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Towards an Intelligent Decision Support System for Public Health Surveillance – A Qualitative Analysis of Information Needs

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Abstract: Public health information systems are often implemented considering the functionalities and requirements established by administrative staff or researchers, but sometimes ignoring the particular needs of decision makers. This paper describes a proposal to support the design of a Decision Support System for Public Health Surveillance in Colombia, by conducting a qualitative study to identify the real needs of people involved in decision making processes. Based on the study results, an intelligent computational component that supports Data Analysis Automation, Prediction of future scenarios and the identification of new Behavioral Patterns is proposed. The component will be implemented using the Case Based Reasoning methodology, which will be integrated as a new component of the Open Source DHIS2 Platform, enabling public health decision-making.

Keywords. Decision Support Systems, Case Based Reasoning, Public Health.

Introduction

Public Health Agencies in developed and developing countries implement different health promotion and disease prevention programs based on epidemiological profiles and health statistics. However, they normally don't identify the real needs and workflows of decision makers, therefore Public Health programs are not properly implemented, affecting the population's quality of life.

In recent years, decision support systems in public health have been developed. These systems are commonly designed to report the incidence of health events and provide at most, descriptive statistics and behavioral patterns and trends. Additionally, some systems support the data analysis, generate alerts and geo-reference data to facilitate public health decision making by health authorities. However, most existing systems implement functionalities and requirements established by administrative staff or researchers without considering the real needs of decision makers [1] [2].

This paper describes a proposal to optimize decision-making processes within a regional public health agency in Colombia. The approach integrates the following elements: (i) a qualitative study for identifying real needs of public health experts, (ii) an intelligent computational component based on the needs identified during the research process (iii) the integration of the intelligent component to the District Health

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Information System (DHIS2) platform. DHIS2 is a free and open source platform widely used by some developing countries and adopted by the World Health Organization (WHO) in the context of its Public Health toolkit. This platform allows creating forms, indicators, store information, generate reports and view graphs of interest to Public Health Surveillance [3].

1. Methods

To identify the real needs of people involved in public health decision making, a qualitative study was conducted. In-depth interviews² were performed with a set of experts and individuals involved in the decision making process at the Public Health in the Regional Public Health Office of the Department of Cauca³, Colombia. The perceptions and opinions of four respondents about existing systems and their limitations were analyzed in order to identify their information needs.

Table 1. Qualitative Research Design

In-depth interview	Description
Objective	Identify the information needs of those responsible for public decision-making at the Regional Public Health Office of the Department of Cauca, Colombia.
Participants	Respondents were selected in the Regional Public Health Office, considering their knowledge and experience on public health decision-making.
Study Flow	A study protocol was proposed and reviewed by the Ethical Committee of University of Cauca. All sessions were recorded, guarantying the confidentiality of the information.
Data Collection	The interview recordings were transcribed and stored in documents, including annotations made by the interviewer during the discussion, in order to specify and consolidate the opinions of the interviewers.
Data Analysis	The Qualitative Analysis tool Atlas.ti was used to analyze the interview's transcripts. A coding process was performed on each document ⁴ . The quotes and/or significant segments of each document were encoded by one or more concepts. The codes generated in the previous phase (and the relationships between them), were graphically represented using concept's networks ⁵ . The networks were graphically analyzed to discover implicit relationships. Finally, the Structuration of Findings and Theorizing phases were completed.

2. Results

As it was described in the methods section, a knowledge network was built using the concepts and relationships identified from the transcripts. The network analysis and the co-occurrence tables describing how the codes were associated in the documents, allowed the research team to identify implicit relationships through transitive relationships. The main findings of this analysis are described in Table 2. Summarizing, four major problems were found: (i) lack of analytical information, (ii) outdated information, (iii) unreliable data and, (iv) limited informatics tools. Table 2 describes the problems, consequences and information needs identified. Following, a characterization of existing tools at the Regional Public Health Office in Cauca was

² Interviewnguide: <http://www.unicauca.edu.co/~maritzag/ICIMTH2014/guide.pdf>

³ Department is the main territorial unit in Colombia.

⁴ Support Documents: <http://www.unicauca.edu.co/~maritzag/ICIMTH2014/docs.pdf>

⁵ Concept's Network: <http://www.unicauca.edu.co/~maritzag/ICIMTH2014/network.png>

performed. The results obtained are described in Table 3, demonstrating that the DHIS2 system - despite prediction, pattern identification and effective monitoring functionalities are missing- is the one that provides more features, therefore is was selected as the information system to be integrated into the proposed solution.

Table 2. Qualitative Analysis of Findings.

Problem	Consequence	Requirement
Lack of analytical information	Complexity in the analysis.	Automated Data Analysis.
Outdated Information	Interventions aren't timely	Future Prediction Scenarios
Unreliable Data	Unexpected behaviors.	Identification of new behavioral patterns.
Limited tools	Difficulties for effectively monitoring diseases	Suitable tools for decision making in Public Health

Table 3. Analysis of current systems.

Tool	Automatic / semi-automatic Analysis	Prediction, Pattern Identification, effective monitoring	Documentation, Extensibility, Accessibility
National Public Health Surveillance System– SIVIGILA	-	-	-
Platform to support data analysis in Public Health - DHIS2	X	-	X
Unified Database of Healthcare Users RUAF.	-	-	-
Aggregated Discharge Summaries Information system– RIPS.	-	-	-

3. Discussion

Considering the information needs that were identified in the previous section, and in order to optimize the public health surveillance decision-making process; a solution that supports Automated Data Analysis, Prediction of future scenarios and the identification of new Behavioral Patterns is required, in order to support the decision-making process of end users in the described Colombian Public Health Scenario. According to the analyzed literature, decision support systems based on data mining [4] [5], multi-agent systems [6] [7], alarm systems, among other mechanisms [8] [9] are in place. However, no single system considers the historical data available to support prediction of population health behaviors and to learn from new situations. This would contribute to perform timely public health interventions.

Given the above, an intelligent computational solution is proposed, which has to be integrated into the DHIS2 system in order to support the decision-making process using the principles of Case-Based Reasoning (CBR) methodology/technique [10]. CBR is relevant because it considers past experience, provides representative cases which are similar to current problems, and provides solutions which take into consideration a range of possible responses. An intelligent component to support decision-making will integrate existing historical data available to support health behavior predictions, learning from new situations and contributing to timely delivering interventions that benefit population's health. The integration of the component within DHIS2 would allow to: process large volumes of information, increase repose time in decision-making processes, interoperate with other systems, predict health events timely, early detection of warnings, and identification behavioral diseases patterns.

4. Conclusions

The qualitative analysis found that public health decision makers at the analyzed public health office agreed that public health information systems face limitations such as not alignment with information needs, poor monitoring of health events and reports which are based on data outdated and poorly reported. Consequently, interventions aren't opportune and are often designed to mitigate past problems, not for prediction.

After the analysis of available information systems at the Regional Public Health Office under study, it was concluded that no single system support the needs and requirements identified. Because of this, an Intelligent Decision Support System for Public Health Surveillance is proposed as a new component of DHIS2. The component is intelligent because it is supported on the CBR methodology. As future work, we plan to implement the intelligent solution proposed in this research, and conduct an evaluation process with a group of real users in order to demonstrate its feasibility.

The paper described in detail how a qualitative analysis was performed in order to identify information management needs of public health decision makers. This is an important contribution to the field of health informatics and software engineering, because it demonstrates that a qualitative analysis can help to identify potential user's needs and guide the future design of user-centered information systems. In addition, the implementation of the proposed solution will provide timely information to improve Public Health interventions.

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