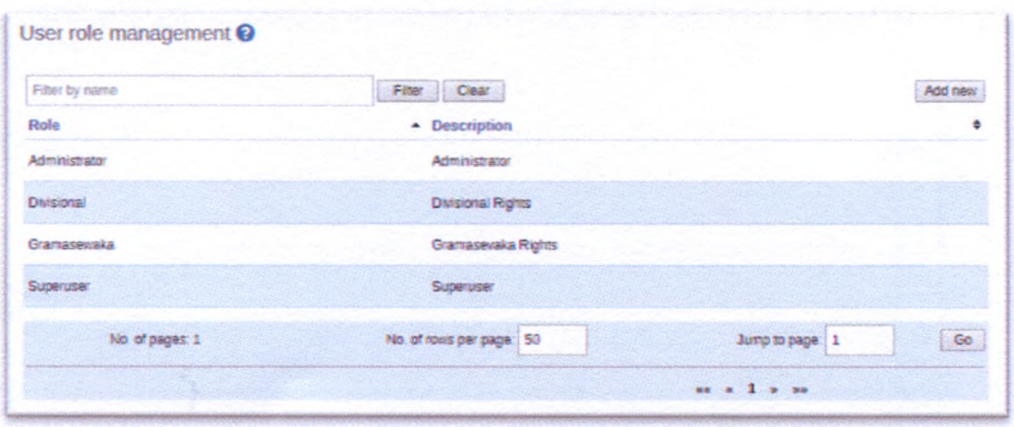


Figure 51: User Roles

The capabilities of each role is assigned in the respective Role Creation step. These capabilities consist of create, read, edit, delete functions for a multitude of data elements / objects that are used throughout the system.

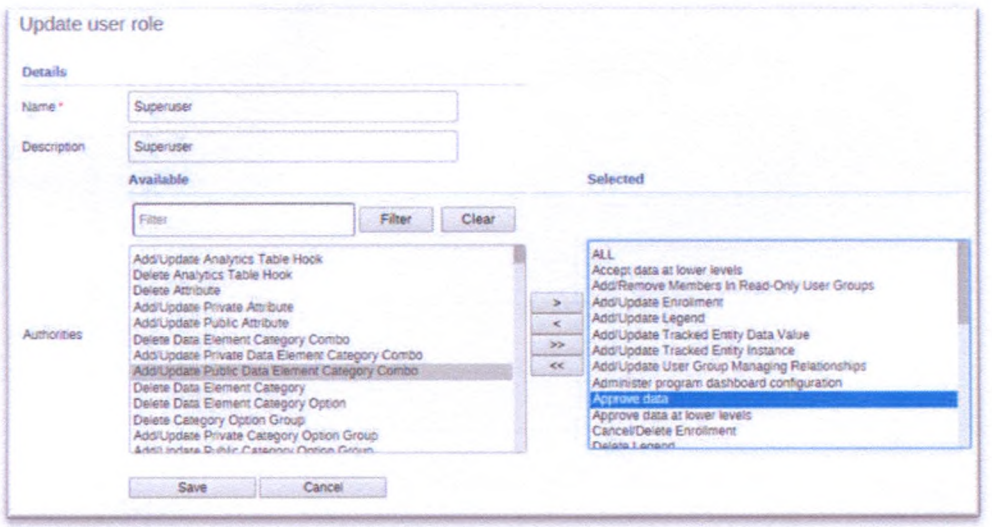


Figure 52: Capabilities for a Role is given here

It is necessary to note that prior to creating a user, an appropriate User Role must be defined. Therefore, a new user could be easily assigned with a role when the account is created.

