ARTÍCULO ORIGINAL

Development of an information system at the Strategic Management Support Office of the Brazilian Ministry of Health

Desarrollo de un sistema de información en la Sala de Apoyo a la Gestión Estratégica del Ministerio de Salud en Brasil

Desenvolvimento de um sistema de informações na Sala de Apoio à Gestão Estratégica do Ministério da Saúde do Brasil

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ABSTRACT

The development of an information system is essential for the generation of information to support the decision-making process, extending its benefits throughout the public sector especially to healthcare related organisms. To guarantee a timely government intervention, it is essential to identify problems, develop and evaluate public policy and activity, coordinate implementation, and monitor and control the provision of related services. The objective of the present study is to describe the development of a public health care information system in the Brazilian Health Ministry. In order to achieve that, a study was conducted on the development of the information system in the Strategic Management Support Office of the aforementioned Ministry. The results show that the development of an information system expands the array of relevant and reliable information through the systemic collection, integration, analysis and data presentation, which can be a key factor for the improvement of health services to the Brazilian population.

Key words: Information systems; decision-making; public health care; Brazil.

RESUMEN

El desarrollo del sistema de información es esencial para generar información destinada al proceso de toma de decisiones, cuyos beneficios también se aplican al sector público y especialmente en lo que a la salud se refiere, considerando que la intervención oportuna es fundamental para la identificación de problemas, desarrollar y evaluar las políticas y acciones, organizar la ejecución y supervisar y controlar la prestación de servicios en este campo. El presente estudio tiene por objetivo la descripción del desarrollo de un sistema de información dentro del Ministerio de la Salud en Brasil. Se realizó un estudio sobre el desarrollo del sistema de información en la Sala de Apoyo a la Gestión Estratégica de dicho Ministerio. Los resultados muestran que el desarrollo del sistema de información en el Ministerio de Salud amplía el espectro de información relevante y confiable a través de la recaudación, integración, análisis y presentación de los datos, desde diferentes ángulos, que puede ser un factor clave en la mejora de los servicios de salud a la población.

Palabras clave: sistemas de información; toma de decisiones; Salud Pública; Brasil.

RESUMO

O desenvolvimento de sistema de informações é fundamental para gerar informações ao processo de tomada de decisão, isto se aplica também ao setor público e, principalmente na área da saúde, cuja intervenção em tempo oportuno é essencial para identificar problemas, desenvolver e avaliar as políticas e ações, organizar a execução, além de acompanhar e controlar a prestação dos serviços de saúde. O objetivo do estudo é descrever o desenvolvimento de um sistema de informações para a área de saúde pública do Brasil. Para atingir o objetivo foi realizado um estudo sobre o desenvolvimento do sistema de informações na Sala de Apoio à Gestão Estratégica do Ministério da Saúde. Os resultados mostram que o desenvolvimento de SI no Ministério da Saúde amplia o espectro de informação relevante e fidedigna por meio da coleta, integração, análise e apresentação dos dados, sob diferentes prismas, o que pode ser um fator chave na melhoria dos serviços de saúde a população brasileira.

Palavras-chave: sistemas de informação; tomada de decisão; Saúde Pública, Brasil.

INTRODUCTION

Information is essential for planning, decision making, control and execution of public policy. However, the complexity and speed at which it must be processed and analyzed, additionally to the high rate of change in economic and technological processes, have made this process even more critical.[1] With respect to Brazilian public administration, establishing a consistent strategy and keeping a long-term

perspective is fundamental to improving outcomes, which consequently result in higher living standards for society in general.

This process is similar in the field of health care: having timely, precise and accessible information is essential to monitoring the services offered to the population. Access to public health information is key to identifying environmental exposure to diseases, as well as to tracking intervention development and effectiveness. The efficiency of measures and techniques depends on the availability of databases and analysis tools to generate helpful information to researchers, professionals, decision-makers, politicians, and society in general.[2]

Generally speaking, public health organizations collect considerable volumes of data; the challenge lies in identifying the essential information within it and prioritizing problems, developing and evaluating policies and measures, organizing their implementation, monitoring and controlling the delivery of health services.

According to *Laudon* and *Laudon*,[3] an information system (IS) can be defined as a set of modules working coordinately to collect, recover, process, store and distribute information, with the objective of facilitating planning, control, coordination, analysis and the decision-making process within organizations. Therefore, IS tools support organizations in the collection, integration, analysis, and distribution of all relevant information, thus helping them to make better decisions. IS can also conduct the research and development of guidelines and standards, as well as in monitoring progress and informing the public.

