

Information and e-learning services for the efficient management of allergy and asthma, employing an integrated environment monitoring network

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Abstract—In this paper we present a distributed telematic platform which is implemented to support health information management and innovative services to people suffering from allergies, asthma and rhinitis. The developed system establishes a trans-European information network offering specialized services to health professionals, patients and the public, by collecting, processing and distributing specialized data and informational content. An integrated monitoring and reporting system of aero-allergens is used to collect Pan-European environmental data and produce allergy maps, forecasting and danger level alerts. Informational content and e-learning resources are also consolidated and combined with personalized health management services. Through the created network, health information is supplied to sufferers via WWW and SMS technologies, and informational and learning resources are offered to health professionals. Sets of services were implemented in pilot form and offered to real users for testing purposes. The results were encouraging towards expansion to fully blown service at a Pan-European level.

Keywords— *telematic services, environment monitoring, health information, teleeducation.*

1. Introduction

The European citizen is nowadays more concerned about his health and he wishes to participate actively in dealing with his health problems. In the era of information, the patients want to know more about their diseases and problems, possible precautions and evolutions in medicine, and they are willing to make use of any type of support to improve the quality of their life. Professionals as well, need to have reliable information in order to help their patients and also the ability to use technology as a tool of quality service provision.

One of the most common distressing and life threatening conditions that impact inimically on the quality of peoples' lives, is allergy and asthma which – with all its complications – have influence not only to the sufferers but also to their families. It affects hundreds of thousands of European citizens with an impact on economic indices. The EU geographical area is characterized by different environmental

conditions that affect the health of citizens and generate a wide range of epidemiological and allergiological diseases. There is obviously a necessity to study, analyse, organize electronically and disseminate the information related to the environmental factors, which have impact on health. There is also a strong demand for health information both from citizens and health professionals. Sufferers need and request information in order to increase their knowledge, to improve health, prevent disease and support their own decision-making. Health professionals are seeking resources of specialized information and continuous medical education.

Nowadays, the evolution of the Internet and mobile technology provides the appropriate technological infrastructure for spreading the above information in the user groups, while it facilitates the information flow between hospital and health centres. Furthermore, it enables the web-based education and training, which can be easily accessed by citizens and professionals.

In this paper, an integrated system is presented for the provision of environmental monitoring and management of allergies, asthma and rhinitis in a Pan-European perspective. The system establishes an electronic workspace and offers specialized services to health professionals, and sufferers, by collecting, processing and distributing specialized information. The related work was done within the project "Integration of Regional Environment Monitoring and Management for Asthma (IREMMA)", which is partly funded by the EU eTen program. The proposed system provides telematic services to health professionals and sufferers to support disease management, prevention and education. The services include live information about environmental conditions (aeroallergen measurements, alerts), support for disease management (self-management tool, e-learning), information (library, news) and training (continuous medical education sessions). The IREMMA system supplements the existing information networks on allergy by offering high data integration, multi-modal access and personalized information and disease management tools. The system aims at Pan-European coverage by integrating existing information networks and establishing additional

data acquisition points. In this way, it sets the ground for establishing a wide integrated network for environmental monitoring and diffusion of health information.

2. The IREMMA approach

2.1. Objectives and technologies

The starting point of IREMMA is to offer innovative telematic information services on allergiological issues in order to improve prevention and public awareness, to improve the quality of healthcare, to reduce hospitalization costs and to offer specialized knowledge to citizens and health professionals. The services are designed and built according to a business-oriented approach in order to achieve financial viability and efforts towards standardization will improve the prospects for wide acceptance and dominance in the field.

The IREMMA uses the latest information and communication technologies. An integrated web-based environment offers friendly access from mobile and fixed locations to integrated information on allergiological diseases and in particular asthma and rhinitis. Internet-based communications are preferred in order to ensure universal user access and high expandability of the services. The mobile phone is also used as highly available medium.

In order to support the above services, IREMMA is building a Pan-European information network on allergies and allergy-related conditions. This network comprises data collection points, either pre-existing or created, that may be located and operated at a national/local level. In other words, IREMMA provides the means for interconnecting national sources of information, such as pollen measurement stations, weather report agencies, medical experts, etc., and integrating the collected information. In this way, information from various sources is concentrated in a standard format, is processed and normalized and then redistributed to users with central control. Additionally, provision is made to expand the network with additional nodes and to create data collection sites where they do not exist.

Important elements of technical feasibility which were investigated are:

- the connection with databases of historical data on aero-allergen measurements;
- the connection with existing agencies providing live aero-allergen measurement data;
- the installation, operation and connection of new pollen measurement stations;
- the importing of weather forecast data and producing pollen level forecasting;
- the coding and normalization of pollen measurements in a standardized way within Europe.

