Geographical and logistical Information System for building management

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ABSTRACT
Nowadays, most of building managers (e.g., companies, local communities, government agencies) have to face up a common set of problems. For instance, these problems are a deficient knowledge of ancient buildings and networks (e.g., gas, water), an inefficient management of green spaces, or a lack of communication between users (e.g., technical staff, suppliers, building end users). In addition, building and spaces to be managed may be shared among several distant areas.

LAMIH works aim to achieve methodologies and computer tools for building management and associated logistic.

These works include two aspects we present in this paper:
- a methodological one: the establishment of a project business plan, applied to building and logistic management,
- a computer aspect: the design and implementation of a decision and management support system, the Geographical and Logistical Information System (G.L.I.S.).

The project business plan includes the creation of a task force which has to lead the project and the description of the project plan.

The G.L.I.S. is a software set which uses shared database. In particular, this set allows the different users to:
- manage a patrimony as a whole, with the help of a Geographical Information System,
- manage buildings and networks,
- improve communication and logistic aspects with the help of a groupware tool.

We present the achievement of these methodology and tools as part of a particular area: the University of Valenciennes which is shared among four towns. The project takes into account existing buildings and those to be built, spaces which separates them, and the relationships between the four different sites of the University. A task force is created as well as a specialised service, the Building Management Department. This department represents an interface between the task force, the LAMIH, and a centre of Information Technologies in construction (CERTIC) which is created as part of the SCENIC project (Support Centres Network for IT in Construction, Esprit project 21772).

1 SET OF PROBLEMS

Nowadays, french universities as other building managers have to face up a common set of problems, as regards control and management of their patrimony. This patrimony includes old and recent buildings, new buildings to be built, spaces between buildings (e.g., green spaces) and networks (e.g., gas, water,
computer). For instance, Building managers are companies, local communities, government agencies, railways and airports. So their patrimony may include factories, warehouses, offices, roads and parkings. Deficiencies and problems are often the same.

There is not a sufficient knowledge of buildings and external spaces. Building plans are not complete or in need of repair, available versions of plans do not correspond with final state of the building, information connected to materials and components are missing. There is not a sufficient knowledge of networks which link buildings and are connected with outside site, with collaboration of concessionaries which manage these public networks (e.g., gas, water, electricity, television, telephony). On the other hand, it is very difficult and expensive to detect buried networks, and to list electric cables.

As regards buildings to be built, the problem is the definition of the brief. Future users of buildings ignore constraints of building site. They accept all solutions to the specifications which are elaborated during the design phase, then they change their mind during the building site phase, because their reflection about the project is more precise (e.g., the location of a particular room in the building). But it is very difficult for architects and engineers to modify the project when companies have started works. The consequence is that the building and its performance (e.g., acoustic) do not satisfy users (Tonarelli 1996) (Delaporte et al. 1997).

The environment of a building to be built (other buildings in the neighbourhood and networks) is not enough taken into account. So the final patrimony looks like an architectural set of buildings without homogeneity.

The lack of tools and methods is a problem as regards a global definition of traffic (roads, pedestrian ways, arrowings) and parkings.

There is an inefficient organisation as regards maintenance planning. Maintenance is curative and not preventive, works are irregular.

Supplying logistic is also inefficient. Managers have to face up delays as regards maintenance works and an increase of supplying tasks, so additional costs.

The lack of communication between actors is a problem. These actors may be the technical staff, the managers, the building users, the concessionaries or the suppliers.

At last, there are deficiencies as regards material security and fire safety. Because of the lack of organisation and information on buildings (e.g., plans), fire brigades are not satisfied (Tonarelli 1998a).
2 PROPOSAL AND OBJECTIVES

2.1 Objectives of the project

In accordance to problems previously explained, the university project is a synthesis of the following activities (figure 1):

- the definition and the control of a strategy for the building management project. This strategy distinguishes and organises activities which has to be realised short dated and those which have to be realised long dated.
- the urban diagnosis of the academic sites which aims to establish a location plan of the university, in its urban environment.
- the establishment of a expansion and construction project. This requires a diagnosis of current patrimony and its capacity to be expanded. First, a sufficient knowledge of buildings is required. It includes to study rooms, their functional organisation and their real use. This study is required for each building and each site, and following activities (e.g., training, research, administrative activities, technical rooms). On the other hand this analysis is also required for external spaces and networks.
- the study of the brief establishment phase which includes to find a suitable methodology. In particular, this methodology aims to explain to the future building users the different constraints which characterise a building site, and organise the brief establishment following a project approach and within the context of concurrent engineering (Yeh 1992).
- the study of maintenance activities which aims to define a methodology for maintenance and security.
- the study of rail and road links between the university and its outside.
- at last, the design and development of an information system which has to support this approach. This part is explained in the following section.