Brazil is amongst the countries to hold a universal public health care system. The focus on health care services quality based on the principles of universality, integrity, and equality has been seen as a major challenge to public planners and managers. In light of the complexity of the services carried out, the Ministry of Health (MS) has several instruments and guiding documents: the Multiannual Plan (PPA), the National Health Plan (PNS), the Annual Health Program (PAS), in addition to the sector-specific health policies such as the National Primary Health Care Policy, National Indigenous Health Care Policy, National Medication Policy, and National Black Population Integral Health Care Policy, among others.

For decades, the process of planning, monitoring and evaluating public health policies within the scope of the Ministry of Health has been carried out through the use of different concepts and methodologies. Even though this has permitted the dissemination of strategic information, it has also hindered the conception of an organized, systemic and critical methodology that would contribute to the implementation of effective program and policy monitoring and evaluation standards.[4]

Considering this, together with the complexity of the health sector, the Executive Secretariat of the Ministry of Health envisioned the constitution of the Unified Health System Monitoring and Evaluation Department (DEMAS). This new department would be in charge of coordinating the health sector's management system, looking to the implementation of institutional guidelines to determine the future of the Ministry of Health.[4]

In this context, the Ministry of Health has been developing a series of tools to ensure the accessibility of information and communicate the government's activities in the scope of the Unified Health System (SUS). In supplying management with technological tools that facilitate the decision-making, transparency, and publicity of government initiatives in the health sector, the Ministry of Health identified the need to assess indicators to measure the accessibility and effectiveness of

government health services. Hence, one of the core competencies of the Strategic Management Support Office (SAGE/DEMAS/MS) is reporting on the programs it monitors to the Ministry of Health.

Health organizations are continually pressured to do more with less, and consequently, the availability of information is essential to decision-making; experience alone can no longer stand as the only basis for choosing a course of action. One of the SAGE/MS major challenges is to implement systems and tools in an environment marked by diverse circumstances, systems and tools which are capable of unifying information into a single database for the purpose of decision-making and communicating government activity to society. Considering this context, the following research question is presented: How can an information system to provide health information be developed? In other words, the central objective of this research is to illustrate the development of a public health information system in Brazil.

The contributions of this study include the processing and distribution of standardized information relevant to government's health networks and health care groups, as well as epidemiological and operational indicators concerning diseases and budget implementation, among others.

This paper is divided into five sections: the first introduces the subject, while the second explains IS concepts and previous studies in the area; the third section consists of a description of the methodology used in the current study; the results and their analysis are provided in the fourth section. At last, the fifth section presents the conclusions devised from the present research.

LITERATURE REVIEW

In order to obtain a better understanding of the subject, a review the literature related to information systems, methodologies and technologies, and also of the previous studies was carried out.

INFORMATION SYSTEMS

An information system can be defined as a set of techniques and procedures that collect, register, store, process and distribute data and information to the coordination of the planning and control system, to the personnel management and to the organization administration, in order to supp the decision-making process. As such, the processes and components of the IS are: input, processing, output and feedback. As per Stair,[5] IS is a series of related elements or components that collect, manipulate, store, and distribute data and information, as well as provide a feedback mechanism. Among the IS components are: organization, personnel, technology, and environment.

According to *Mosimann* and *Fisch*,[6] an information system can be thought of as a network of information, the flow of which feeds the decision-making processes in a specific departments and across the organization as a whole. This information should have a specific logical significance to the administrator, so that the measurement concepts employed must not be dogmatic, but, rather, rational.

Information systems can be classified into two large groups: Management Support Systems, including the Executive Information System (EIS), the Management Information System (MIS) and the Decision Support System (DSS); and Operation Support Systems, which includes the Transaction Processing System (TPS) and the Expert Systems.[3-5]

METHODOLOGIES AND TECHNOLOGIES

Currently, IS refers to the methodologies and technologies used for collection, integration, analysis, and distribution of all relevant information in an organization, with the objective of improving the decision making process.[7-9] One example applied by organizations is Business Intelligence (BI), which can be understood as a set of information systems to support decision-making, normally comprised of database storage, analysis and mining technologies.[10] BIs are designed for gathering information using data stored in transaction databases.[11-13]