The IREMMA technical approach is based on the following principles:

- Internet-based communications are used both for the exchange of data among the system nodes and for user access;
- multiple access devices are offered, including web (through PC or public access locations), mobile phone (SMS) and PDAs;
- flexible, modular and expandable design ensures that the system is able to support updated services, new technologies and expansion to additional target groups and application sets;
- mature and reliable technologies are used to reduce risk and time to market;
- business oriented issues are taken into account in all technical decisions (e.g., cost, support, dependencies);
- efforts towards standardization will improve the prospects for wide acceptance.

Three different levels of service provision were identified, each one being targeted to a different end user group, namely general information services, services to patients and services to health professionals. A web-based user environment, in combination with an access control component, gives access to individual user interfaces for each user group. The specific functionality offered by the system has been defined according to the needs of the specific user group. Differences also exist in the informational content, presentation of data and level of information depth.

2.2. The services

Based on the results of the user requirements phase, the market investigation tasks and the feedback received from user trials, IREMMA concluded to a specific set of services. The services offered by IREMMA through the developed platform are addressed to both people suffering from allergies and to health professionals (e.g., allergologists, GRs), as well as travellers, so that IREMMA becomes a common reference point on allergies, rhinitis and asthma.

A set of services in the IREMMA site is directly accessible without registration. They are common for all, that is every site visitor, including sufferers, professionals, travellers and potential users can access the IREMMA web-page and get general information about the dominated environmental conditions concerning asthma and allergies. These are valuable services, such as pollen levels for any location, forecasts, information library, links, etc., which are however not personal and are offered free of charge to any user in order to attract his interest about the site.

However, if someone wants to access personalized and more specialized services, he has to register himself and get a personal account. There are different personalized

services depending on the profile of the user. As regards the health professionals, they can access e-learning material, teleeducation sessions that are eligible for CME credits and participate in discussion lists. Additionally, sufferers can receive SMS alerts about increase pollen levels in the atmosphere, view their personal allergy map, download informational material, change their profile and plan their travels according to the allergy information they get. In the following, all the services offered by the IREMMA platform are presented in more detail.

2.2.1. Public services

Allergy maps. The use of IREMMA Pan-European pollen trap network data from the IREMMA web site provides mapping of allergens concentration in each European country. Following collection of data from pollen traps across Europe, aero-allergen data from each country are stored. Collection of historical data, according to the area and the season, is used for forecasting purposes. The user, through a web-based application has the ability to search for all or a specific allergen existing in a geographical area. The service provides pollen measurements for selected aeroallergens and for selected location and time. The result can refer to the latest actual measurements, the prediction for next week or to a specific date around the year. In the latest case, estimation based on statistical data is used. A high-medium-low indication per aeroallergen is displayed and in the case of actual measurements, also the precise pollen count is available. It is also possible to display the yearly distribution of aeroallergens for a specific location, according to statistical data.

Information library. The purpose of IREMMA information library is to provide to each user, Internet based information on allergies and asthma on demand like:

- reference medical information in the form of a medical encyclopedia;
- new advancements/developments in rhinitis and asthma;
- description of most common allergens;
- list of precautions and useful tips for sufferers;
- specialized medical centres across Europe;
- information on medicinal products in collaboration with pharmaceutical companies.

Latest news. The user can access scientific news on allergies, rhinitis and asthma in the form of short articles that are updated on a daily basis.

Frequently asked questions. The frequently asked questions (FAQ) screen displays a set of questions and their corresponding answers. It is accessible by all users and intended as a basic reference of information. It is frequently updated as new questions and information arise.

Useful links. A set of frequently updated links to relevant sites is offered, such as allergiological societies and organisations, medical sites, pharmaceutical companies, health organizations, etc.

2.2.2. Services to patients/sufferers

SMS and e-mail alerts. The user (sufferer) can receive SMS or e-mail alerts when increased pollen levels are expected in the atmosphere. He defines the corresponding preferences in his profile, including allergens of interest, e-mail address, mobile phone, location, etc. The user can also activate or deactivate the alarms and he is able to view the messages he has received and the corresponding charging.

Personal allergy map. The personal allergy map service provides the user with aeroallergen levels for the area where he lives, as selected in his profile. Only the allergens, which the user has selected in this allergy profile are displayed. The displayed data can be the latest live measurement or the forecast for next week. In the displayed report a list is provided with aeroallergens, counts for the date and location and color indication for danger. Only the allergens which are selected in the patient's profile are shown.

E-learning. The e-learning service offers information that is useful for the patients in order to increase their knowledge on specific issues related to their health problem. The information is organized as downloadable files (e.g., presentations) and a charging mechanism applies. The corresponding page displays a list of e-learning items available to the patient and provides a search facility for e-learning titles according to category (e.g., posters, presentations, research papers, etc.), date or keyword.

