

## ABOUT MODELS IN FACILITY MANAGEMENT

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### Abstract

*The facility management deals with integrated information handling of buildings, spaces, environment and any actions in business. The increasing amount of information and effectiveness requirements force us to improve preparedness in the technical and practical sense. Also continuously changing circumstances will require the information technology to face definitely new challenges.*

*In this study the major attention has been paid to the fundamentals of facility management from the information technology point of view. All action in this branch should be based on business idea(s) and business strategy. The main business idea can be divided into sub fields and their strategies. Well managed companies should have a facility management strategy. While considering facility management, strategies of information technology have to be taken into account. The other needed viewpoint rises from mapping or connection to real life in an easy comprehensive form. The approach used here is GIS based. All information is based on spaces and geography.*

*The aim of this study is to develop models for computerization of facility management. The models include the activity model and the concept model, the latter of which is designed to be carried out later. The activity model describes the actions, processes and tasks which are carried out by the facility manager and the concept model proposes the hierarchical structure for classification of information. The models are designed to be commonly applicable in the field of facility management without being case dependent.*

*The activity model deals with tasks such as itemizing facilities, defining their current status, devising of a solution for facility management and applying that solution in practice. The model also aims at representation of data flows for activities. Practice has indicated the importance of care in the classification of data. The enormous amount of information may cause high maintenance expenses and will lead to trouble if the basic concept is not well controlled. The activity model is presented using the SADT-technique.*

*The concept model which is not yet available will introduce the classification of a building information system from the perspective of facility management. The building information system includes space system, technical system and environmental system which are classified in more details. The EXPRESS-G technique will be used in this representation.*

*The result of this study presents a business oriented approach to the computerization of models for information handling in facility management. The models are designed to be expedient to future applications which is expected to be the next step.*



# 1 INTRODUCTION

In order to develop a model that can be used to address facilities, it is first necessary to establish the role it should play in a business, how it should fulfil these roles and then check whether it meets these requirements. FM like all management needs a decision support system and an evaluative framework for reviewing and managing all activities and results. The strategy level of a business is the level to start from to enable the addressing of the questions. Facilities can be regarded as tools or conduits for the realization of the master strategy of a firm. They are important enough to be the subject of their own sub strategy or program strategy. Facilities management should be considered along with all the other functions of management during formulation of a strategy. The main element of master strategy as denoted by key words purposes, missions and objectives[ 2] should also consider the facilities necessary to implement the strategy. Increasing awareness of an existing situation has a good potential for enabling increased effectiveness. This awareness requires knowing what factors affect the system, how they are related to each other and the degree of control that the firm has over them. Knowledge of these factors enables the addressing of any problems that might exist leading to benefits though value adding. The awareness also enables better decisions and controls to be made. In the management of facilities there is also the need to know whether you have the correct facilities or if you are operating the facilities correctly.

## 1.1 APPROACH OF THIS STUDY TO THE FACILITY MANAGEMENT

The approach of facility management modeling has to be based on research of fundamentals in company's business (see SADT-model in Fig. 2). The business functions in companies have to be carried out according to specific strategies. A business idea in an enterprise needs strategy which defines the way the business is to be practised. In order for a company to be more efficient and well managed its strategies should be divided into case dependent strategies according to different processes. This type of approach enables the creation of an overall picture of the model required for facility management. Appraisal of facility from a bird's eye view will guarantee a better understanding that is not limited by case dependent application. Failure to carry out proper analysis of fundamental principles will often be followed by a deadlock which is obvious during updating and changing of the information in databases. Adoption of a clear over view could eliminate many problems encountered in modeling.

## 1.2 DESCRIPTION OF FUNCTIONALITY

According to approach of this study the FM is understood to be integrated management of space, technology, surroundings and customer service that supports any business operation. Activity model describes all the main activities needed to get an adequate result. Integration here refers to optimization of the entirety. The total optimization process is not a task to optimize a single individual function. Management means activities like knowing, understanding, organizing, controlling and developing.

The main problem is to manage facilities with the most effective way. The activity which arises from the process is "manage facilities". The model (Fig. 1 ) includes

the steps from start to end. In this model a presumption is that there is no well organized previous facility management in the company where the model is intended to be applied. The activities are designed to begin from scratch. The strategies, business ideas, different facility documentation etc. can be entered into the model as input information. In running the model the results involve a solution for facility management and well managed facilities. As a feedback the model takes into account experiences from real life. There is also a control part in the model. Among others the control deals with laws, norms, standards and quality. Normally that works on a general level.

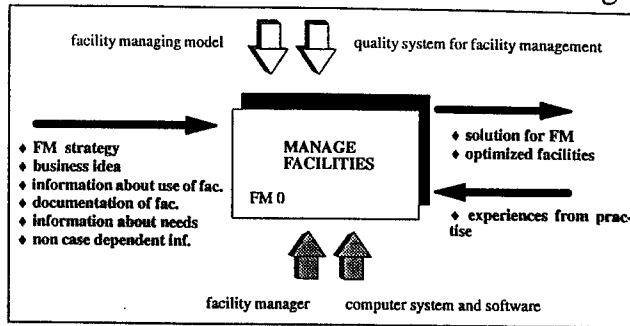


Figure 1. Main level of the FM activity model

If a company is large enough to own a subsidiary or a specialized department which is responsible for facility management of whole company, the model should be modified to reflect this especially as regards strategy definition.