BI systems consist of a set of products and methodologies targeted to support the synthetic and analytical information environment of an organization. In this sense, it is a process of collecting, transforming, analyzing and distributing data and information for decision-making. Its infrastructure normally includes Data and Knowledge Warehouses or Data Marts, Online Analytical Processing (OLAP) tools, Executive Information Systems (EIS), Data Mining, queries reporting, and data visualization software, among others.[14] According to *Wu*,[15] BI systems can be classified into two categories:

- *Intelligence tools related to database management systems.* These tools are used to manipulate operational data and extract data essential to managing an organization. Examples include Decision Support Systems (DSS), Executive Information Systems (EIS), Online Analytical Processing (OLAP), Data Storage, Data Mining Systems, Knowledge Management (KM), Geographic Information Systems (GIS), Digital Dashboards, etc. These methodologies are constructed over database management systems and are used to verify trends and patterns.
- *Competitive intelligence tools*: aim to systematically collect and analyze information on the competition environment to support the organization's decision-making process; information is gathered chiefly from public sources, such as those available on the internet.

  In general, the conceptual architecture of a BI system is divided in four steps: integration, storage, analysis and presentation:

  1. *Integration*: is a fundamental stage of the process given that it is in this stage that the consistency of data collected from various sources is verified, following which the data can be converted to a standardized format. The integration process is known as extract, transform, load (ETL).
  2. *Storage:* is the organization of information in a data storage, often using a relational database management system. Relational databases are currently the most popular model for commercial and open-source use.
  3. *Analysis:* is a technique of organizing data using OLAP. In this stage, data is represented by cubes of data rather than tables, and gathered and organized in a multidimensional format. This format allows for a rapid inquiry, transforming raw data into a more adequate and user-friendly configuration. Relational databases can be connected to OLAP in a variety of ways using proprietary and open-source tools. In this stage, key performance indicators (KPIs) should be defined.

4. *Presentation*: is the BI interface for end users through which the executive administrators, business analysts, and advanced and regular users have the capacity to make decisions with adequate information. Knowledge compiled through this process can then be used to adjust or alter conducts and outcomes, as well as modify the planning, execution, and control processes. Tools designed to present KPIs, including the Balanced Scorecard and Quality Dashboards, have been used in the field of public health.[16]

Among the main objectives of BI, the following should be highlighted: to understand the internal strengths and weaknesses of the organization; to determine the relationship between different datasets in order to improve the decision making process; and also to perceive opportunities for innovation, cost reduction and resource optimization. In other words, IS tools help transform raw data into intelligent information and knowledge.[7]

PREVIOUS STUDIES

In this section, studies published in national and international journals related to information systems and Business Intelligence applied to the public sector, and more specifically to the health sector, are presented. *Costa*[17] developed a study on the development of the Health Information System (SIS) of the Brazilian Ministry of Health, detailing the general conditions of the information available in the health sector, the System implementation stage, corresponding objectives and functions, and the strategies and parties involved.

Facchini and *Vargas*[18] provided the results of the evaluation of an information system built for a seven thousand employee public sector organization. The evaluation, carried out eight years after the system started operating, aims to verify the perception of the users regarding pre-determined aspects of the system, as well as identifying shortcomings and limitations, and measuring the level of satisfaction with respect to the system's performance.

Pereira and *Angeloni*[19] investigated the way in which communication takes place between developers and users in the construction of an IS at the Court of Auditors of the Brazilian State of Santa Catarina. *Cintra* and others authors[20] analyzed the impact of applying a management information system (MIS) to public contract administration at the University Hospital of Dourados, in Mato Grosso do Sul, Brazil.

Nyamtema[21] explored the shortcomings and factors that impact the use of MIS in 11 health sector establishments undergoing change in Tanzania. Of those interviewed, 81 % had never been trained with MIS, 65 % could not adequately describe the system, 54 % did not know how to use the collected information, and 42 % did not use the data collected for planning, budgeting and evaluation of services provided. Notwithstanding that 91 % of interviewees answered positively regarding system utilization. According to the author, the current MIS-related shortcomings are linked to lack of training, absence of supervisors, personnel workload-based stress and the high maintenance of the system. This study revealed the poor state of data collection in the health sector, and the lack of information for decision making in health care facilities and in national MIS change factors.