Self-management tool for asthma. The IREMMA self-management tool for asthma helps patients to monitor their asthma by measuring their peak flow. The measurement of their breathing flow helps in assessing their current breathing status. A common peak flow meter is used to measure the peak flow. The user can then send the obtained measurement to IREMMA in order to monitor his condition. The self-management tool uses a personal best value (calculated according to the sufferer's age, sex and body measures) and peak flow history in order to:

- inform the user immediately if he is ok or need to take actions;
- show him a chart which presents his progress; a chart shows in graphical form the history of the patient's measured values; the graph can be 15-day, or 6-month; there are 3 color zones, the green zone which means that everything is going well, the yellow zone which suggests to take additional measures to control his asthma and the red zone which is an emergency situation and urges the patient to ask for medical help.

Travel planning. The travel planning service allows travelers with allergy problems to view pollen levels for a specific location in Europe, in order to plan their travel. It is particularly relevant to frequent travelers and tourists. Pollen levels can be displayed as follows: the latest live measurement, the forecast for next week, the yearly distribution or the expected levels at a specific date. The yearly graph allows the user to view the occurrence of specific allergens in the specific area around the year and plan for the best period to visit the specific location or he can choose a different location. The user can also view pollen levels on the specific date of interest, according to statistical estimation. In case he is interested for an immediate trip, he has access to live measurements and forecasting for next week. The registered user can view pollen levels at the location of interest according to his own allergy profile, i.e., for the specific allergens relevant to him. After selecting the location, the user can also access local information, such as a presentation of the allergy profile of the area and information on the local health system.

Profile. The registered user can view and update his allergy profile and personal preferences. The information contained includes:

- the allergens in which the patient is sensitive;
- the area for which he wants to be informed;
- the presentation of his personal allergy maps;
- information necessary for the self management tool;
- preferences about SMS or e-mail alerts;
- info about his subscription and chargeable services.

Discussion list. The users can enter the discussion list, either to read comments and contributions on issues that may interest them or to participate actively in posing questions and commenting on ongoing discussions. An expert assigned by IREMMA enters the discussion list on a frequent basis and adds comments to ongoing discussions. In this way, certain posed questions are also answered by an expert and the attention of the users is drawn to opinions that have been expressed and are not acceptable by the medical expert.

2.2.3. Services for health professionals

Medical education. Medical education (teleeducation) is offered to health professionals through recorded training sessions, ground rounds and recorded telemedicine sessions. The material is transmitted through ISDN lines between a teleeducation provider and rooms with teleconferencing equipment. Participants are able to attend in teleconferencing rooms close to the area where they live and work. The event is organized by IREMMA with the collaboration of local organizers who provide the room and specialized centers in Europe, who provide the training

sessions. The web platform is used to announce scheduled sessions and professionals are able to register their participation. Teleeducation sessions are eligible for CME credits and have a specific cost. Users can be informed about the cost, summary, provider and place/date of each session through the site. Users are also informed about the sessions for which they applied for participation.

E-learning. The e-learning service offers information that is useful to the health professionals in order to increase their knowledge on specific issues related to their specialization. The information is organized as downloadable files (e.g., presentations) and a charging mechanism applies. The corresponding page displays a list of e-learning items available to the health professional, together with their description and price and provides a search facility for e-learning titles.

Profile. The health professionals are able to define, view and update their profile information and preferences. The data screen is accessible only by the corresponding professional after successful login. The displayed data are derived from the record of the specific doctor who enters the screen. The displayed items are:

- personal information, address, medical specialization, contact information, username and password;
- information about the professional's account, such as charging info for medical education and e-learning (date downloaded, title, price and total).

Discussion list. The professionals can enter the discussion list, either to read comments and contributions on issues that may interest them or to participate actively in posing questions and commenting on ongoing discussions. The discussion list for health professionals is separate from the discussion list for sufferers and the discussions are on a professional level.

2.2.4. Services for travelers (includes the visitors of the olympic games in Athens)

The services to travelers and in particular to the visitors of the olympic games are in principle the same as those for all other allergy sufferers. However, in order to address in a better way the needs of this special user group, additional designing features are added to the IREMMA website. More specifically, a link has been added in the home page with the symbol of olympic games, which links directly to special information about the olympic sites and the health system in Greece.

3. Methods

3.1. Overall architecture

The IREMMA architecture is based on the concept of information technology (IT) center and of national sites. The procedures of data collection and presentation are decen-