On the other hand, an analysis of the human technical structure is necessary. It includes:

- an analysis of its competences and weaknesses,
- the definition of modernisation objectives,
- the definition of methods to make optimum the realised services,
- the definition of human and material means, required to achieve the information system which supports the project.

The approval of main steps of the project has to be realised by the board of directors. Different partners have to be associated to these approvals (e.g., local communities).
2.2 The Geographical and Logistical Information System

An information system has to support the project. It is constituted of database which store and manage a set of information connected to the academic patrimony. It has to take into account buildings and external spaces, and allow the different users to establish a proposal for the improvement of the patrimony. Database group all information required for knowledge, use and management of the patrimony. Data set is necessary for activities connected to maintenance, supplying, security, staff management. The design, development and operation phases of the system have to be lead by a specific task force.

So we propose a Geographical and Logistical Information System (G.L.I.S.). In particular, a Geographical Information System (GIS) is a computer system which permit, from different sources, to organise, to manage, to analyse, to combine, to elaborate and to present geographically located information (Aronoff 1989). The structure of this data set allow users to establish synthesis and then make decisions.

Our system has to include logistic aspects with specific software tools which share the data set. These are presented in fourth section.
The G.L.I.S. aims:
- to supply a support for definition, achievement and maintenance of logistic means and services in the university,
- to contribute to make these means optimum,
- to reduce associated costs,
- to establish a knowledge base connected to buildings, external spaces and equipment, taking into account their chronological account and their development.

The main advantages of G.L.I.S. use are:
- a better works management from internal services and external companies,
- a better management of technical hitches,
- a better use of technical means,
- the decrease of supplying delays as regards technical documents,
- the satisfaction of all patrimony users.

The GIS development phase is a complex and long activity, because of the following reasons.
First, it is difficult to create and exploit cartographic data. These data include geometric data (e.g., line, point), topologic data (e.g., proximity, adjacent or inclusion relationships) and alphanumeric data. For instance, topologic data are used to represent entities which are located up river. Alphanumeric data are used to associate semantic data to geometric and topologic data (Aronoff 1988).
Second, the creation of a partnership is necessary. It groups patrimony managers, local communities, transport companies and / or concessionaries.
Last, a GIS may have as many applications as users. For instance, an academic GIS may be used by:
- visitors and students who want to locate the service where they have to go or the person they have to meet,
- technical staff who have to locate and list on a map all the equipments or buildings where they have to do a particular work,
- fire brigades or safety services, in the aim to obtain a simultaneous location of an incident or a fire,
- teachers who search a room with particular features, and want to locate it on an academic map.

3 HUMAN ORGANISATION AND STRUCTURE

3.1 Organisational structure

The project realisation requires the creation of a task force which has to control and manage different activities.
We propose the following structure:
- a task force including patrimony managers (e.g., chairman of university, staff manager, technical service, computer service) and project partners (e.g., local communities),
- a specialised service, the building management department, which includes an engineer.

This department represents an interface between (figure 2):
- the task force,
- the LAMIH and its research activities,
- the CERTIC, centre of information technologies in construction, which is created as part of the SCENIC project (Support Centres Network for IT in Construction, Esprit project 21772) (Scenic 1998),
- students in construction training who work on some activities of our building management project.

Figure 2: The building management department and its relationships
3.2 Tasks Groups

Seven tasks groups are defined (Tonarelli 1998b).

• TG1: project control
This group aims to define the business plan of the project and control its development. It includes the definition of the business plan (task T11), the creation of the patrimony partnership (task T12), the definition of areas designated for future developments (task T13) for a progressive analysis of the patrimony.

Expected results of this group are:
- the business plan of the project,
- the academic task force for building management and its partnership,
- the building management department.