Reis and others authors[22] carried out a study identifying the elements that support the use of an information system in a public institution, applying the TAM and TTF technological acceptance models. An analysis of the results obtained showed that

all of the factors evaluated support the use of the system, including perceived benefits, ease of use, purpose of use, and applicability of the technology to the task. From this it can be established that the IS use is related not only to technological applicability to the task or the individual behavior and attitudes towards the system, but to a combination of the aforementioned factors.

Other studies also detail the application of IS in the health sector. The study by Elebead and others authors[23] demonstrated the application of IS to the geographic mapping of cancer; *Lomurray* and *Sander*[24] applies the same methodology to the vaccination of the adolescent population; *Spiegel* and others authors[25] studies the health and safety of health care workers in two Canadian and two South African provinces; *Mujeeb*[26] describes the use of Human Resource for Health Information Systems (HRHIS) to improve the use of available human resources in hospitals in Sri Lanka.

As well as on IS, studies on Business Intelligence (BI) were also analyzed: *Petrini*, *Pozzebon* and *Freitas*[27] researched the BI use in 15 large Brazilian companies. *Vanti* and others authors[28] presents elements, or system designs, that can constitute an informational setup in order to support strategic decision-making processes in universities. *Reginato* and *Nascimento*[29] investigated the contribution of BI for controllers in performing decision-making tasks taking into account the relevant information available. *Leite*, *Diniz* and *Jayo*[30] studied the application of BI in a large commercial bank in Brazil within the scope of the operations management of the branch network. *Serbânescu*[31] covered the importance of implementing a BI solution in a company. *Affeldt* and *Silva* Jr.[32] analyzed the architecture of information systems using BI technology. The latter analysis was conducted over questionnaire responses provided by executives.

Nevertheless, studies of BI in the public sector and especially in the health sector are still rare. In this field, a study by *Jinpon*, *Jaroensutasinee M* and *Jaroensutasinee K*[2] on the IS development in the Thai health sector deserves attention. The study reveals that the development of IS in health care is a big challenge. *Foshay* and *Kuziemsky*[33] examined the processes related to decision-making in a Canadian health organization. Their article demonstrated that the lack of resources impacted negatively on decision-making processes. Issues related to information, procedure and personnel also play a decisive role. In this sense, health organizations should employ a process structure that defines the information requirements in the implementation of BI. In other words, process management in the health sector has strategic impact on resources, operations and on quality and risk indicators.

There are numerous articles on this topic, such as the description of the advantages of, and limitations to, the application of BI.[16,34-36] As demonstrated, health organizations yearn for the implementation of IS and there is no research currently available that provides a specific framework to guide this process. In order to fill this research gap, the current study presents the development of an IS at the Ministry of Health.

RESEARCH METHODOLOGY

This form of research is defined as descriptive from its objectives, considering that, according to *Gil,*[37] a descriptive research has the primary objective to detail the specificities of a pre-determined population or phenomenon, or establishing relationships between variables. The research proceedings are described throughout this section, with special attention to its specificities.

STRUCTURED PROCESS FOR THE CONSTRUCTION OF A THEORETICAL REFERENCE

The structured process for the selection and analysis of references is divided in three stages: the selection of a database, the selection of articles, and the systematic analysis.[38] The first stage is basically the selection of a database. At the second stage a selection of articles related to the subject is carried out using key words to search for titles, abstracts, and key words of articles also taking into account the academic reputation (based on the number of citations). At last, the third stage involves a systematic bibliometric analysis of the article portfolio.

Based on this structure, articles aligned with the subject of information systems and Business Intelligence were gathered sequentially from the Scientific Periodicals Electronic Library (SPELL) database. At the international level, the Coordination for the Improvement of the Higher Level Personnel (CAPES)'s Journal Database was searched for national and international journals. The keywords searched were "information system," "health sector," and "business intelligence", in the title, abstract, and keyword fields.

Data collection occurred from August 1st to September 30th, 2014 from a selection of 32 national and 74,061 international articles. Results were filtered to select international articles related to "information system" and "business intelligence" in the public sector, using the keywords "public" and "health." After filtering, a total of 158 articles were identified. The studies gathered provide the base for the theoretical framework and support the results contained in Section 4, as well as the conclusions presented in Section 5.