### 1.3 ACTIVITY MODEL

SADT-method [3] is used here to illustrate the business definition model (B). The diagram below (Fig. 2) describes those activities that can be at level-one established with six sub activities:

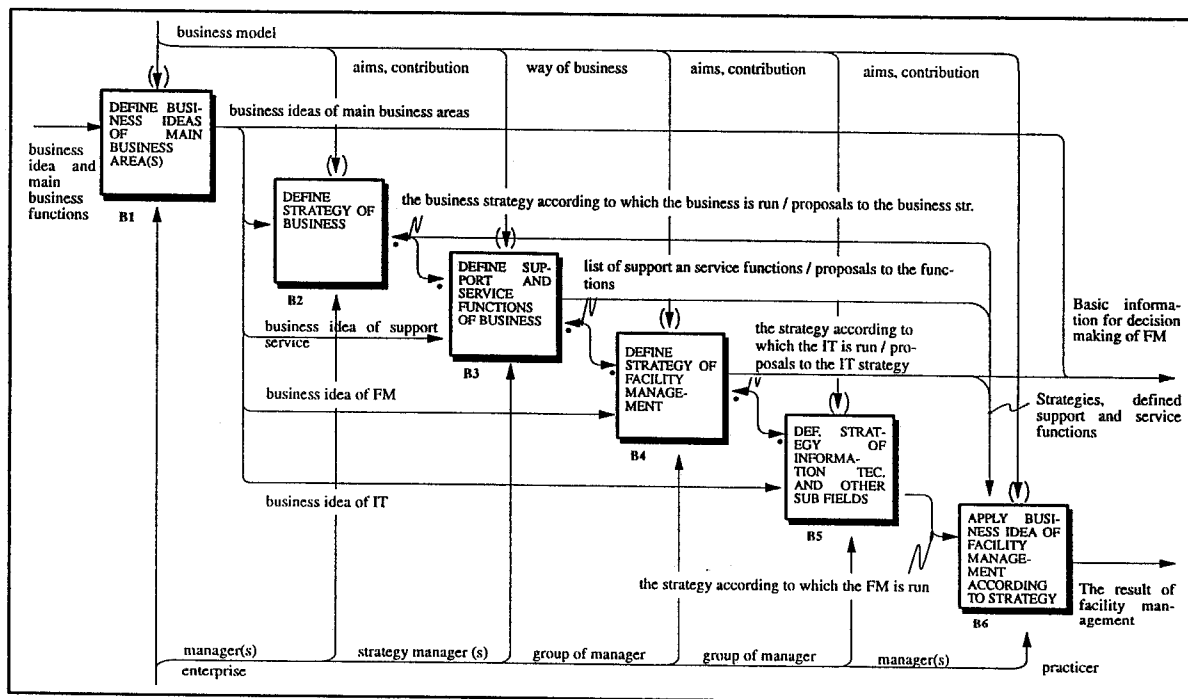


Figure 2. Main level of the business definition (B) activity model

Fig. 3 describes facility management model (FM) in which activities at level-one are established with six sub activities:

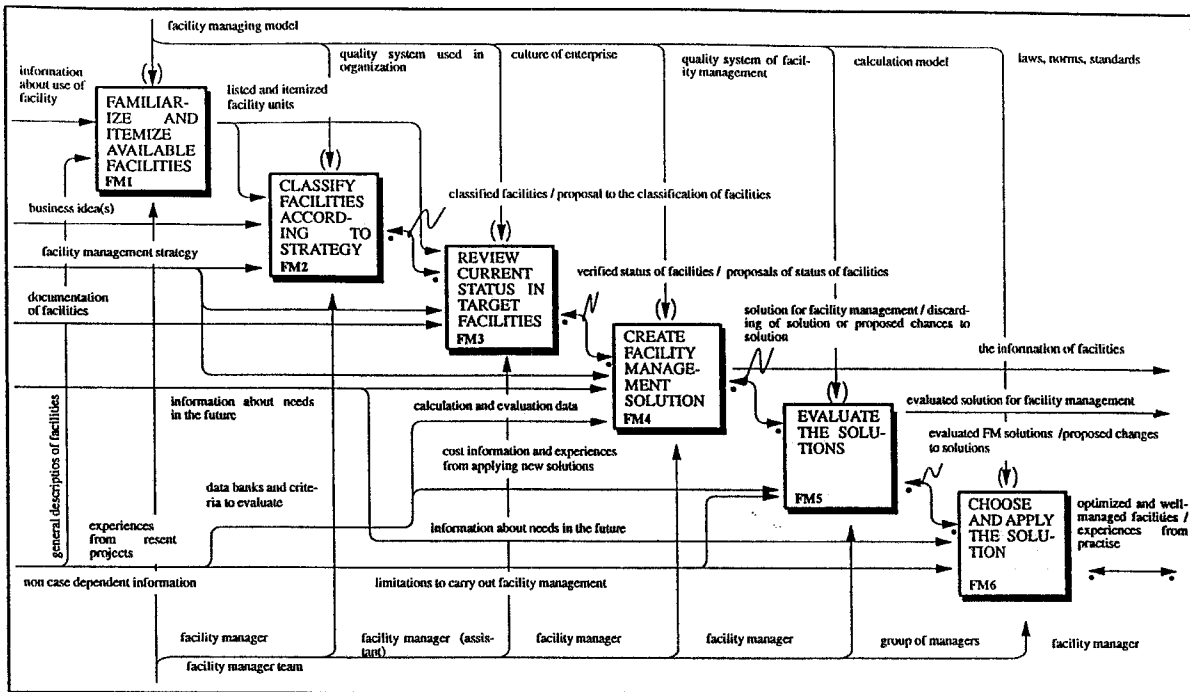


Figure 3. 1-level of the FM activity model

”Familiarize and itemize available facilities (FM1)” is the activity which produces preliminary information about facilities and use of them as an input data. The goal of the activity is to get a clear directory of those items which will under go more accurate investigation. The input data (general list of facilities) is not predefined information. That data has to include large scale information about the field, instead of a concentrated observation of a sub field, for example life cycle cost or energy consuming data. To procure source data means a process to investigate spaces, building technique, environment and client’s functions at a very general level.