• TG2: Buildings management
This group is connected to buildings: old or recent constructions, and those to be built. On a research level, it includes study and control of the different phases which characterise building project process: brief establishment, design phase and relationships with designers (e.g., architects, engineers), building site control which takes into account point of view of academic client, maintenance strategy and activities, until rehabilitation.

It groups three main tasks.
First, the technical analysis of existant buildings (task T21), to be realised for each of those. Each building has to be identified and described on a sole manner, with, for example, plans of each stage or materials description. Then, methods and documents for fire safety have to be established and achieved. On the other hand, maintenance files and methodology of control maintenance have to be defined.
Second, a functional analysis of rooms use has also to be established, in the main aim to define academic needs in terms of rooms (task T22).
At last, a task (T23) aims to analyse and control the building projects in progress, connected to academic expansion, and taking into account a building management point of view.

Expected results of this group are mainly:
- the historic of materials and technologies which have been used,
- maintenance files for equipment associated to each kind of building (e.g., research, training, administrative),
- methodology for brief description,
- methods and tools required for security and fire safety.
• TG3: *External spaces and networks management*
This group is complementary of the previous one and is particularly connected to:
- the networks and their location, especially for buried networks, their maintenance and their development,
- the urban situation of university,
- the roads, pedestrian ways, and parkings,
- the green spaces.

It also groups three main tasks.
First, the functional and analysis of external spaces and networks (task T31). This task includes description of basic data (e.g., situation plan, networks lines), diagnosis of external spaces, the establishment of an academic circulation plan.
Second, an urban and architectural study (task T32) which aims to establish the urban diagnosis of the academic site, and a strategy and a planning of expansion of buildings and associated external spaces.
At last, a task (task T33) aims to analyse and control the projects in progress, connected to external spaces management, and taking into account a building management point of view.

Expected results of this group are mainly:
- the historic of networks realisation,
- the maintenance files of these networks,
- the maintenance files of green spaces, roads, parkings,
- a strategy of academic expansion, following an urban and architectural point of view.

• TG4: *Logistic management*
The project also takes into account the logistic aspects. So this group is connected to supplying and storage management, data transmission, human organisation, and all kind of client / supplier relationships which exist on the academic site.

This group includes three main tasks.
First, supplying logistic (task T41) which includes analysis and methods required to make optimum stocks and supplying. In particular, it concerns office material, material for maintenance works, technical equipment.
Second, communication and information logistic (task T42) aims to develop communication between academic staff and between university and its external environment (e.g., suppliers, local communities), with the help of the academic computer network. It also includes all works of communication and arrowing on the different academic sites. On a computer level, these aspects are supported by groupware and workflow tools, and by intranet / internet servers.
Third, organisational logistic (task T43) which aims to study and make optimum the technical academic structure (technical staff). In particular, this task has to analyse the logistic means required by academic events (e.g., sporting or cultural events).

Expected results of this group are mainly:
- the methodologies and tools for supplying and stocks management,
- the methodologies and tools for communication and information,
- the new organisation of academic technical structure.

• TG5: G.L.I.S. design and implementation
This group includes all activities which aims to design, implement, operate and maintain the G.L.I.S., and is defined by four main tasks.
First, it is necessary to describe the information system specifications (task T51). In particular, this task has to take into account the existing information system, and the historic of the academic site construction.
Then, task T52 groups all activities of design (e.g., data models establishment) and implementation, with in particular the implementation of a demonstrator, required for a first evaluation of this information system.
Third, an advanced evaluation of the system (task T53), by all its potential users. At last, a real use of the system, with the creation of decision support synthesis and its maintenance.

The academic G.L.I.S. constitutes the result of the tasks group.

• TG6: Communication, training, transfert of methodologies in companies
Objectives, methodologies and results of the project have to be communicated in a progressive way. It is necessary to exchange ideas and points of view about this kind of building management project, and to research other collaborations. With the help of the CERTIC centre, one objective is to reuse some methods and tools in construction sector (e.g., clients, architects).
On the other hand, training and information aspects of future G.L.I.S. users have to be taken into account.

