Development of a management information system to facilitate the daily activities of a public health group and promote public health awareness in society

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Abstract

This paper explores the development of a knowledge base within the European Public Health and Environment Network (EPHEN) research group at University College London, which had a pressing need to change the way its work activities were conducted. It is intended to provide some insight to managers, group members within EPHEN, as to how this development can bring about changes to service delivery and practice that empowers service users and involves them in the process. It seeks also to identify possible difficulties that might be anticipated. Also a public Web site will be integrated into the system to promote health awareness, especially as EPHEN's primary concern is to encourage public health in society.

Introduction

A research group of European Public Health and Environment Network (EPHEN) was established at University College of London (UCL) in 1999 (Parvanova, 1999). At present EPHEN uses a traditional system of storing information in filing cabinets. There are several problems with the existing system. First, all of the details on employees', service users', etc. were stored in a filing cabinet, which made manipulation and sharing of data a tedious and time-consuming activity, especially as most of the members were situated in different rooms. Second, communication between each member took place regularly via e-mail rather than on the phone or in person, as the members spent a lot of their time at meetings and presentations. However, the email system frequently had problems that affected the flow of communication amongst the members. Third, it did not use Internet delivery as a cost effective medium to support EPHEN's primary mission in terms of encouraging public health in society.

The project of a management information system (MIS) addresses the above issues by creating a multi-user network information system to automate the daily activities carried out by the members of EPHEN and a public health Web site to promote health awareness in society. The system design and development will be discussed in depth in the paper. The project has covered all the software-engineering phases, which are vital for the successful development of most systems.

System requirement specification

The requirement analysis phase is the first major step towards the solution of a software problem. During this phase, the user requirements concerning the proposed application are carefully identified and documented. It is a task which allows the software developer to refine the software allocation and build models of the data,

functional and behavioural domains that will be treated by software. System requirements may be either functional or non-functional.

Functional requirements

The system is to support several functions.

Function 1: personal e-mail system
The personal e-mail system will be used only by the EPHEN members and thus will run independent of the main e-mail system. This e-mail system will be used only for work-related purposes. The following functions should be available in the communication system with regards to e-mail: composing, reading old and new mail, forwarding, deleting, modifying the read/unread status of the e-mails, notification of new/unread e-mails, deleting, and the ability to navigate through messages received.

Function 2: view and enter new timesheet rows
For example, employee's number and project number must be unique, and when entering timesheets both values must be valid references. Users must enter week numbers in the range 1 to 500 and hours in the range 1 to 70. Users' input must be validated and, if not in the range specified, the users must be informed of the correct range. Incorrect data must be prevented in being input, where possible. The charge field should be locked, as it should be calculated automatically, e.g. via working out what the charge rate would be for each employee depending on their job role.

Function 3: security
The network operating system in the department, Novell version 5.0, will be used to enforce security so that only the EPHEN members and the network manager will have access to the system. However, another security layer should also be incorporated, to make the system more secure.

Function 4: changing passwords and setting reminders
The facility of changing a new password and setting or adding a reminder should be available from a menu.

Function 5: service user details
Users need to view and also add new service users to the service user database. It would be very helpful if a user could enter either a service user name or number in order to retrieve the service user's details and to

perform other functions such as deleting data and printing out service user information. It was discussed that the users would not prefer to get help from the system in entering the service user names to search for, as this function was previously available in the old database and was found to be very annoying rather than helpful after a while.

Function 6: mail merge
Frequently, service users are sent letters, and it is very tedious to have to open Word and go through a number of steps to create a mail merge. It would be very effective to be able to have an option to create an automatic mail merge from the service user form.

Function 7: employee details
It would be of much use if users could search for information on employees, by typing in the first name of an employee. Also, there should be a facility where users can navigate and view all employees' details. Common functions should be clearly visible which allow the user to add, delete, undo, save and print the data.