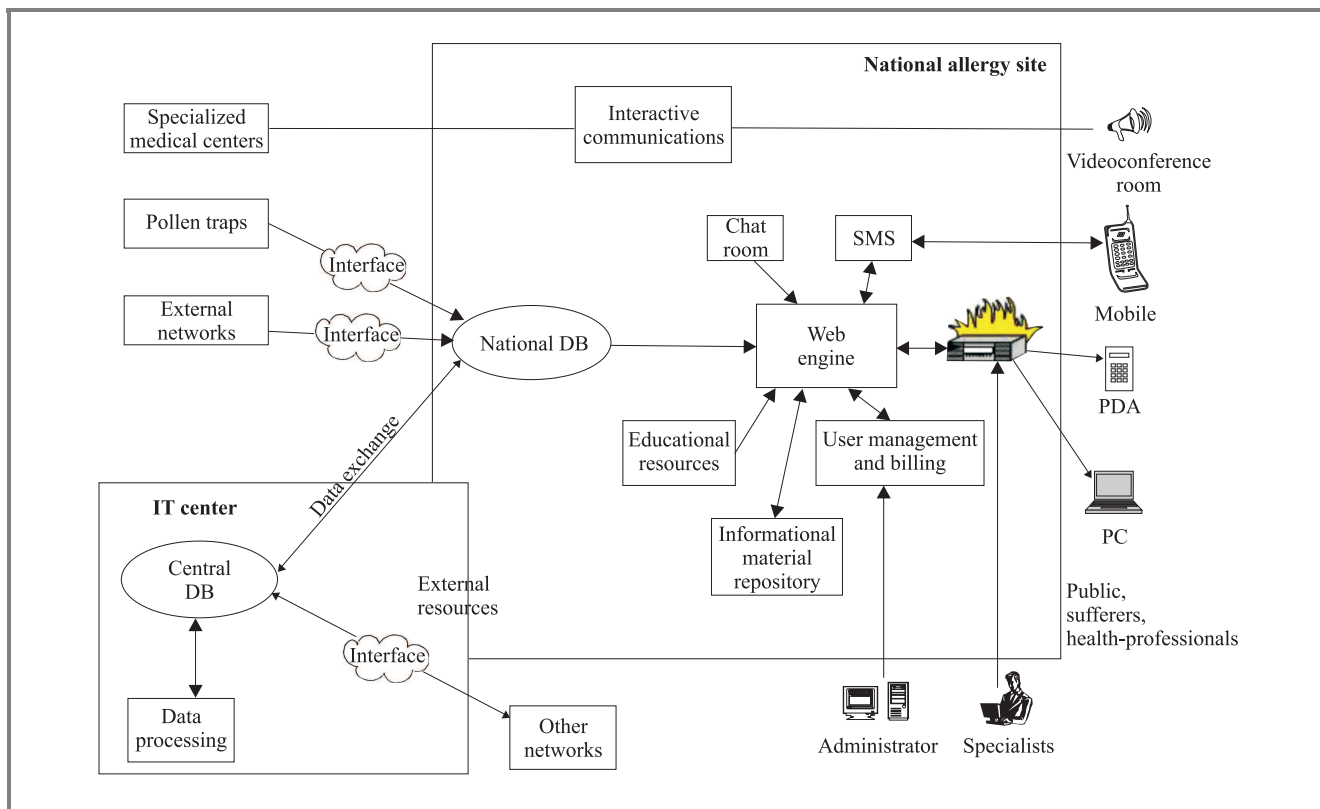


Fig. 1. System architecture.

tralized through the national sites, while information integration and processing are done centrally in the IT center. Each national site acts as an interface between the local data sources and the information center. The data communicated between the national sites and the IT center is standardized. In this way, additional national sites can be easily connected. On the other hand, the communication between the national sites and the data sources are specific to the data sources, not only technically, but also organizationally.

As depicted in Fig. 1, the heart of the IREMMA information network is the IT center, while the service provision and user management point is the set of national sites. An integrated data processing scheme includes collection of all allergiological information (e.g., pollen measurements throughout Europe) together with additional information that may be useful (e.g., meteorological data). The data are then normalized, stored in a standardized format, processed to define alerts and dangerous conditions, and are prepared for uniform presentation. The integration of all data from many local sources into a single point and its centralized processing is one of the strong points of the architecture and increases the capabilities of the system.

The allergiological data and informational material are distributed to the end users of the system through the national sites. Each national site is responsible for collecting local information and for this reason is connected to different data sources (pollen measurements, weather report agency, experts). It is also connected with the IT center to which

it forwards all local information. The national sites are finally the access point of users and provides for this purpose web-based user interfaces. The infrastructure allows the existence of any number of national sites, according to the expansion of the system.

The end users are connected to national sites:

- through Internet connections of any type (e.g., dial-up through ISP, xDSL, etc.) using PC from fixed location of mobile location (through GSM modem);
- through SMS messaging using mobile phones; the corresponding service is implemented in collaboration with a GSM operator (in our case COSMOTE);
- special web-based interfaces will be considered for access through PDAs;
- expansion to additional media such as e-mode or satellite/cable TV is open.

Each national site must provide also informational resources for national – local users with a specific decentralized service provision. National sites are developed in order to meet the needs of national e-learning applications and telemedicine support.

The national allergy sites play a double role:

- the one is of the intranet application that will be browsed by professional users for storing the data into the sub-system’s database;

- the other role of national sites is that of the main IREMMA interfaces forming a presentation layer for the local national end users accessing the data through desktop computers, laptops, mobile phones, PDAs.