The following paragraphs (identified in italics) will describe the FM-2-level activities in more detail.

*List common facilities issues (FM11).* In order to collect material for subsequent improvement one shall generate a chart of facilities. This list can be made according to general information (see example in Fig. 4) available in literature and practice.

<p>Space/room planning Space organisation Workplace analysis Removals</p> <p>Inventory compilation/ updating Space compilation / updating Stock compilation / updating Systems compilation / updating Room log compilation / updating Disposition / Space reserves</p> <p>Central services Building security service Reception Telephone switchboard Cleaning Snow-clearing service Upkeep of outdoor facilities Garden care Plant care in the building Pest control Post room Travel office Office service Central secretariat Motor pool management Canteen management Removals service Conversions Central archive Courier services Printing shop Office supplies Safety specialist</p>	<p>Building control Occupier support Owner support Building support Building inspection Budgeting Cost optimisation Mediation of services Coordination of services Monitoring of contractual obligations Space handover and acceptance Support of occupier and advertiser groups Centre and building management Documentation / Reporting</p> <p>Accounting Collection of rents and incidental costs Cost unit and cost centre allocation Rent and space-related accounting Liquidity analysis Reminders Preliminary turnover tax returns</p> <p>Contract management Conclusion / updating of contracts Conclusion / updating of insurance contracts Security deposit management Rent and incidental cost adjustment</p> <p>Leasing management Leasing concept, tenant mix Initial leasing Subsequent and sub-leasing</p>	<p>Servicing</p> <p>Maintenance, inspection, repair, equipment, emergency service Gas systems Water systems Wastewater systems Heating systems Water heating systems Ventilation systems Cooling systems Electrical systems Lightning protection Lifts, conveyor and warehousing systems Automatic door and gate systems Security systems Measuring and control systems DDC, central and building control systems Communication systems Cable and network systems EDP systems EDP security systems Laundry and dry-cleaning systems Medical and laboratory equipment, general building equipment Other equipment and systems</p> <p>Technical operations management House technician / Caretaker 24-h service and stand-by service Operation of the technical systems and centres Central control systems Energy management</p>
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Figure 4. An example of a general list due to facility management issues [5] page 10.

*Check list to understand facilities (FM12).* This activity enables comprehension of facilities management. If an inadequate picture is used the result of managing facilities will not be the best one and therefore too much attention may be paid to the secondary subjects.

*Check list for relevance to own environment (FM13).* Those items and issues that appear to address one's own specific requirements with no other basis should be identified. This process should be based on needs and feelings.

*Create an understandable description for facilities (FM14).* The description of facility issue given by its title in a list is not enough to clarify the exact definition of a single facility.

**"Classify facilities according to strategy (FM2)"** is designed to be the activity which synchronizes the facility list with the business ideas and strategies.

*Define the criteria for selection of facilities (FM25).* Business ideas and facility management strategy shall create the basis of selection the process. Business ideas refer to objects and targets of business and strategy how to carry out those ideas. Two points should be taken account concerning the selection, the significance of the facility for the business and management availability.

*Rank the facilities according to criteria (FM22).* When the information from the selection process above is combined with source information (listed and itemized facility units) it is possible to arrange the list of facilities issues into an appropriate order.

*Evaluate the ranking (FM23).* In evaluation process it should be possible to determine whether criteria for facilities have been adequate or what kind of changes have to be made.

To verify facilities it is necessary to **”Review current status in target facilities (FM3)”**. Input data (classified list of facilities) works as a check list in the process. The first task is to procure requisite material for future processes. The material consists of building drawings, specifications, technical documentation etc.

*Define the required information and verify the existence of data (FM31)*. The bulk of the source data (documentation of facilities) has typically been more or less updated drawings and specification of buildings. Documentation in the form that it appears, does not support facility management very well.

*Apply and reconcile facilities management perspective and documentation (FM32)*. It is very obvious that there is an abundance of information and therefore some data truncation should be carried out, concentrating on the aspects of facilities with powerful influence on business.

*Sketch a preliminary facility management judgement model (FM33)*. The purpose of this activity is to inspect facilities in a more detailed manner. Activity should show the most unsatisfied fields and the biggest disadvantages in use of facilities.

*Evaluation of compliance (FM34)*. This activity is designed to uncover all existing shortcomings in facilities.

**”Create a facility management solution (FM4)”**—activity is strongly based on FM strategies and future needs. In the solution the facility manager specifies spaces for rent, facilities for sale, and other strategical facilities.

*Analyze self ownership spaces (FM42)*. In the analysis an account should be taken of items such as the geometry of spaces and their functionality.

This activity will produce information which includes:

- ▣ the complete specification of required spaces and their functions
- ▣ current and proposed space use plan
- ▣ accurate documentation and models of spaces

*Analyze rental spaces (FM43)*. The activity here is the same as above except for the information from the market concerning leasing and market status.