Function 8: skill details
It is common for members of the EPHEN to frequently attain skills in a number of various disciplines. Thus it will be effective to have a system where we can add new skills to the database as well as displaying the skills possessed by an employee and skills required on a project. Also, a facility should be made available for members to select a range of skills in order to create some form of list to display the employees who possess the selected skills. Once again the common functionalities of allowing the user to add, delete, undo, save and print the data should be made available where appropriate. Skills required on a project should also be made available for viewing and modification.

Function 9: grade details
This form should be very similar to the previous forms discussed, e.g. skills form. Users would need to be able to view, update, delete, print and add grade details.

Function 10: different access levels
Different members should get access to different sections of the system according to their job role.

Function 11: paper generation
The following reports will be needed by EPHEN: EPHEN work paper, EPHEN

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timesheet data, skills possessed by each employee and employees possessing each skill, etc.

Non-functional requirements

Mainly in the creation of work-related information systems there has always been an emphasis on automating work-related tasks in order to enhance work productivity. When manual tasks are automated work generally becomes less time consuming, time is money, thus more money is saved, data are easier to manipulate and are more secure. Figure 1 shows the data flow diagram (DFD) of the information system.

The extra dimension

It was discussed and agreed with EPHEN that an element of fun and non-work related features should be included in the system. The aim of the non-work related section would be to enhance health awareness within EPHEN, as the group is concerned primarily with public health in our society. The health system would be available for all users, thus everyone will benefit, both employees and the employer. Also as it will be aimed to promote a healthy lifestyle, it is a known fact that the healthier the work force the more productive output (work) is produced, thus benefiting the employer and the company indirectly. When you enter the "health alert" section you are presented with a door which you must push in order to enter the section. Next you are presented with a menu (Figure 2) which is made available from every form within this section.

The health section is to contain seven features.

Health feature 1: healthy recipes
This provides members of the EPHEN with a variety of vegetarian and non-vegetarian healthy and low fat recipes and also gives ideas on what can be eaten at different times of the day, e.g. breakfast, lunch and dinner. For example, to see some healthy recipes, you need to select the type of recipe, i.e. vegetarian, and the click the button labelled – "display" to see the menu. To view the different menus you can use the navigation buttons on the bottom. To view a vegetarian recipe for lunch, you click on the button labelled "lunch" (Figure 3). To return to the menu with the different types of recipes click the button labelled "menu". To see an image of how the prepared dish would look you click the button labelled "image" (images need to be added yet, just included for demonstration purposes).

Health feature 2: promote healthy shopping
To further promote users actually trying out the recipes, a facility should be provided where users can create a shopping list, choosing items needed to make the recipe suggestions and allowing the user the flexibility of adding their own items. To create a shopping list, click on the orange coloured basket on the top of the form, which takes you to the last option on the main menu.

Health feature 3: health-related informative quizzes
To play the quiz you need to answer health-related questions. Feedback and your scores

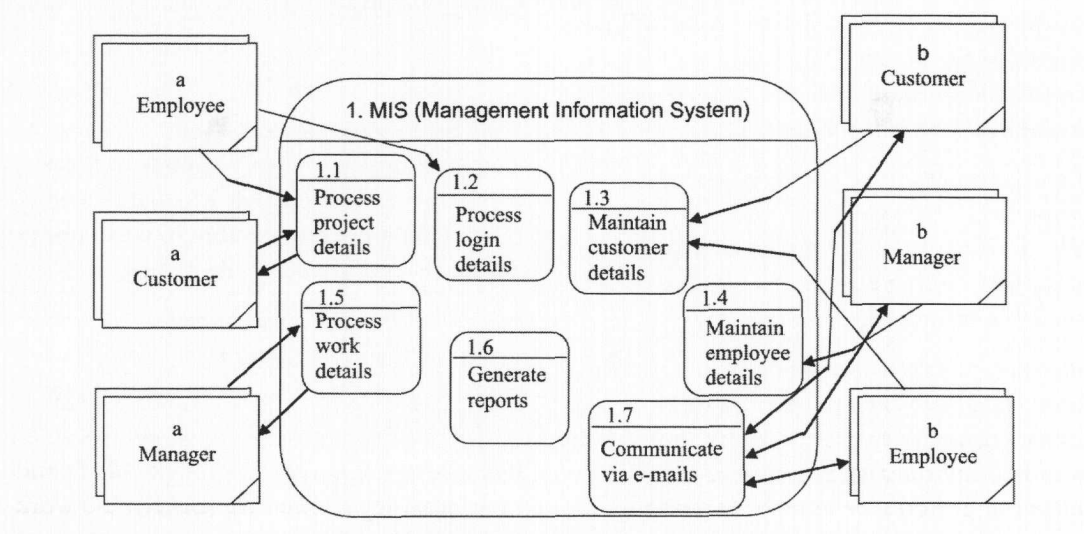Figure 1 Data flow diagram level 1 of the management information system