DATA SELECTION AND ANALYSIS PROCEDURES

The present research was conducted through a study at the Strategic Administration Support Office (SAGE) of the Ministry of Health. SAGE is a department of the Unified Health System Monitoring and Evaluation Department (DEMAS) and was created to support the public administration summit at the Ministry of Health, the Brazilian President of the Republic and civil society in general. The Office's website receives over six thousand visits daily and provides epidemiological data, information about Ministry programs, and information about resources and implementation.

The establishment of DEMAS was an initiative intended to shift the intricate scenario of concepts, methodologies and instruments of Management and Evaluation (M&A) in place at the Ministry of Health. It also demands the integration of the Strategic Planning (SP) and M&A as an input to improve the management practice.[4] DEMAS was founded in 2011, through Decree 7.530, subject to the Executive Secretariat of MS and split into two General Coordinations: the Monitoring and Evaluation Coordination (CGMA) and the Strategic Information Administration Coordination (CGGIE). Furthermore, the Department has an advisory board, a technical support team, and a task force team.

SAGE, as a data and information processing and distribution office, produces information to support the internal decision-making processes, administration and knowledge creation, as well as contributing to the transparency of activities developed in the area. Therefore, it publicizes the government's initiatives in the context of the Unified Health System (SUS). Its organizational structure is composed of three departments: Networks and Programs, Health Status, and Administration/Financing.

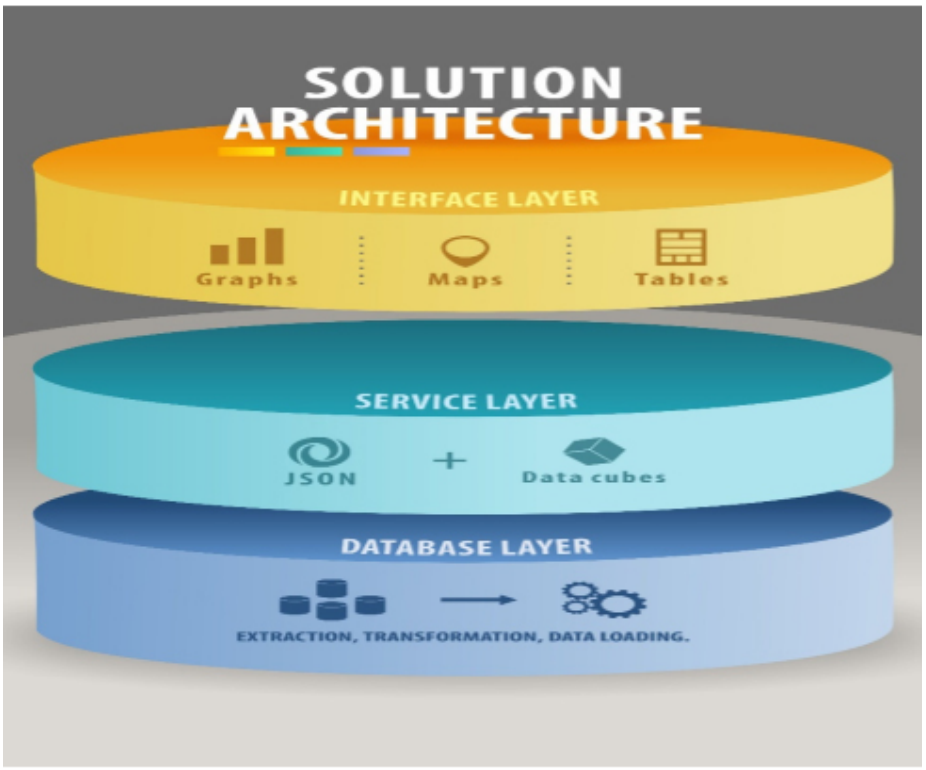
RESULTS

The presentation of the results was divided into three sections: IS development, layers and Electronic Government Program, and finally a discussion of achieved results and new potential developments.

INFORMATION SYSTEM DEVELOPMENT

The IS of the Ministry of Health was designed in layers so as to organize the tasks of the various professionals involved. It also was designed to organize logically the applied concepts, facilitating code maintenance and personnel training. The figure 1 shows the three layers, which are described as follows:

1. *Data Layer*: Responsible for the capture, processing and storage of data. Also referred to as the Database Layer, it primarily designed for storing the database, loading processes, automatically updating the database, and collecting queries from the Structured Query Language (SQL) server.
2. *Service layer*: Responsible for the communication with the data layer and for drawing up data in the most suitable form for compatibility between systems.
3. *Interface Layer:* Responsible for presenting the information to the end user.