*Analyze support and client service (FM44)*. In order to complete analysis of clients and customers, one has to go through a similar process as it was done in main business.

*Analyze any other issues based on FM—solution*. Items which were not handled earlier have to be analyzed at this point i.e. space, support, service or facility. It also is beneficial to check that every official aspect was taken into account.

**”Evaluate the solution (FM5)”** is the activity which includes tasks to define arguments for the evaluation process. As an input data there is cost information to calculate the market value of the solution.

To make the choice among the candidates **”Choose and apply the solution (FM6)”**—activity takes place. The ranking of solutions is made according to earlier evaluation. The best solution is a case dependent question. After the selection the solution is applied to practice in order to provide the feedback and experiences of the process which leads to well managed facilities in use.

## 2. APPLICATION OF COMPUTERIZATION MODELS IN FACILITY MANAGEMENT OF UNIVERSITY CAMPUS AREA

### 2.1 INTRODUCTION

Several projects where the models presented above will be applied are on-going in Finland, one of which is described here. The approved project was the computerization of facility management in a governmental environment. In this case the developed theoretical model was applied to the facility management of Tampere University of Technology (TUT).

At the beginning the situation was quite ordinary. Characteristic facility management was manually driven, source information was little or non-existent, building documentation was not updated, facility management plans were unclear etc. The project had to be started from scratch.

The goal of the project was to change manually driven management into a digital environment. The solution was the implementation of the theoretical model into a CAD-environment with a relational database. The first task was to clarify the business idea and to generate a facility management strategy according to the business definition model (see Fig. 2). Some parts concerning the task are represented below (see Fig. 5).

As a result of the project a basis was established for business ideas and strategies thus investigating the development of useful software implementations.

### 2.2 THE DEFINITION OF BUSINESS IDEAS AND STRATEGIES

Although much of the universities' business was defined by law and standards, it does not let them ignore the necessity of investigation in all business areas. From the information technology point of view it was very important to realize which of the facility actions have the most influence on business. Verification of data flows is a useful way to try to find judgement for facility management. For historical reasons the space management was selected to be the basis for user interface and therefore the basis for facility management. By applying the method it was possible to find a solution which was very useful and easy to use. By analyzing the value of the information and comparing it with the maintenance of data it was possible to find the most beneficial data structure for computerization.

The definition of business ideas is presented in Fig. 5 and it is generated for being the input data of the other facility issues.

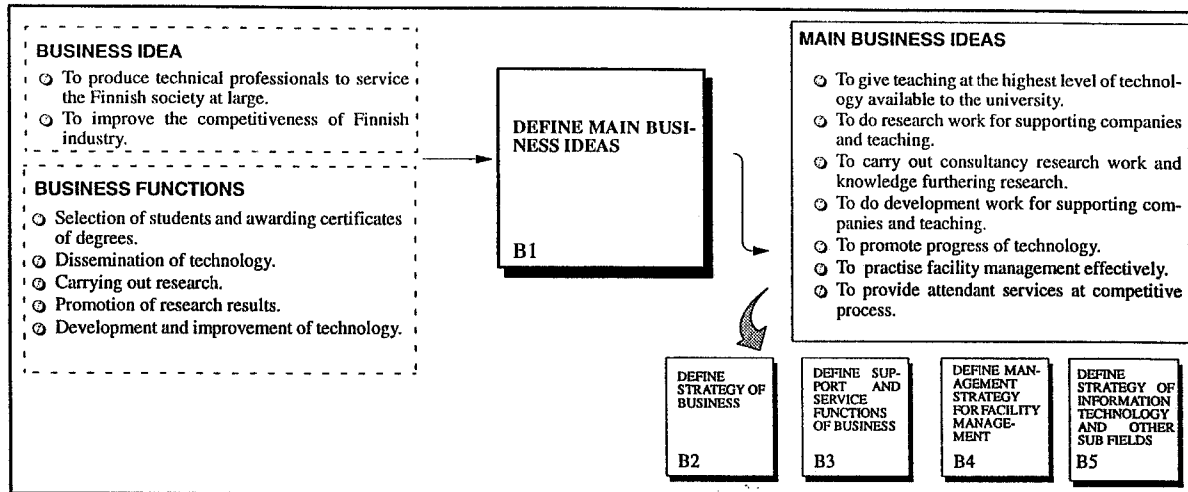


Figure 5. Case study of activity model (B1) application.

The strategy of how to carry out the business (see Fig. 6) is fundamental from the entirety point of view. In it there is described in very concrete form, those actions which are needed to reach the target objectives in business. The main strategy is supported by sub strategies such as service, space, information etc.