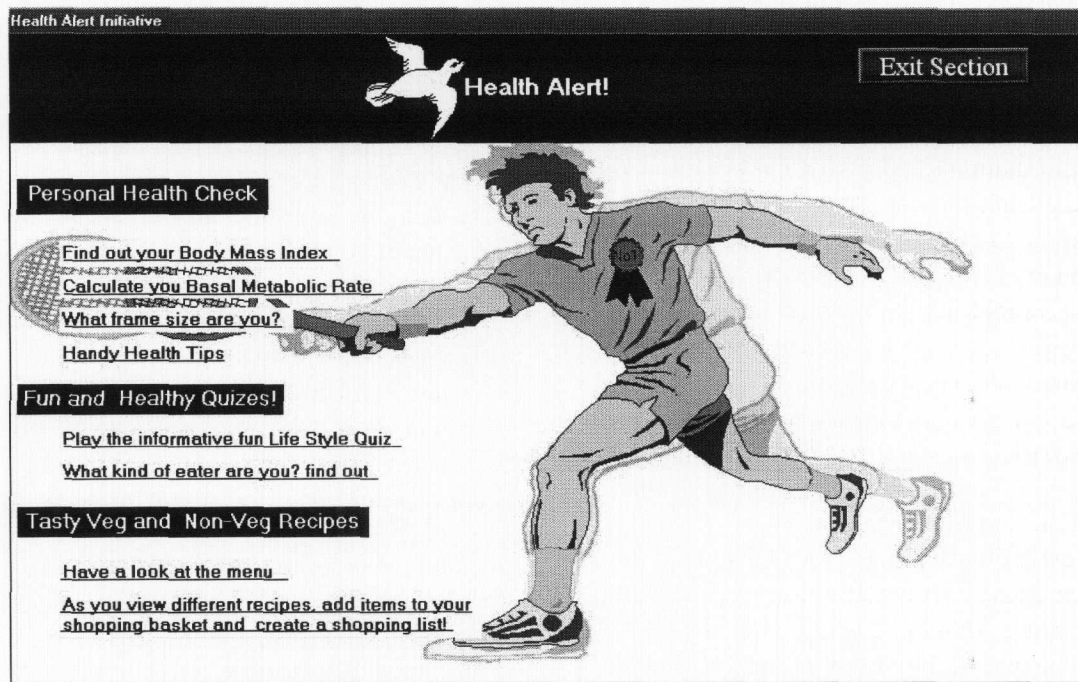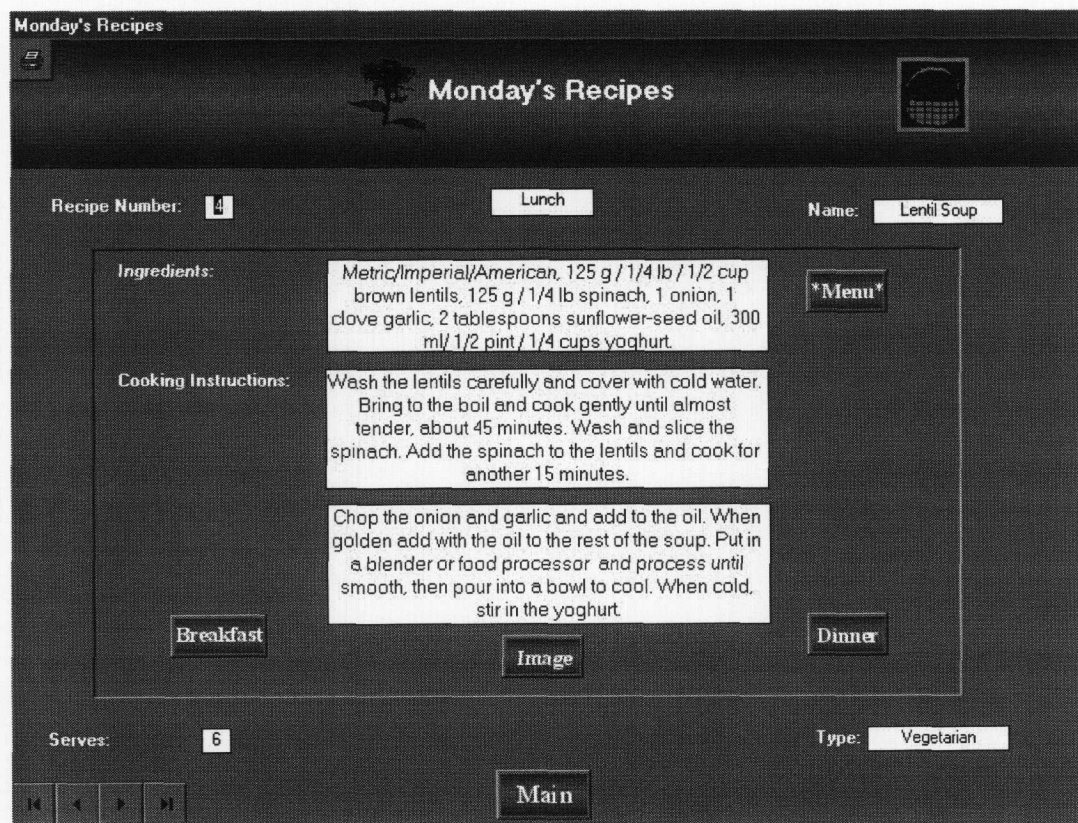**Figure 2** The main switchboard of the health alert section

