

# A Review of Disease Surveillance Systems

Agung Fatwanto<sup>1</sup>

<sup>1</sup>Informatics Department, UIN Sunan Kalijaga, Jl. Marsda Adisucipto Yogyakarta Indonesia 55281  
agung.fatwanto@uin-suka.ac.id

**Abstract-** Several health institutions in various countries have developed and implemented disease surveillance systems. Although these systems have relatively similar functions, they actually adopted different approaches. This paper reviews the currently available systems which have been successfully deployed. The review is conducted upon peer-reviewed literature, releases from the developing and implementing organizations, and media reports.

## I. INTRODUCTION

A number of institutions in several countries have developed and implemented health informatics applications (which sometimes can also be called as electronic health or eHealth in short). Those applications serve for several purposes, namely: remote data collection, remote monitoring, diagnostic and treatment support, disease and epidemic outbreak tracking, education and awareness, and also communication and training for healthcare workers [1].

Diseases surveillance systems, among others, are important due to the increasing threats of the communicable and infectious diseases which may spread quickly over different regions, threatening public health and national security. Disease surveillance system is a type of eHealth application. It is a kind of system that is developed to monitor any disease and epidemic outbreak which might occur within a particular region. This type of application is therefore important for minimizing the threats and anticipating the worst scenario. The technology is implemented to assist the identification of outbreak and hence could better allocating resources to the places with greatest need.

The aim of this paper is to provide a description of the currently available disease and epidemic outbreak tracking systems especially in terms of their development and implementation context. This paper is not intended to exhaustively review every available application. It rather focuses on the applications developed and implemented for resource limited context which, in most cases, heavily relied on mobile communication devices. This review is presented to provide a depiction on currently available and practiced systems. In overall, the aim of this paper is to review the development and implementation context and provide an analysis of the currently available systems based on their development and implementation concerns (goals and issues).

This paper will be structured as follow. Section 2 discusses the analysis of disease and epidemic outbreak tracking systems from technological perspective. Section 3 discusses the analysis of disease surveillance system from data gathering perspective. Section 4 discusses the analysis of the diseases

surveillance systems from medical perspective. Eventually, section 5 summarizes this paper.

## II. THE TECHNOLOGICAL ANALYSIS OF DISEASE SURVEILLANCE SYSTEM

Disease surveillance systems can be deployed either manually or automatically (meaning electronically). Among the manual deployments are: paper-based and communication tool-based surveillance. Paper-based technique is the oldest way of conducting disease surveillance. This technique relies on paper-based reporting from the lowest-level officers/paramedics send over their higher rank colleagues to be compiled and analyzed further. This process is apparently slow (time consuming) and error-prone since it pretty much involves human tasks. However, this technique requires minimal investment and very suitable for places with strongly limited-resources.

The communication tool-based surveillance is an extension to the paper-based technique, in which it involves the use of communication tool such as telephones, facsimiles, radio communication devices, telegraphs, emails, etc for reporting purpose. Although this technique already uses technology, however there still no automation in compiling and analyzing the report. This type of technique is actually similar as the paper-based technique but with making use of the available communication tools without further exploitation on process automation.

The main difference between manual and automatic (electronic) disease surveillance is in the way on handling report compilation and analysis. Manual surveillance requires report dataset to be compiled and analyzed by human. Meanwhile, automatic (electronic) surveillance utilizes technology for the compilation and analysis of report dataset. Hence, automatic (electronic) surveillance systems can result in faster and more accurate report than their manual counterparts due to the use of technology.

There are two types of technology used as the building platform for automatic (electronic) disease surveillance systems: desktop-based and mobile-based system. Although they implement different technology, both rely on web-based platform.