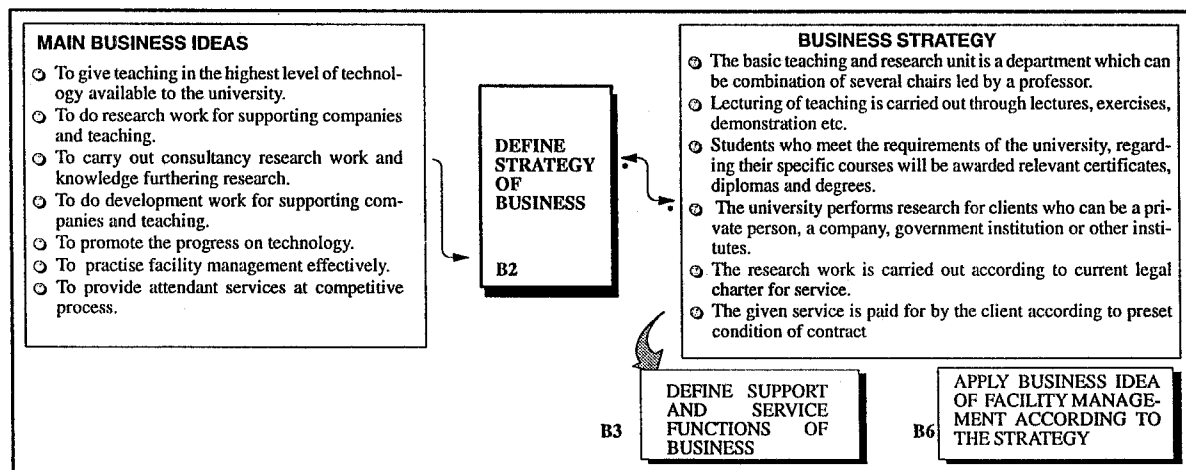


Figure 6. Case study of activity model (B2) application.

Following the business definition, the space strategy was specified (see figure 7) and it played a very important role in this application. The importance arises from two points, the approach to facility management solution and the computer application interface. In Finnish universities space management has undergone a radical change, previous management relied heavily on conventional methods. Strategy specification is aimed at predicting the biggest changes which will be met in the future.

The principles described above created the basis for the development of the computer system due to its inherent flexibility.



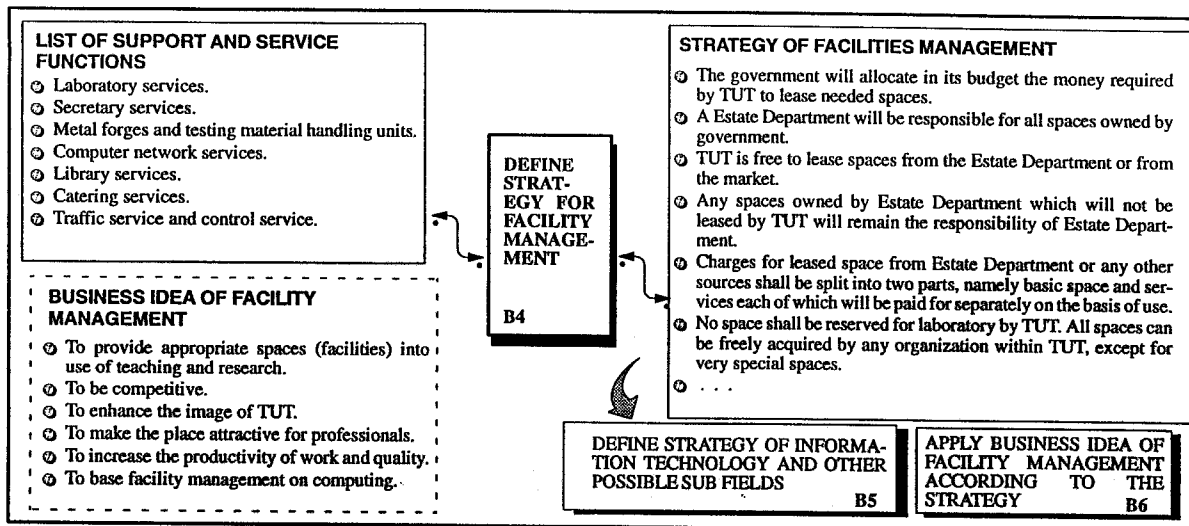


Figure 7. Case study of activity model (B4) application.

### 2.3 THE SOLUTION OF SPACE MANAGEMENT AND APPLICATION

The development of the space management solution was carried out with the method shown in figure 2. In order to get an effective solution in practice the requirements for the application were as follows;

- ⊙ flexibility in changes
- ⊙ fully based on computer environment
- ⊙ data transportation utilities
- ⊙ 3D-graphics

In the created solution, account has been taken of utilities concerning among others, personnel management, space management and leasing, management of equipment in spaces, service management etc.