Figure 3 An example of a vegetarian recipe for lunch

are given on your answers as you go through each stage. For example, to find out what type of eater you are, you need to fill in the form and another one, then on the last form you click the button labelled "feedback" to find the answer.

Health feature 4: personal health check
In order for users to find out what their general health state is, they should be able to work out their body mass index (BMI) and their basal metabolic rate (BMR). To work out your body mass index you need to enter

your height, weight and the click the button, which is labelled "calculate BMI". Once your body mass index has been calculated you can go to the section on this form labelled – "BMI weight category", to find out what category you fall under. Then click the question mark next to the category you fall in to find out more information. Also there is a question mark positioned under the box where the BMI calculation is given, which again displays more information on BMI when clicked. When calculating your BMR you first need to select what gender you are, then click the button labelled "display"; once the selection has been made you are presented with a form (Figure 4). Then you need to enter your weight, age and select the how active you are in your daily routines. Again, help is offered by selecting the appropriate question marks next to the activity factors.

Health feature 5: health tips
To view the healthy tips just click on the button labelled.

Health feature 6: what frame size are you option
To work out your frame size you just need to follow the instructions given and finally click

the button labelled "analysis", to provide you with feedback on the type of frame size you are.

Health feature 7: weight and height conversion help
A facility should be available to users to aid them in carrying out weight and height conversions. To carry out weight conversions, for example, you need to enter your weight, then click the button with the equal sign to get the results. To re-enter your weight you need to click the button labelled "clear", which clears the weight values entered.