Desktop-based systems normally developed and implemented in a non resource limited context where the environment into which the systems are going to be deployed have a certain readiness level. At least, there are two prerequisites the environment has to provide in order for a desktop-based system can be deployed: infrastructure and human-resource readiness. Infrastructure readiness means that the environment into which the systems will be deployed

should have particular instruments where the desktop application can be installed and executed and also sufficient internet connection coverage where the data can be transmitted from all data entry point to the datacenter and vice versa. The instruments can be in the form of PC desktop, laptop, or netbook with sufficient component specifications hence the application can run on top of the particular hardware. Internet connection must be widely available and covering most of the regions where the system is deployed. The connection should also have enough bandwidth hence the data transmission can run over it. Human-resource readiness means that the environment should have person with the capabilities to operate and maintain the system.

Considering the implementation context for desktop-based surveillance systems, thus most of the places which developed and implemented this type of system are those of developed countries (such as European and North American). Only a few developing countries that already deployed this type of system, such as Indonesia with EWORS (Early Warning Outbreak and Response Systems) [2] and Peru (Alerta Disamar) [3].

Mobile-based systems normally developed and implemented in a resource-limited context where the environment into which the system are going to be deployed does not have a certain level of infrastructure readiness, especially in regard to the internet connection coverage. Most developing and under-developed countries, especially those with vast areas or uncentralistic settlement pattern, tend to develop and implement mobile-based system. There are at least two advantages of using the mobile-based system for deploying the disease surveillance system. First, data transmission can be arranged over mobile phone network that even though with a relatively limited bandwidth but have wide coverage. Second, the availability of the instruments (especially that for data entry) which is cheaper and widely available. Another advantage of using mobile phones as the tool for data entry is that most people are getting used to mobile phones hence minimizing the adoption efforts, learning time, and training. It helps the responsible person in mastering the application thus increasing human-resource readiness level.

As the examples of mobile-based disease surveillance systems are: AESSIMS that has been deployed in Brazil, EpiSurveyor which has been successfully deployed in Kenya and other places, and InSTEDD that has been deployed in South East Asia [1].

Table I summarizes the analysis of disease surveillance systems from the technological perspective.

TABLE I  
THE ANALYSIS OF DISEASE SURVEILLANCE SYSTEM FROM TECHNOLOGICAL PERSPECTIVE

No.	Type	Advantage	Disadvantage
1	Manual		
	Paper-based systems	Lowest requirements and highest infrastructure and human resource readiness level	Very slow (time consuming) reporting and error-prone (full human involvement)
	Communication tool-	Low requirements	No realtime

2	based systems	of infrastructure and human resource readiness	reporting and still have human-error potential
	Automatic		
	Desktop-based systems	Realtime reporting (with full reporting features) and less human error	Requires highest infrastructure and human resource readiness level
	Mobile-based systems	Realtime reporting (with limited features) and less human error	Requires sufficient mobile network coverage for the serviced region

IV. THE DATA GATHERING ANALYSIS OF DISEASE SURVEILLANCE SYSTEM

From the data gathering perspective, data might be gathered using two types of approach, namely: structured and unstructured.

Structured data gathering is a kind of approach where data are collected from the authoritative parties such as paramedics, health authorities, etc. Since the data are gathered by design, the database format can be structured accordingly. However, this type of data gathering implement passive mode, meaning that the system collect data whenever an event occur and reported to the authority. This kind of data gathering can be deployed for both resource-limited and non resource-limited context.

Unstructured data gathering, on the contrary, collect data from several sources both from authoritative and non-authoritative references. Since the data are collected from various sources, the database format cannot be structured according to the designers' need. This type of data gathering implement active mode, meaning that the system actively collect data anytime it requires from various sources such as mass media, social networking, blog, and media having user generated content. This kind of data gathering can normally be deployed only for non resource-limited context.

Table II summarizes the analysis of disease surveillance systems from the data gathering perspective.

TABLE II  
THE ANALYSIS OF DISEASE SURVEILLANCE SYSTEM FROM MEDICAL PERSPECTIVE

No.	Type	Advantage	Disadvantage
1	Structured	Provide accurate report	Requires authoritative approval for data entry (slow)
2	Unstructured	Can collect data actively (fast)	Less accurate report

IV. THE MEDICAL ANALYSIS OF DISEASE SURVEILLANCE SYSTEM

From the medical science perspective, disease surveillance systems can be classified into two categories based on the way how the data are gathered, namely: traditional (diagnostic) and syndromic (pre-diagnostic) surveillance.