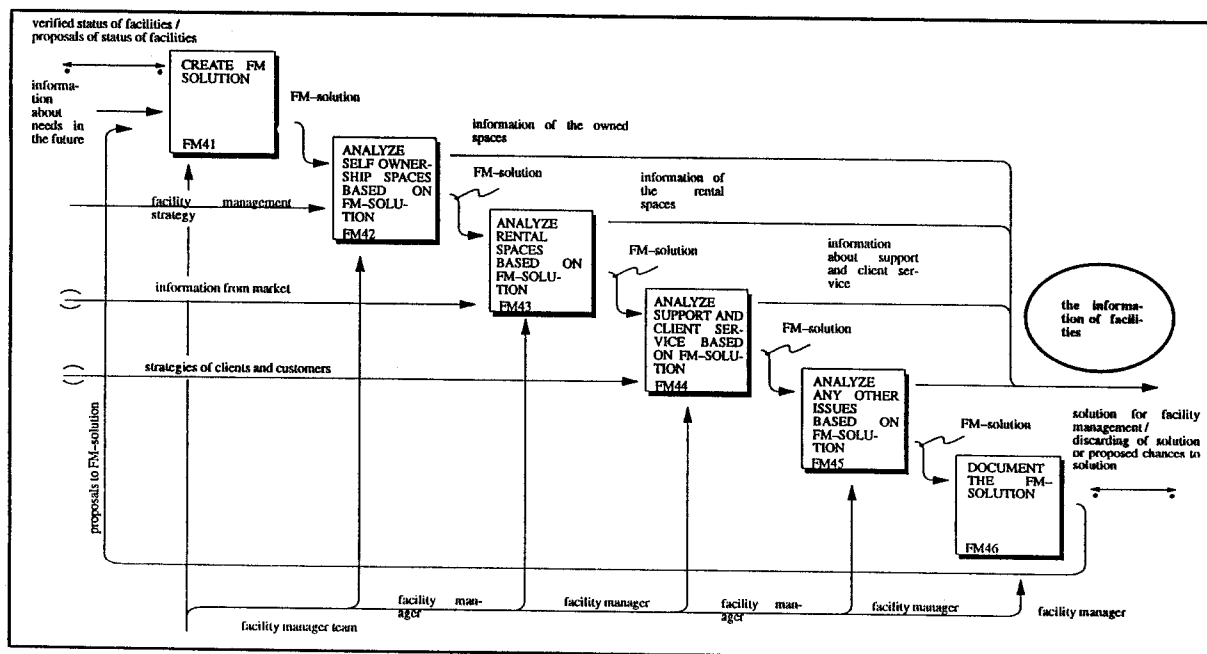


Figure 8. Case study of activity model (FM4) application.

The information flow and data for computerization was generated in activities shown in Fig. 8.

The interface between data and users in the application is carried out by using spaces as a basic element in connecting facility management actions to user's thought. All information handling functions in the software are directed through spaces and through them again to space users. In the solution a space represents a figurative border line between computer data and real life for software users. Using spaces like this way allows us to add any new utility of software coming at a later state. Even a large sub system can be connected with facility management system via this unambiguous border line.

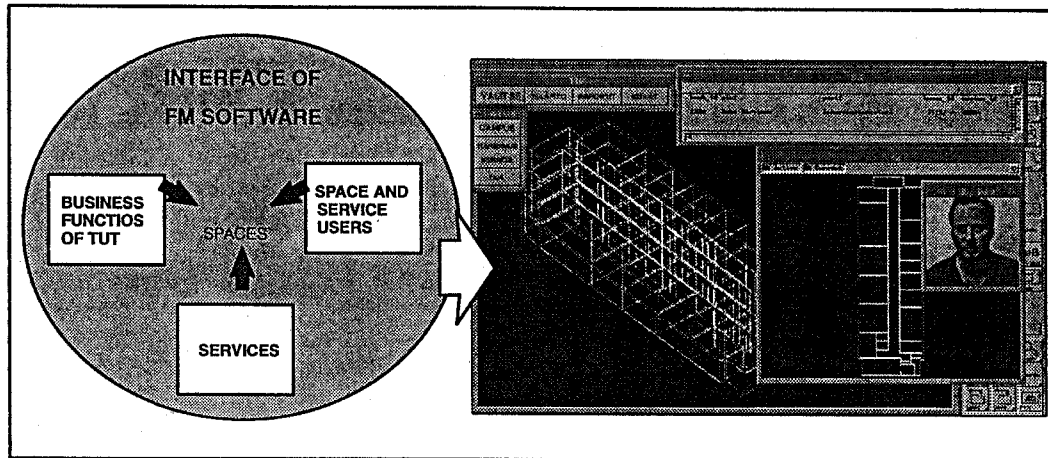


Figure 9. Interface of FM computerized model.

It is important to realize that a space oriented solution concerning the interface is not based on the activity model of facility management but it is clearly the interface of software.

From the modeling point of view it is remarkable that physical spaces and services are separated from each other. All the factors represented by the terms space and services can be identified so that management of spaces is made to include things which directly use physical spaces, and service management, to include all other functions. In the application both terms are conceptually connected with the common space function.

## 2.4 SPACE MANAGEMENT

According to space management strategy the university leases the required spaces without owning buildings and estates. In the solution the maintenance is carried out by an Estate Department. From the space holder perspective it is significant to manage information concerning the use of single spaces. Empty spaces can lead to costs which can be minimized by an appropriate facility management system.

At the operative level of management, the main interest of space management is directed to users and services. A good management in those sub fields shall give the best benefit to laboratories in serviceability of resources and internal support functions in service management.

A successful application should be easy to use. In practice this means 3D-graphic images and graphically driven selection of information. In this case much attention was paid to get a clear interface and to minimize the need for software education.