Development of an information system

Any attempt to improve efficiency and effectiveness requires an organization to understand its outcomes and measure its performance. Information systems are "an integral component of the decentralised model" (Leonard and Mercer, 2000). It is important to recognise that the introduction of an information system with a backend database can never simply be a technical matter; it is primarily a management issue.

Figure 4 An example of basal metabolic rate (BMR) calculation for females

There are a host of matters that need to be attended to as the system is developed (Payton, 2000). Decisions have to be made about how the system will be paid for, who will drive it forward, the extent and timing of the involvement of top management, group members, and service users. Crucially, there needs to be some vision of what the end use will be. Otherwise, it will seem like unnecessary work for no purpose (Rea and Rea, 2002).

Investment in a database of service users and their needs is a task that requires resources and commitment. Microsoft's Access software on the platform of Windows NT server/client has been used. A database clerk has been employed to input data and maintain its routing operation. As a prerequisite, the EPHEN members have adopted a common method of individual needs assessment and entered into a shared commitment to manage individual care through a care management process. Given that EPHEN members are a jointly-managed responsibility of health and public health authorities in the area, there were concerns initially about sharing individual records that had been created for other purposes. Principles of confidentiality have to be balanced against the demonstrable dangers that follow from not sharing such data.

It was this local development, and the fact that it was already up and running before it was formalised and extended, that made it possible to develop an information system that was widely perceived as valuable. Formalisation (and further funding) for extending this information system throughout the service was found at senior management levels because, on the one hand, the information system was already in use locally and because the EPHEN was demanding the development of management information systems. Without such a management information system, the "personal system" had to be used to manage staff skills and workloads and to collect some local performance management data.

The current database draws on information for skill management and makes it easily possible for someone to identify when enquiry took place, what the decisions were as a result, and who has management responsibility. The information can be used by anyone on the team to deal with any enquiries. It has a clear value locally in

ensuring that services are provided for people whose needs have been identified and it is this which should ensure local management of the services will continue to be the focus of information system development. Another equally important aim is to build an on-line dialogue through a public Web site between service users and the service, so that service users would feel they could participate. Service providers want service users to feel that their views are important and that they have a right to make their views known. In the past, the surveys had to be carried out manually and inefficiently.

The network is installed with Novell NetWare and Novell Directory Services (NDS) software, which enables the effective maintenance and control of all IT related activities.

Whenever a user accesses a program from their desktop, it is retrieved from the server not from the computer's hard disk. Programs are more easily maintained when they are stored on a server. For example, if all the programs were installed on the user's hard disk it would be quite a lot of work to install a new program on over 180 computers. The advantage of having all the programs stored this way is that you only need to install a program once on the server, which would then be available for all users. Another advantage is that more space is available on the users' computers. So the users' computers have to do less work and thus can run more effectively (White, 1999). Only a couple of advantages in having a server and storing programs on a network have been discussed, but there are many more. This highlights the advantages of placing the newly built system for EPHEN on the network.

Access might allow multi-user access, but is still not a true client/server implementation. Microsoft database (MDB) files are what are created in Access to store data (Halvorson, 1998). When an MDB is used, you are using a file-server implementation. What happens is that a query is processed on the client side and is never sent to the server. The MDB is aware that it needs a table of data in order to process the request, and before it applies the WHERE clause of the SELECT statement it first makes a request for the entire table across the network. Thus if the table contained a large amount of data, then frequent requests to this table would greatly increase network traffic (Noel *et al.*, 1997). This file-server

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structure can increase network traffic, especially when a large number of requests are made by many users and where the data are retrieved from very large sized tables. However, for EPHEN this is not a major problem as there are not many members in EPHEN and also the tables do not contain an excessive amount of data. However, in a file-server and multi-user environment, it is necessary to take the locking mechanism into consideration.