A large amount of data will flow back and forth to/from the national allergy sites, either in raw form or processed by the appropriate components. Direct access and data interaction with end users is also foreseen. The maintained and circulated data is however of diverse nature and is relevant to different types of users and subsystems. For this reason, information management procedures ensure that each data item is visible only by the appropriate actor. The IREMMA system provides a secure, scalable, highly available, reliable, manageable, and easily usable environment suitable to the heterogeneous and distributed healthcare field.

3.2. Technical architecture of national sites

The developed platform is based on a three level approach. The lower level is the allergy warehouse which comprises the infrastructure for information collection and management, user administration, inbound data management and security issues. The second level is the multi-service tool provider, which acts as the service implementation level. This is an intermediate level which accesses internal procedures of the allergy warehouse and provides processed data to support the provision of general information services and personalized services for professionals and sufferers. The third level is the end-user applications which provide telemedicine, teleeducation and e-learning services, access to the information library of the system and a self-management tool for the pollen profile administration of each patient.

3.2.1. Allergy warehouse

The main purpose of the allergy warehouse is the manipulation of allergy data, derived from measurements that come from specific pollen networks and will be processed and presented appropriately for environmental monitoring purposes. The format and the conditions of this information differ for various such networks and the allergy warehouse applies an integrated structure for them. Distinct entities support the services of information library, e-learning, news, discussion list and medical education. The common element of these services is that they provide informational data, that can be faced either as simple data-types within the warehouse or as special objects. Their discrimination regards their different content, context and type and lead to the design of different entities.

Aeroallergen counts and meteorological data are the basic data used to offer allergy maps and to initiate alerts. The consortium has concluded to a specific coding, rules for transmission and procedures for processing and displaying this data. There are two basic categories, statistical data and live data. Live data is introduced daily or weekly and includes forecasting. Statistical data is static but also needs

certain updating, e.g., storage of new data, expansion to additional locations, etc. It has been decided that aeroallergen levels are recorded and communicated as actual levels measured as spores/m³ and not as danger levels. The danger levels are estimated by the end-user level of each national site individually because they involve a degree of subjectivity according to other environmental conditions. Additionally, recorded measurements are stamped with the time period and the location to which they correspond. More specifically, the location of each pollen trap is numbered and named uniquely so that there is no overlap of measurements coming from different sources. Measurements can also be daily or weekly.

Informational material can be in a variety of formats, which makes integration with other information systems difficult. It is also expected that some kind of editing will be needed in any case, even if the file format of the informational content matches between provider and IREMMA. For this reason, technical integration between information systems in order to automatically exchange information has not been considered. The IREMMA platform uses certain templates for informational material, in order to store the content in the database and automatically present it through the web. These templates can be refined in the future and be used for standardized exchange of content between national sites and IT center. However, during the pilot phase, the existing material was in diverse formats and it was decided not to spend many resources in transforming this material. The information was thus provided to the user in its original format, by allowing him either to download it as a file or open it through the common plug-ins of the web browser (e.g., for MS Word, MS PowerPoint, Acrobat Reader, etc.). The allergy warehouse also contains user profile information in order to allow user management, access rights management and effective service provision. User profile data include, apart from demographic information, their allergy profile, service provision preferences, charging and billing information.

The file management is a critical issue for the allergy warehouse and a special protocol has been established [1, 2]. To use the available information formatted in binary files, including multimedia files and textual data effectively, efficient methods for storage, browsing, indexing and retrieval are implemented. The base for all of these is the fact that the physical data and the features of files are not both included in the allergy warehouse. A special indicator object is used as an encrypted alias name of the physical path, where the file is located and it is registered to the corresponding entity in conjunction with the rest features of the specific file. The users who attempt to collect the available files follow an assessed set of steps. The users undergo the constraints of the authentication data; call an already fixed special query for the context and indicator; and then the host's operation system restrictions are enforced to them. It is recommended that the three steps must be passed successfully as to obtain the target information. Finally, for the maintenance of the system the allergy warehouse in-