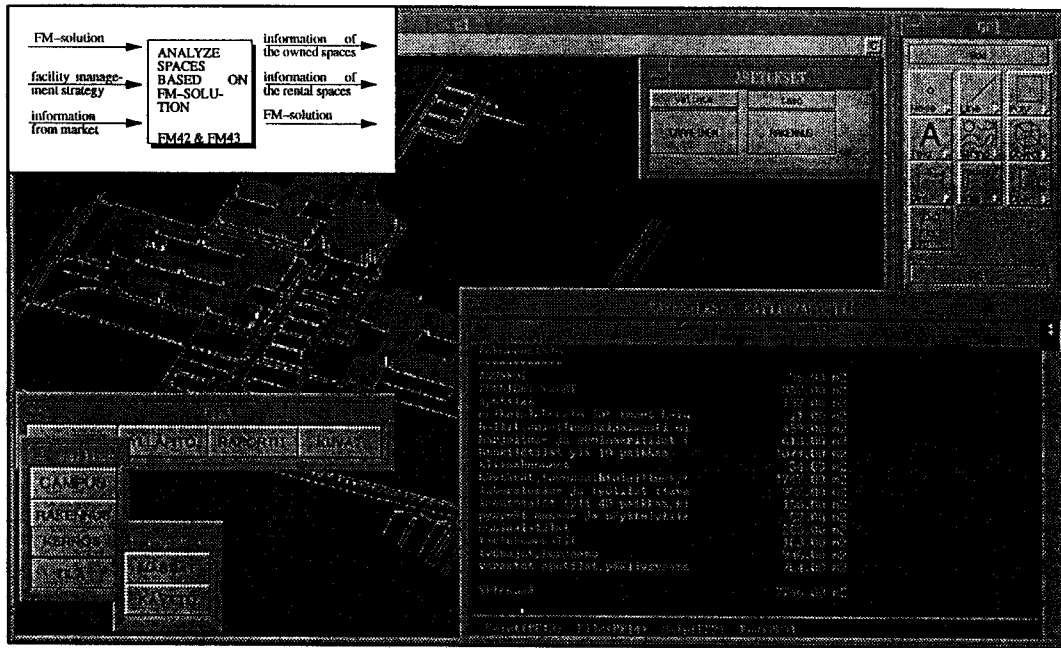


Figure 10. Computerized model of space-management.

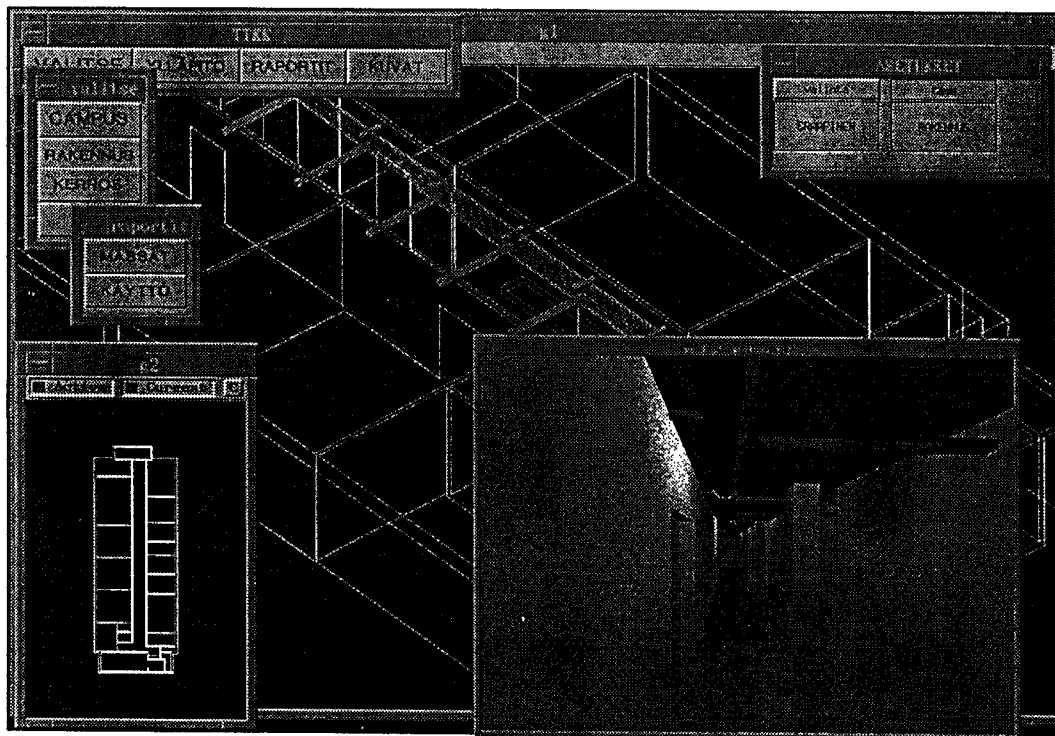


Figure 11. Informative representation of spaces concerning the spatial serviceability of spaces

## 2.5 SERVICE MANAGEMENT

The conventional facility management have mainly ignored the connectivity of the support service and the other services. Support functions are felt to be difficult to

manage or that they are not assumed to be a part of facility management. As mentioned support services include all actions giving added value to business.