In the system there are a number of forms which need the locking mechanisms, i.e. service user, employee, grade forms, etc. The locking mechanism reduces the chance of errors entered in the tables. When two users begin editing data in the same record (this includes adding new records to the database), a lock is imposed on those records, preventing other users from making changes to the same record. Therefore in this instance the locking mechanism which could be invoked if two users were to update or delete the same record on the service user table are not seen as a problem. This is due to the way that the groups' work activities are co-ordinated. Only one user at a time makes modifications to these forms. There exist several levels of record locking that you can fine-tune to suit how your users work with their data, such as pessimistic, optimistic and entire table locking mechanism (Steve, 1996). It is useful to note how the lock file is comprised of the MDB name and an extension of LDB. The solution used in overcoming the locking mechanism in the e-mail system was also applied in the implementation of the shopping baskets in the health alert section. When two users created a shopping list, an Append and a make-table query were executed, thus the locking mechanism were invoked. To resolve this problem, separate shopping baskets was created for each employee.

A series of tests have been carried out to ensure that the system has met all the requirements set. Different sections of the system will be tested individually, before being integrated into the system and tested as a whole. All operations in each section of the system will be tested using the white box and black box testing methods to ensure that all aspects of the system have been thoroughly tested. The testing will be carried out at different stages of the design and development. Test data will be used in the testing process to help expose any errors or defects in the system. The testing will be carried out as follows:

- *Stage 1: testing different sections.*
  Each section will be tested on a stand-alone basis, checking for any logical errors.
- *Stage 2: integration testing.*
  Once the different sections are integrated together, a user-based testing strategy will be used. Finally the system will be tested as a whole to ensure that all the requirements set are being fulfilled.
- *Stage 3: validation testing.*
  This section of the testing process requires a series of black box testing to be carried out. This will demonstrate, again, how the system is meeting the requirements initially set.
- *Stage 4: acceptance testing.*
  This part of the testing will be carried out by the EPHEN members, based at the University College of London. In order to ensure that the system fully met the requirements set, the system was tested not only in the presence of the members but also by the members themselves. The system is new, therefore it will be under testing stages for another three months by the EPHEN members, to fully test it by using the system to carry out and co-ordinate their day to day work tasks. Each member of EPHEN was given a survey consisting of many questions in order to provide feedback on the MIS. This is a very important stage in the testing process, which is a well-known requirement in software engineering practices (Edward, 1995). All the members' preferred the MIS to the original file-based system as it greatly enhanced EPHEN's work activities, communication and health awareness.

Also all the members were more than happy with their involvement in the process, which has undoubtedly given them more confidence in using the system. It is always crucial that the graphical user interface is very well designed as this is what the members will interact with whilst working with the system. The main reason why all the members liked the interface was due to it being customised and designed the way they wanted it. The design of the new system has proven to be very effective as all the members find it easy to navigate through and use. There is no other

system like the MIS in the whole department, thus its uniqueness and innovative touch is an added quality.

The survey and conclusion

In the summer of 2001 and again in summer 2002, all service users were asked to complete a questionnaire. The questionnaire included questions about the value of services, about the need for information, and about how information should be provided. The questionnaire was designed in anticipation of what would be the main issues for service users. There is not the space here to detail the survey results. Overall the feedback received was all very good and positive. This is very encouraging and proves that the system is very comprehensive and complete as it has fulfilled the needs of all the EPHEN service users.

The MIS automates the EPHEN's daily tasks, as well as providing a fun element for the members to use outside work hours. The project has covered all the software-engineering phases, which are vital for the successful development of most systems. Many techniques were used and adapted from a number of methodologies, e.g. a rapid application development (RAD). Again, a number of techniques were applied in the data modelling stages that helped to visually represent the different processes and data flows in the system. Once the system is installed it is expected to provide the following features: facilitate the communication between all members, and make data storage and manipulation more effective and easier. It also promotes health awareness through a public Web site considering that the EPHEN's primary concern is to encourage public health in society.

All the requirements and additional requirements set have been met. The

development and implementation of the innovative, multi-user, network information system, called the MIS for the EPHEN group at UCL, has been successful. The MIS's effective and strategic incorporation within the EPHEN can now enable growth and scalability of the group's business and culture at a faster rate, and help enhance the link to the service users.

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