Source: SAGE/MS (2014).

Fig. 1. Representation of the layers and the flow of information.

The organization of the system in layers is a widely-used concept in the IT market known as Model, View, and Controller (MVC). MVC is a software architecture model that splits the representation of information, the structure of data, and the interaction of the user with the system. The data environment in the model is represented by the Database Layer. The controller mediates the input from the user, the data search in the model and the final delivery of the data to the interface layer. In this design, the controller is represented by the Service Layer. The last element of the MVC architecture is the objective, which is responsible for presenting and collecting data from the system user, represented by the Interface Layer in this design. Along with the layers, SAGE's internal processes were mapped in Business Process Model and Notation (BPMN), identifying the flow of information, parties responsible for data, input frequency, as well as other information relevant to the processes that required documentation.

LAYERS AND THE ELECTRONIC GOVERNMENT PROGRAM

The detailed internal processes of each of the layers and their relation to the Electronic Government Program are presented next:

- Data layer, database, modeling, extraction and processing of information.

  With respect to data storage tools, such as the Database Management System (DBMS), the option suggested to SAGE was the PostgreSQL (http://www.postgresql.org), since it is a free database also used by other public administration organizations at the federal, state, and municipal levels, such as DataPREV, PRODEPA, and CELEPAR, among others.

  The aforementioned tool is licensed under a PostgreSQL License, which guarantees usage, modification and distribution of the software and its documentation without the need for payment or written agreements with the software developer. The software selection is in accordance with the first Free Software Implementation Technical Committee Directive, which prioritizes free software solutions, programs, and services.

  For data modeling, the multidimensional model was chosen. According to Kim*bal* and *Ross*,[39] it is a logical design that structures data into dimensions and facts, reducing query time and promoting a simpler organization. This is due to the knowledge management and strategic information technical committee directive, which promotes the use of principles, concepts and methodologies for knowledge management, together with the Electronic Government Program Executive Committee. In this sense, multidimensional modeling meets the demands of this directive by organizing data in the logic of business, valuing its concepts and relations.

  With the DBMS tools and data models defined within international standards and in harmony with the Brazilian Electronic Government Program, the last layer is the tool that makes the extraction of data from various sources possible, whether they are other databases, electronic spreadsheets, or text files.

  The main objective of the information extraction system is to provide a visual interface for data processing through the use of tools that access other databases, complete calculations, perform text operations, insert code and store data in the destination database. Thus, the proposed workflow uses a dimensional model to structure information, implement it in a robust database, and use the system to enable a continuous and structured supply of data.

- Service layer.

  After developing the first layer the next structure was configured, whose function is to manage data through a visual interface, as well as administrating the data through interoperability standards. The primary technology relevant to this layer is the data cube, also known as the Online Analytical Processing (OLAP) Cube. It is a representation of the data and its relationships to allow the user to create different objectives for a defined information[40] set. The data cubes are created to meet the requirements defined by the administrator and represent the outline of defined problem. From these data cubes, it is possible to obtain information about the number of patients attended by a specific medical specialty in a given month, and the total number of patients in a given period, among others. These "reports" are known as data cube perspectives.

  There is a visual tool called the Mondrian Schema Workbench (MSW) used in data cube construction. Given that SAGE's database was modeled in a multidimensional model and applying the MSW for the creation of cubes, the consistent generation of information and utilization by SAGE administrators becomes possible. In order to manage the cubes, the Saiku tool was chosen (http://www.meteorite.bi/saiku), which is free and allows for the creation of new perspectives from previously constructed cubes.

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- Interface layer.

The interface layer is coupled with the service layer for the user's data consumption using the previously mentioned Uniform Resource Locators (URLs). Once the data has adequate annotation for transfer, but not for presentation, this layer plots the data into charts, tables and maps as necessary. The technologies used in this layer are the CCC2 and accessibility technologies:

CCC2. A free software, available under the GNU GPL license, used to present data in various types of charts, such as bar charts, pie charts, line charts and others. The data source used for this technology is JavaScript Object Notation (JSON). Thus, upon integrating this chart generator with SAGE's service layer a free quality tool that has already been tested in various desktop platforms (commercial use browsers such as Firefox, Internet Explorer, and Google Chrome) and also in smaller devices such as tablets is obtained. The application of this technology guarantees that SAGE users can access information through his/her operating system and browser, which means there will not be any extra costs associated to the end users' access nor will there be shortcomings on browser technology.