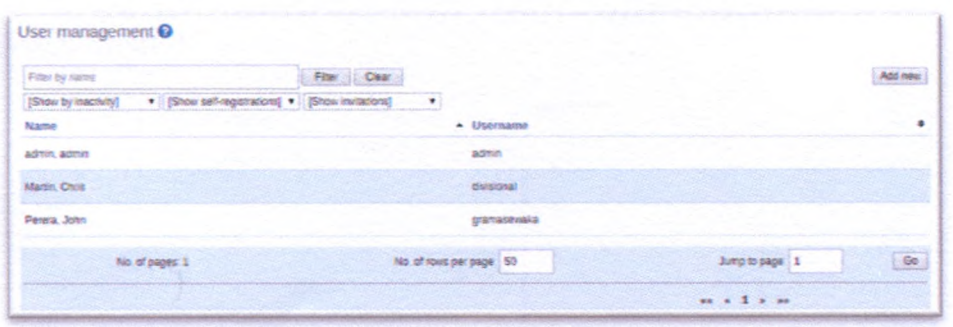


Figure 53: Users

Create new User

1. Provide basic information such as username, password etc.

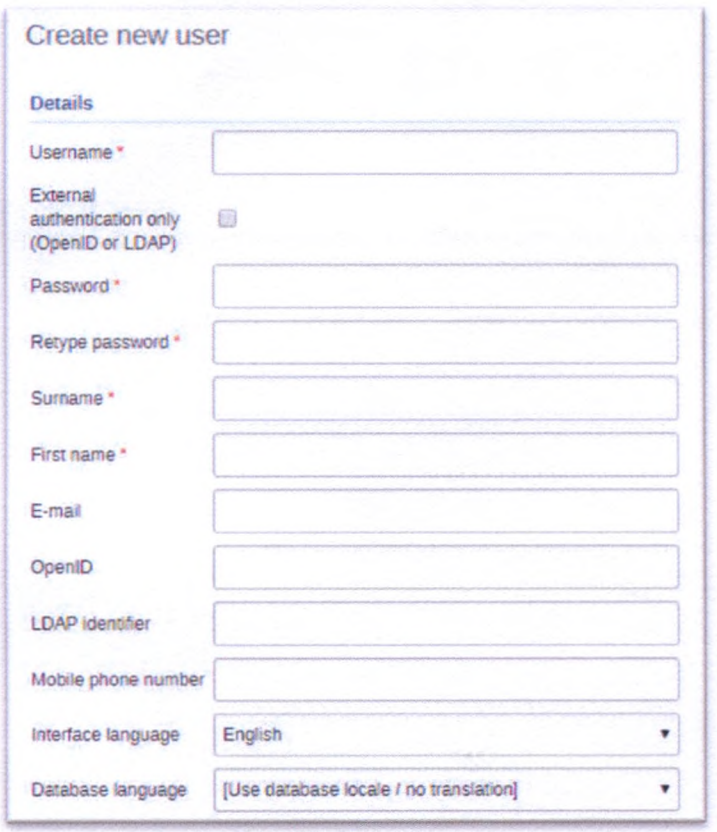


Figure 54: New User - Basic info

Assign Role(s)

Figure 55: New User - Role assignment

Assign Organizational Unit(s)

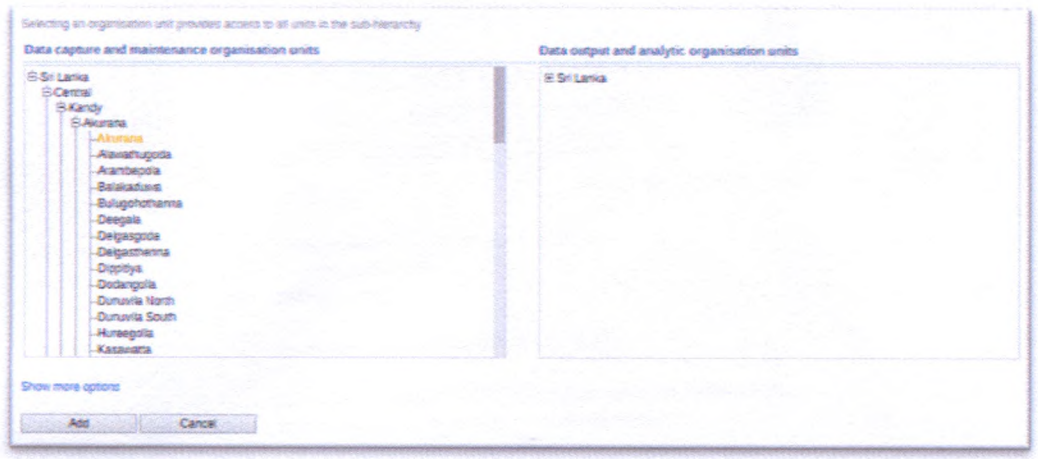


Figure 56: New User - Organizational unit assignment

Appendix F: Ethical approval

ETHICS REVIEW COMMITTEE

POSTGRADUATE INSTITUTE OF MEDICINE

UNIVERSITY OF COLOMBO, SRI LANKA

29.01.2018 *Ref No: ERC/PGIM/2018/05*

Dr Gammeddegoda Liyanage Randimali
26/A Jaya Mawatha,
Boralesgamuwa.

Application Number: ERC-PGIM-2018-05

Title: Customization of DHIS 2 for Management of Drowning Information at Disaster Management Center.

Investigator – Dr Gammeddegoda Liyanage Randimali, Trainee (MSc Biomedical Informatics)
Supervisor – Dr. Achala Jayatilleke (MBBS, PgDISM, MBA, MHSc, MSc(BMI), PhD), Dr. Vishaka Hidellage (MSc Process Engineering, MSc Food Science and Technology PhD. Food Science /Economics)

The ERC/PGIM has reviewed the following documents submitted by you.

Document	Version No.	Date of Submission
Study Instrument-English	1.0	28.12.2017
Study Instrument-Sinhala	1.0	28.12.2017
Study Instrument-Tamil	1.0	28.12.2017
Project protocol	1.0	28.12.2017

The ERC/PGIM at its meeting held on 15.01.2018 has reviewed your protocol and decided to exempt it from review for the following reason.

1. Not collecting personally identifiable data

Please note that this exception is pertaining to the submitted protocol and any alteration or deviation should be notified to the ERC.

Dr Achala Jayatilleke
Secretary-ERC/PGIM