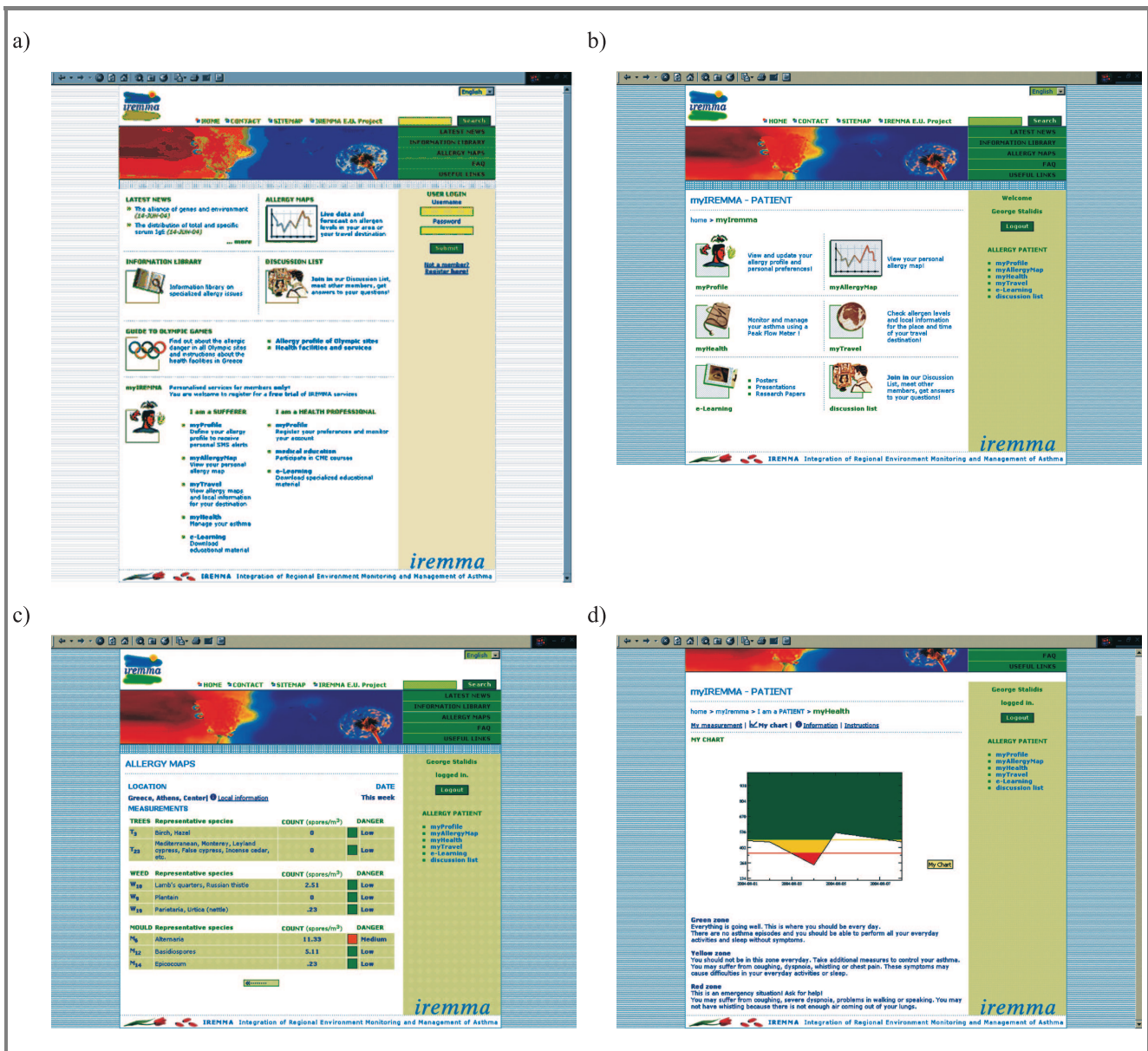


Fig. 2. User screens: (a) main home page; (b) home page for registered patients giving access to personalized services; (c) personal allergy maps; (d) the progress chart presented by the self-management tool for asthma.

cludes procedures for backup and restoring of the application data, the application programs and the exact structure of the repository entities in case of a failure. More frequently the backup will be applied for information related with users' attributes and allergy data, imported from the pollen networks.

3.2.2. Multi-service tool provider

The multi-service tool provider is the middle level in the proposed architecture. It is the core of the application layer and implements the functionality and application logic of the supported services. It performs a number of tasks in order to manage the users' data and transactions, routing the application data and translate the users' requests to understandable statements for the functional interface of the al-

lergy warehouse. The first consideration is to identify the users and access their profiling information, ensuring that the appropriate access rights are enforced and the necessary information to provide personalized services is obtained. The appropriate mode of usage is defined, depending on the user identification. Secondly, it channels the information to and from the users according to their preferences, location and access mode [4].

In order to perform the routing and transfer of application data, apart from the above mechanism, the definition of the participating entities for each communicating session is required. The conversion of information to the appropriate mode according to the participants' access modalities is being performed based on a logic table, which implements the correspondence between the supported transactions and the array of services. The lower layer of the multi-service

tool provider performs the translation of the application user requests to sets of multiple statements, defined using a high level data manipulation language (DML) [5]. This mechanism makes a search for the appropriate already fixed functions and addresses their specified interfaces as calls to the communication interface of allergy warehouse.