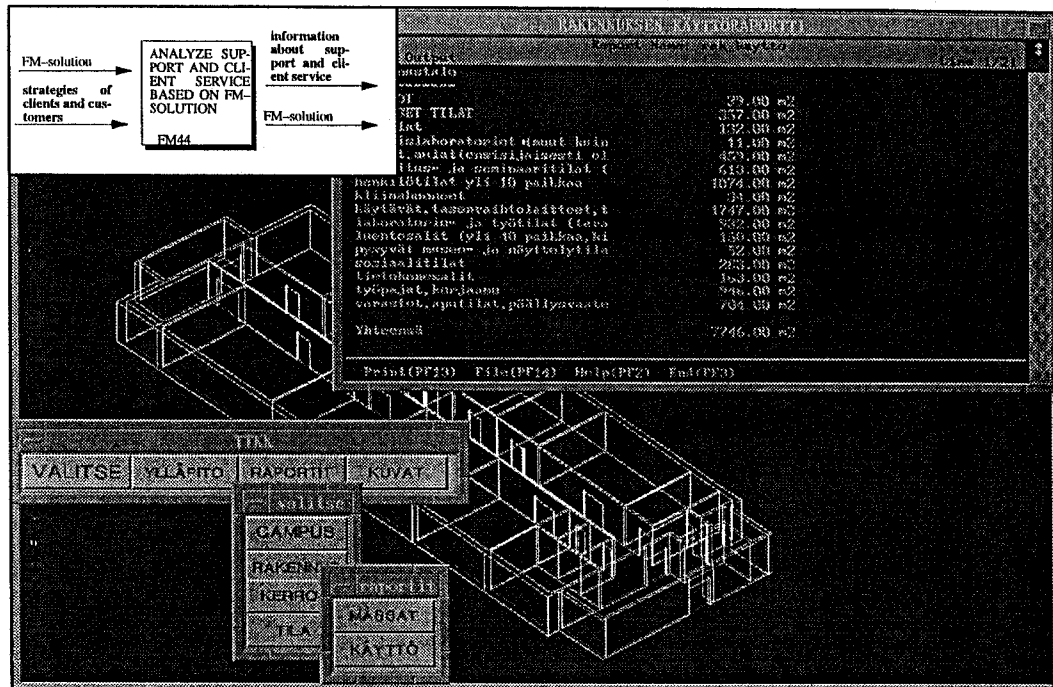


Figure 12. An example in computerized model of service-management.

At the operative level the most typical severability of spaces includes support service such as locality, connectivity, communication service, conformability, usefulness.

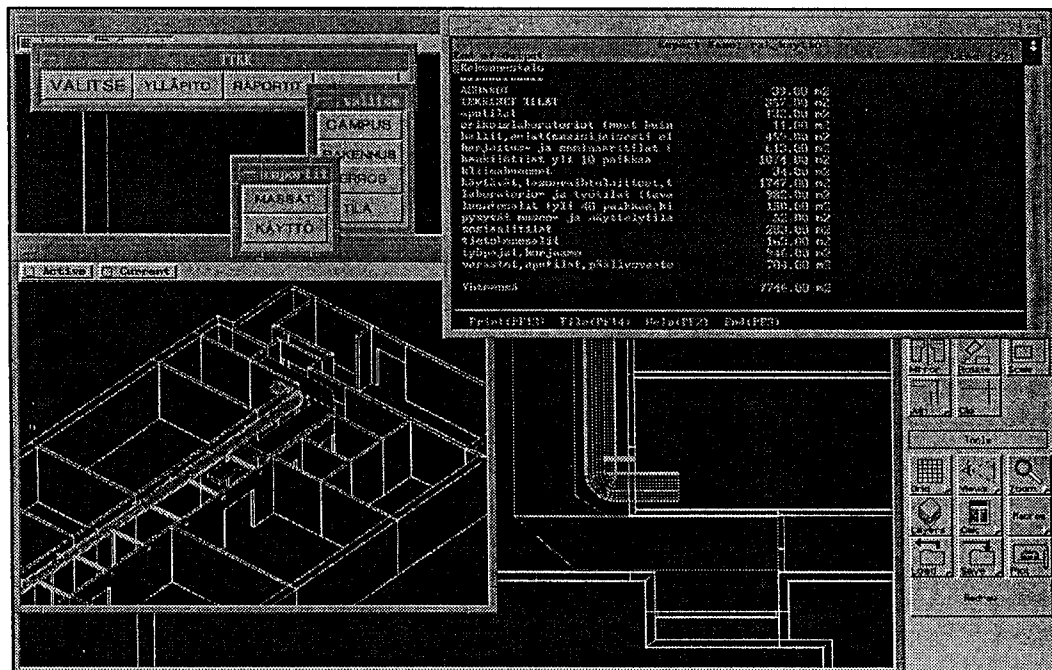


Figure 13. HVAC-systems as a service of space.

## 2.6 SOFTWARE SOLUTION

The management of data is based on graphic and non-graphic databases. The spaces are modeled in 3D and they are located in global coordinates. The system is designed

to be completely GIS-based. A non-graphic database is linked to graphic data and both of them creates functionally compact entirety. From the information technology perspective the database can be distributed or centralized.

The software is developed in IBM RS/6000 UNIX-environment. The software is programmed in INGRES environment using C-language with embedded SQL utilities. The developed software uses IBM AES 2.2.2 as a CAD-environment.

The application differs very much from software conventionally used in this area. In an application there is no data saved ahead concerning the queries and reports according to selection. All queries and reports are processed simultaneously from the databases. For example 2D drawings are generated from 3D-model whenever requested. The solution will require considerable processing power, but maintenance of data is quite simple and the adequacy of data is guaranteed because changes addressed to any part of database are updated immediately elsewhere in application. Also new interface utilities are easy to generate.

### 3 CONCLUSION

In this study the aim was to model significant activities and data flows due to facility management. The main interest was focused on the inspection of input and output information which has been the basis of the software application. The model established here is not case dependent and therefore useful to apply commonly in the field.

The pilot project was carried out in the university environment. The goal was to create a facility management application by applying the model accurately step by step. Also it was to test whether activities were able to be applied in practice.

The use of 3D-graphic makes application visually comprehensible. From the end users point of view the highly developed 3D-graphic would be recommended. On the other hand this type of graphic with large rendering pictures consumes considerable hardware resources thus increasing the cost of hardware investment.

The conventional facility management have mainly ignored the connectivity of services. Support functions are felt to be too difficult to manage or they are not assumed to be a part of facility management. As mentioned before the support services include all actions giving added value to business.

In the case of TUT (Tampere university of technology) the results obtained in practice have been very positive. The application has shown that a systematic approach to facility management according to the form of the model enables versatile information handling on large scale computerization in any field of facility management and model is very useful. The model helps to concentrate interest to most noteworthy subjects.

The application was carried out in a relational database environment. Certain known disadvantages in the properties of relational databases makes the use of it slightly inflexible. Programmers are looking forward to developments concerning the structures of future databases which would address this problem.

#### 4. REFERENCES

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