Technologies to ensure accessibility. Regarding the structure of the web page, HTML5 was used This language is a standard proposed in 2009 by the World Wide Web Consortium (W3C), widely used in the development of web systems around the world. However, the application of HTML5 does not guarantee that the web page created follows the accessibility guidelines proposed by the Electronic

Government Program Model for Accessibility (e-MAG). Nevertheless, for the development of all websites, complete adherence to the e-MAG is necessary. The system also uses a Community Edition of the Pentaho software in order to meet the objectives of DEMAS/SE/MS.

On top of the previous tools, EAP is also used in data presentation. The EAP dictionary is applied to detail each EAP work package in order to highlight outstanding tasks so that all of the deliverables are completed. As can be observed, the software and tools were chosen among those available in the market in order to meet the Electronic Government Program principles and to facilitate dissemination and the effective replicability in other environments.

DISCUSS POSITIVE RESULTS AND POTENTIAL NEW DEVELOPMENTS

SAGE/MS's information system gives information support to users' decision-making. Figure 2 displays information on one of the MS-SUS programs, namely the Better at Home program, designed to provide health care services at people's houses. The program provides free health care to people undergoing body motor control rehabilitation, elderly people, patients with chronic conditions and post-surgery patients, to name a few examples.

An example of the quantitative information provided by the system is the number of trained personnel teams in each Brazilian state, also displaying charts and information on geographical positioning. In the case of the Better at Home program, health care is provided by multidisciplinary teams, comprised of doctors, nurses, nursing technicians, and physical therapists. Support teams can be comprised of other professionals such as nutrionists, psychologists, pharmacists, dentists, and speech therapists. Each team can provide service to 60 patients simultaneously on average.

In this way, the computer system can help in planning activities and demands, as well as helping to monitor and evaluate the administrative support in each state. The system can provide information on the number of patients served by state, by team, etc. Figure 3 displays the increase in the number of qualified teams per month, and the number of patients attended per month and per year.

As evidence of the importance of information beyond the decision making process is its relevance for planning, implementation and control: SAGE/MS's information system receives more than six thousand visits on a daily basis. Systems such as this are crucial to developing policies based on evidence, to inform decision making in the planning stage, to support implementation and evaluation of health programs, and also for the adequate use of resources in all levels of the health system.[21]

In order to verify the level of usage, potentials and limitations, specific measeures can be undertaken in sequence, such as the training of users, pointed out by *Nyamtema*,[21] and the evaluation of information systems by its users, as illustrated by other studies done by *Facchini* and *Vargas*[18] and *Nyamtema*.[21]

Source: SAGE/MS (2014).

Fig. 2. Presentation of the SAGE/MS information system.

Source: SAGE/MS; 2014.

Fig. 3. Example of the information representation supplied by the SAGE/MS system.

CONCLUSIONS

The Strategic Administration Support Office (SAGE) of the Ministry of Health is an important body constituted to communicate health care data and information not only to Brazilian society and federal, state, and municipal administrators, but also to any other interested parties in Brazil and abroad.

This study detailed the development of an information system in the Ministry of Health, with a description of the data, database, modeling, information extraction and processing, services, and presentation layers. This system allows the data to be accessible in various formats, all of which comply with international standards and are easy to access by other systems or users.

Several tools are used in each stage of the IS process, such as DSS, EIS, ETL, Data Warehouse and Dashboard, among others. Along the development and application processes, a selection of the most appropriate technology must be carried out, which can also be critical. In the case of SAGE/MS, preference was always given to free, open source software and systems, taking into account the guidelines of the Brazilian Electronic Government Program, as well as the possibility of distribution and replication of solutions to other environments.

The public health care system normally takes in large volumes of data. The benefits of an IS system in this field comprise the assistance in identifying key information, prioritizing problems, and developing and evaluating policies and initiatives. As described, the IS can be used as a valuable tool to develop a system for efficient and effective decision making in the public health sector. Along with the application of Business Intelligence (BI), relevant and reliable information can be collected, integrated, analyzed and presented to different users, with the objective of improving the decision-making process.

This study showed that there is potential for future research in this field, such as a study to improve key performance indicators on MS programs, in order to enhance activity evaluation and monitoring and support major decisions. Also, surveys on users's perceptions and satisfaction levels with respect to the information generated and distributed by the system would be important to improve the system.

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