3.2.3. End-user application

The end-user application level, including the user interface is web-based. The users of the services are mainly using PCs to access the information needed and mobile phones to receive SMS alerts. The use of devices such as PDAs with mobile access is foreseen, which are also web-based. The user access for all types of users is through an Internet browser window, which contains all the information, navigation capabilities and functionality (Fig. 2). Three different levels of service provision are identified, each one being targeted to a different end user group, namely general information services, services to patients and services to health professionals. An access control compo-

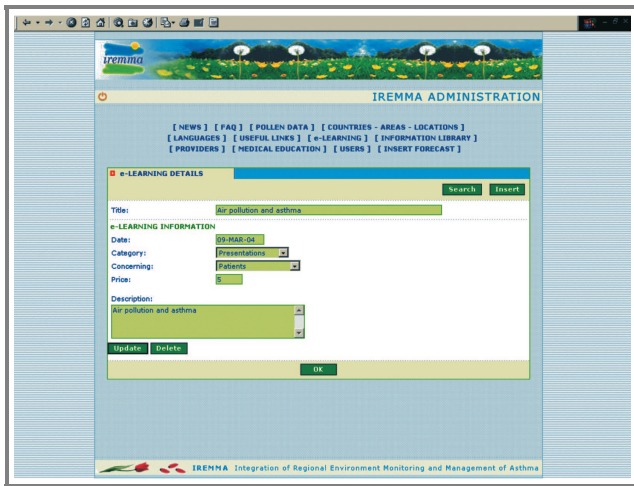


Fig. 3. The administration tool. The updating of an e-learning item has been selected.

nent, gives access to the functionality corresponding to the specific user group. Differences also exist in the informational content, presentation of data and level of information depth. An additional set of applications is offered to experts who maintain the content and to the administrator (Fig. 3). These comprise a set of tools for information and user management and they are accessed through a similar web-based interface, which however has slightly different designing than the end-user interface.

3.3. Integration with data sources

The implemented IREMMA prototype is a complete national site which supports service provision to end users by collecting, storing and delivering allergy information. During pilot trial, all data and informational material was collected by a limited number of providers and was made

available to the users. However, at the future Pan-European perspective it is foreseen that a number of independent national sites will be operational. Information collected by each national site will be sent to the IT center which will act as a hub controlling the data flow. Integration between national sites and the IT center is thus necessary, related to the following issues:

- pollen data collected and owned by the national site is sent to the IT center;
- pollen data collected by the IT center from all European sites is provided to each national site;
- informational material produced and owned by a national site is sent to the IT center;
- informational material collected by the IT center is provided to a national site on demand;
- transactions involving the exchange of information between a national site and the IT center are recorded and the value of these transactions is calculated according to a fixed pricing policy.

In order to deal with the above issues, the following has been defined and/or implemented.

A standardized codification of aeroallergens has been defined, which includes all the types of aeroallergens that may appear throughout Europe. Although it is still subject to revision, the produced codification is usable and possible causes of confusion regarding the naming or categorization of individual species have been clarified. Using this codification, it is possible to exchange and integrate data on aeroallergen levels at Pan-European level.

A template file in MS Excel and a definition of XML message have been produced allowing the easy transfer of measurement data through Internet-based communication.

It has been decided that aeroallergen levels are recorded and communicated as actual levels measured as spores/m³ and not as danger levels. The danger levels are estimated by each national site individually because they involve a degree of subjectivity according to other environmental conditions. Additionally, recorded measurements are stamped with the time period and the location to which they correspond. More specifically, the location of each pollen trap is numbered and named uniquely so that there is no overlap of measurements coming from different sources. Measurements can also be daily or weekly.

The collection of pollen data is performed by TCP/IP based communication between pollen networks, pollen traps and national sites. Aeroallergen data is received either by pollen traps through the hospital or institute which operates them or by existing networks which act as providers. A survey was performed in pollen trap technology and it was found that in most of them the measurement is acquired after manual processing and can not be automatically transmitted (usually sent by fax or e-mail). The result is expressed in standard units (spores/m³) and the only subjectivity lies in the categorization and naming of the aeroallergens. There

are also different types of pollen traps, according to the measurement period (e.g., one day, one week, etc.). Pollen networks collect data from many pollen traps and keep them in their own format.

The solution given in order to integrate existing and new pollen data sources into a unique allergy data repository as:

- to standardize the coding of aeroallergens;
- to develop a web interface for manual insertion of the measurement by the pollen trap operator directly in IREMMA database;
- to propose a file template which can be used by the data provider in order to insert the data and upload it to IREMMA, where it is automatically imported in the database;
- to propose an XML schema to allow pollen data exchange through http connection;
- to develop filters that import data provided by pollen networks, according to the format used by the providers.

The scientific partners within the IREMMA project consortium concluded to a specific codification of allergens and technical partners have implemented a message format for data transmission. Live pollen measurements and forecasting are sent by the operators of pollen traps (usually a hospital clinic or an allergiological institute) to the national sites with which there is an agreement for data provision. This can be done either by sending a message in an agreed format (defined in XML and alternatively in Excel file) or by using the provided web interface, which allows the manual insertion of the pollen data directly by the experts to the database. In addition to live measurements and forecasts sent on a regular basis, there is provision for the exchange of statistical data covering the pollen levels at specific locations during past years. Such data has been successfully exchanged within the pilot phase by developing a configurable importing component which has been adjusted to the format of origin. Since the format of pre-existing data can not be controlled, such interfacing components are necessary in order to import external data. A standard coding of aeroallergen types is also used, such as the one proposed within this project.