So this group is defined by three main tasks.
First (task T61), some results of the project can be re-used in another context, with the help of the CERTIC. On the other hand, research activities of LAMIH can be applied to the building management project. For instance, LAMIH works aim to define concurrent engineering approach for building trade, and these works can be applied to the construction of future academic projects (Tonarelli et al. 97).
Second, a task (T62) aims to communicate results and methods, with papers, conferences, or internet server of the university.
Third, a task (T63) is connected to all training aspects (e.g., GIS project course, building management software).

Expected results of this group are mainly papers and communications, and courses.

- **TG7: Connected services**
  Technical means and competences of LAMIH are used to realise particular studies, connected to the building management project. For instance, the studies may be:
  - the realisation of computer tool which aims to manage all documents and data transmission of an academic service,
  - a feasibility study and cost estimation about scannerisation and vectorisation of available academic plans.
  In addition, these services may be particular means which are at academic managers disposal (e.g., books of LAMIH connected to construction sector).

All the realised services are the results expected of this tasks group.

- **Synthesis**
  Figure 3 presents a synthesis of these tasks groups, following three levels:
  - project management (TG1 group),
  - studies connected to buildings management (TG2), networks and green spaces management (TG3), logistic management (TG4),
  - project support which includes design and implementation of G.L.I.S. (TG5), communication, training and transfert aspects (TG6), services (TG7).

In the following section, we particularly present the G.L.I.S..

**4 G.L.I.S.**

In this section, we present G.L.I.S. functionalities, associated software, handled data, computer structure.
Figure 3: **Project synthesis**

### 4.1 Functionalities and software

Figure 4 presents these functions. The G.L.I.S. is supported by the integration of a set which groups shared data treatments. The exchange and communication of these shared data is ensured by the academic computer network. The functions are:
- the organisation of data communication and groupware works, in the aim to limit access data following kind of user,
- the creation and the management of an academic geographical information system, which allows users to have a global point of view on their patrimony,
- the maintenance of buildings, networks and external spaces,
- a function of computer assisted drawing and design, for the treatment of buildings plans,
- a function of computer assisted publishing (e.g., spreadsheets use),
- particular applications connected to the construction sector (e.g., brief establishment).

Figure 4: Functionalities and software
4.2 **Handled data**

Main data and information which are managed by the G.L.I.S. are:
- plans which represent academic sites, with buildings and lines of transport companies,
- plans of buildings for each stage,
- plans of external spaces and networks,
- juridical data (e.g., connected with the local communities properties on the academic sites),
- technical data (e.g., technical features of electric or computer equipments),
- economic data (e.g., cost which is associated to a particular maintenance work, estimates for no usual maintenance activities)

4.3 **Computer structure**

Computer structure of G.L.I.S. (figure 5) is supported by the use of:
- the computer network of the university,
- a server for the information system administrators,
- some clients for the G.L.I.S. users,
- shared database.

![G.L.I.S. computer structure](image)

Figure 5: **G.L.I.S. computer structure**
5 CONCLUSION

Like other buildings managers in France, universities have many problems as regards their patrimony management.

The university of Valenciennes has decided to develop methodologies and computer tools, in the aim to solve these problems. So current works of LAMIH, as regards this research domain, include two main aspects:
- a methodological and human one, with the establishment of a project business plan applied to building and logistic management, and the creation of an academic task force and a specialised service, the building management department,
- a computer aspect with the design and implementation of a decision and management support system, the Geographical and Logistical Information System (G.L.I.S.).

The project has began in 1997, November. Different computer tools have been chosen by the academic task force and the building management department:
- MAPINFO ® (ADDE 1998) for the G.I.S. development. We do not need very advanced cartographic data treatments but we need a tool which allows developers to easily present synthesis useful for decision support. On the other hand, it is not an expensive software,
- RS ABYLA ® (RS Consultants 1998) for buildings, external spaces and networks management. This building management tool presents graphic functions which allow developers to create plans of buildings and networks on an easily way, and to manage all types of equipment (e.g., electric equipment) and maintenance works,
- LOTUS NOTES ® (Lotus 1998) for groupware and workflow developments, required to organise activities of technical staff and patrimony managers. One of the interests of this tool is its capacity to create and administrate intranet servers.

In addition, another criterion is that all these tools may easily communicate and exchange data with academic database. With the support of those database and software, a first demonstrator of the academic G.L.I.S. is expected for the end of the year 1998.

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