The traditional (diagnostic) surveillance is a type of disease surveillance where the data that are going to be entered into

## International Conference on Informatics for Development 2011 (ICID 2011)

the system is obtained from the medical authorities (doctors, team of paramedics, etc.) diagnostic results. This type of surveillance provides an accurate report since the gathered data is based on very mature result of paramedic diagnostics which in some cases are strengthened with the laboratory data. However, this kind of surveillance takes a lot of time in waiting the diagnostic result and requires medical authorities' approval for data gathering.

In contrast to the traditional (diagnostic) surveillance, the syndromic (pre-diagnostic or symptom-based) surveillance does not require diagnostic results from the medical authorities. Instead, it gathers the data based on the syndrome or symptom felt by the patients that are observed by the paramedics (Anamnesis). Although it does not provide report as accurate as the traditional surveillance, it offers quicker report since the data can be compiled and analyzed as soon as the patient observation has been conducted. Another advantage for this type of surveillance is that it does not require the availability of paramedics with certain level of expertise to enter the data into the system, a condition that hinders the deployment of traditional (diagnostic) surveillance for regions having limited medical expert coverage such as in developing countries.

There are several names for the syndromic surveillance, such as: symptom-based surveillance, health indicator surveillance, prodrome surveillance, information system-based sentinel surveillance, biosurveillance, outbreak detection system, and early warning system [4]. However, these names are actually similar in terms of data gathering: syndromic (pre-diagnostic) surveillance.

Table III summarizes the analysis of disease surveillance systems from the medical perspective.

TABLE III

THE ANALYSIS OF DISEASE SURVEILLANCE SYSTEM FROM MEDICAL PERSPECTIVE

No.	Type	Advantage	Disadvantage
1	Traditional (diagnostic) surveillance	Provide accurate report	Very slow (time consuming) reporting involvement)
2	Syndromic (pre-diagnostic) surveillance	Faster report	Less accurate report

## V. SUMMARY

Although a lot of disease surveillance systems have relatively similar function to monitor any disease and epidemic outbreak which might occur within a particular region, they apparently adopted different approaches. This paper provides a review on the disease surveillance systems that are developed and implemented by several institutions in different countries. Based on technological perspective, the surveillance systems can be categorized into manual and automatic (electronic) system. The manual system can further be classified, according to the reporting media, into paper-based and communication tool-based platform. Meanwhile, the automatic (electronic) systems can be classified into desktop-based and mobile-based platform. Based on data

gathering perspective, the surveillance system can be developed and implemented using structured and unstructured database format. Eventually, based on medical perspective, the surveillance system can be classified into traditional (diagnostic) and syndromic (pre-diagnostic) surveillance.

This review is intended to assist the system analysts and designers who are going to develop a disease surveillance system. An analyst or designer can make a decision regarding the type of the proposed system based on its development concerns (goals and issues). A suitable design decision can eventually increase the likelihood of system success level.

## REFERENCES

- [1] ---, "mHealth," <http://en.wikipedia.org/wiki/MHealth>, Last accessed November 22<sup>nd</sup> 2011.
- [2] H. Siswoyo, M. Permana, R.P. Larasati, J. Farid, A. Suryadi, and E.R. Sedyaningsih, "EWORS: Using a syndromic-based surveillance tool for disease outbreak detection in Indonesia." *BMC Proceeding*, vol. 2 (Suppl. 3):S3, pp.1-5, 14 November 2008.
- [3] E. Gozzer, *Alerta: Electronic Disease Surveillance for Rapid Detection of Potential Outbreak in Rural Setting*. Asia Pasific Economic Forum Industry Roundtable, 13 October 2008.
- [4] K.J. Henning, "What is Syndromic Surveillance." *MMWR Supplement*, vol. 53, pp.7-11, 24 September 2004.