Informational material can be inserted, edited and revised directly on the national sites by authorized experts through a web interface dedicated to information management. The corresponding functionality is offered by the administration tool of IREMMA, which is addressed to information providers, experts and the IREMMA administrator. The implemented tool offers the required functionality to experts in order to insert and manage news articles, frequently asked questions, e-learning items, useful links, description and schedule of medical education sessions. It also allows them to edit or upload content for the information library. The tool offers the ability to the administrator to define new languages, areas and locations of pollen traps, providers of

medical education sessions and a user management window for viewing and managing user accounts. Finally, a usable web interface is offered to experts acting as providers of pollen data to insert manually live measurements and forecasts and to upload already prepared files with measurements.

3.4. Implementation issues

The IREMMA services are offered through a telematic platform that is designed, implemented using mature technologies and operated in pilot form within this project. This platform is the basis for future expansion to fully blown commercial services. Information delivery and supporting transactions are offered over both wire line and wireless links to a set of end devices, such as desktop PC, laptop PC, mobile phone and PDA. Modular design allows future expansion to additional user devices, such as digital TV, MMS and others. The telecommunication infrastructure is based on public switched digital networks and data networks. Internet-based communications ensure universal user access and high expandability of the services.

The hardware and communications infrastructure of OTE were used in order to run the services for pilot trials. The platform used is UNIX-based which was considered as the most appropriate for future expansion to wide scale service provision. The database has been implemented in Oracle 9i and the implementation language of the web application is php. An Apache webserver was used [3].

4. Results

The IREMMA platform is currently operational in pilot form and services are offered to groups of trial users in Greece and Spain. The prototype is currently implemented in English, while the multilingual edition has not yet been implemented. Data is collected by aeroallergen networks with the participation of Corporacio Sanitaria Clinic – Spain, Royal Brompton Hospital – UK, Venizeleio hospital – Greece, Sotiria hospital – Greece, Laiko hospital – Greece, Municipal Institute of Medical Research – Spain and the Italian National Research Council, who also provide the medical expertise and informational content.

The system has initially been evaluated by expert users regarding usability and completeness of functionality and by developers regarding technical issues, such as reliability, correctness and performance [6]. Evaluation results have been used to perform a second development cycle and lead to updating of the services and prototype implementation. The major points which required update were: it was decided to add or modify certain services in order to emphasize the specialized and personalized nature of the IREMMA and differentiate it from medical information sites on the Internet. More specifically, the self-management tool for asthma was implemented, the structure of travel planning service was changed to make it more easily accessible by travellers and the link to “Guide to

Olympic Games” was added. It was also specified that patients/sufferers must be registered on their own, even if their doctor recommends IREMMA to them and the doctor is not responsible for maintaining the profile of his patients in the system. For this reason, the patient archive initially implemented as a service to the health professionals was removed. Minor changes in the interface were also carried out, such as the replacement of certain icons, the change of colouring and the refinement of the layout of the home screen.

Full user trials with real sufferers and health professionals are being performed since the spring 2004 and all the services are freely available to the public until the end of September 2004, with the collaboration of National Greek Telecom provider (OTE). During this period, all paid services, including SMS alerts are offered free of charge and the site is publicised to allergic patients and travellers, and especially to tourists and travellers to Athens 2004 Olympic Games. Additionally, three testing groups of patients have been formed, in Greece, Spain and UK and formal evaluation procedures are carried out by the collaborating hospitals [7]. The first cycle of results which are now available show high degree of satisfaction and intention to use. The basic principles of IREMMA have been verified as a promising approach with high potential of leading to a successful and financially sustainable service with considerable socio-economic impact. The selection of service sets seems successful and appealing to the users and the interfaces were found as well structured and usable.

5. Conclusions

The work presented in this paper intended to perform a feasibility study and market validation for the public health information services concerning environmental and allergy issues. The project’s aim is to establish a trans-European network, providing a wide range of services related to environmental diseases, asthma and allergy, such as allergy forecasts, real time alert reports, self-management for asthma and medical education.

A technological platform has been implemented to support sets of services provided via world wide web and SMS technologies, based on an integrated monitoring and reporting system of aeroallergens. IREMMA has set the ground for establishing a trans-European network to support, through telematics solutions, groups concerned with common environment-related allergic diseases. Based on this network, it will supply health information to citizens with allergy and asthma problems, support the management of environmental diseases, and will finally collect, organize electronically and disseminate information on environmental factors.

Sets of services to sufferers and health professionals were implemented in pilot form and offered to real users for testing purposes. The approach and designing of these services were successful and a promising architecture has been proposed for creating a sustainable and efficient integrated

network for information collection, processing and diffusion. The ambition of IREMMA is to expand its network of data sources throughout Europe and to collect credible informational content. In this way, it can be realistically transformed from a pilot service into a fully blown high-quality service of considerable value to an extremely high number of users.

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