A model integrating the facilities management process with the building end user's business process (ProFacil)

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Abstract. *The ProFacil model is a generic process model defined as a framework model showing the links between the facilities management process and the building end user's business process. The purpose of using the model is to support more detailed process modelling. The model has been developed using the IDEF0 modelling method.*

The ProFacil model describes business activities from the generalized point of view as management-, support-, and core processes and their relations. The model defines basic activities in the provision of a facility. Examples of these activities are "operate facilities", "provide new facilities", "provide re-build facilities", "provide maintained facilities" and "perform dispose of facilities". These are all generic activities providing a basis for a further specialisation of company specific FM activities and their tasks.

A facilitator can establish a specialized process model using the ProFacil model and interacting with company experts to describe their company's specific processes. These modelling seminars or interviews will be done in an informal way, supported by the high-level process model as a common reference.

Key words: *Process model, Facilities Management, Construction*

1 Introduction

Although process modelling using computer-supported tools is a relatively new phenomenon in the facilities management and construction industry, companies and trade associations have made definitions of the construction process or its parts for many decades using less formalised methods. These definitions have for instance served the internal needs of companies for rationalising their working methods, the needs of the construction industry for standardised principles for setting fees as well as the needs of society or the clients for quality control. Often such models have taken the form of checklists of activities published by trade associations.

An important conclusion from studying earlier efforts is that construction process modelling can be done on many different levels, ranging from the overall life-cycle of a building, thus spanning decades, down to the technical details of how to install different types of building components. The motives and views of the models differ considerably from one level to the other. On certain levels the central motive for modelling may be establishing the borders between the activities of the different companies that take part in the construction process, as well as defining the flows of products, materials, information and money that occur at the interfaces. On other, more detailed levels, the exact sequence of activities needed for some technical task may be modelled, in order to increase job safety, minimise the risk of defects or even to provide information support for the development of automation and robotisation equipment.

2 Earlier work

During the last couple of decades the need for more formalised models as well as better (in practice computer-aided) modelling methods has steadily increased. The proliferation of integrated CAD, document management systems and the Internet make it difficult for the different participants in construction projects to co-operate efficiently unless the data creation and exchange process is well known and agreed to. At the same time there is increasing commercial pressure as well as legislation which force companies to define their processes as a part of defining quality systems. Many companies striving for competitive edge, for instance in utilising the possibilities offered by IT, have launched business process reengineering efforts where process modelling has a prominent role.

Important earlier attempts to define formalised construction process models include the IBPM from Pennsylvania State University (Sanvido *et al.* 1990), VTT's model of the Finnish Construction Process (Karhu and Lahdenperä 1999), and the Generic Process Protocol (Aouad *et al.* 1994). Each of these efforts has had a slightly different focus. Both the IBPM and the Process Protocol work have tried to define normative models which try to illustrate to industry how it should work in order to become more efficient. VTT's model is closer to current practice and tries to define it more precisely using formal modelling tools, in order to facilitate communication about the process.

In the multinational MoPo (Models for the construction process) project the aims were not so much to build a comprehensive normative model of how the researchers think the process should work, as to create new computer-aided tools and modelling methods that would allow companies to build models for themselves, both describing their current way of working and possible reengineered processes. The project has resulted in one doctoral [Karhu 2000] and two licentiate theses (Berg von Linde 2001; Lundgren 2002), looking at different aspects of process modelling in the FM and construction setting.

The different process modelling methods and/or resulting models can be categorized as follows (Karstila *et al.* 2000):

- *Generic process description methods*, which typically are generic and not specifically developed for construction process modelling. Examples of this category are the IDEF0-method (NIST 1993), PetriNets, various kinds of flow charting or data flow methods. These methods are often based on a very limited set of concepts that have corresponding graphical symbols for developing models, which are represented and presented as graphical diagrams.
- *Construction process activity or functional models*. These models have been typically developed for a specific purpose with a specific viewpoint, using e.g. one of the above mentioned generic process modelling methods, such as the IDEF0 modelling method.
- *Construction process information models*, for instance formalised using the EXPRESS data specification language, which describe and represent various objects, their attributes and relationships.
- *Simulation models for construction tasks*, which describe the dynamic aspects of some construction subprocesses (i.e. mechanical engineering), or tasks of construction work, like earth moving of crane lifting. The goal of the simulation is to analyse the performance of the process as well as the impacts of process disturbances on the queuing and performance.

3 The need for generic framework models

According to Davenport (1993), the design of new business processes should start with a high-level business model, which engages both the senior and the middle management. The purpose is to avoid a too detailed description of processes in the initial creative stage, because a detailed model will only lower the motivation of the management team. Rentzhog [1998], discuss a core process model as a tool to communicate a shared view of a company's core processes on a high level of abstraction.

Davenport also points out that the information engineering approach which includes phases like system planning, business area analysis, system design and construction, should not be a method used for process innovation. The innovation or modification of business processes should be done in the strategic context and together with the senior management in the company. Too strong focus on tools and techniques can be counterproductive and stand in the way of achieving the desired change of processes. Communication at each stage within the company is essential and a prerequisite to reach commitment of people to adopt a new business process.

A key object in using generic process models is to facilitate the analysis of a particular business process in depth and to learn about the dependencies in the process. These models are used as references when making analysis of business processes, thus being used to describe existing processes or to formalise a description of a not yet existing business process. In order to establish a modular set of partial re-usable sub-models a framework model on a high level of abstraction is needed.

In the following a proposed generic model of the facilities management process (ProFacil) is presented. The focus of the model is to define the relationships between the building end user's business process and the activities needed to constantly supply this process with operational facilities. The model in particular sees FM as only one of a number of supporting activities that all businesses need (in line with the primary value chain and supporting activities proposed by Porter (1980)). The model is generic in the sense that it models activities which are always present, although they may be performed by different parties under different contractual arrangements, and although the degree of formalisation may wary. Large public FM and building organisation often have quite formalised procedures for the processes depicted in this model, whereas one-off construction clients often lack such procedures.

4 The functional modelling method

The Structured Analysis and Design Technique, SADT for short, is a modelling methodology that was originally developed to describe a system and its environment, for example before making specifications for information systems, planning and coordinating large projects, describing shop-floor operations, designing telecommunication networks, or explaining how something is worked out by using a transformation perspective.

The Integration Definition language 0 for Function Modelling (IDEF0) is a subset of this methodology and one out of a number of available process modelling languages for technical process descriptions (NIST 1993). IDEF0 has recently been quite popular in construction process modelling efforts and is regularly used in product modelling for describing the processes in which product data is defined and exchanged.

By using IDEF0 it is possible to the reveal the purpose of a particular activity. An IDEF0 model has boxes and arrows. The boxes represent activities that take place in a process and these boxes are interrelated and may be arranged in a hierarchical decomposition. Arrows connect boxes together and represent interfaces between boxes. An arrow represents a collection of things, which can be plans, machines or information of any kind, which can be present in one and the same arrow and specified in a lower level diagram.

An activity uses some input and transforms these inputs into outputs by use of machines or people in the organisation. The resources that an activity needs to transform inputs into outputs are named mechanisms. Controls constrain these activities by specifying which conditions actually are regulating the performance of an activity. (Figure 1.)

An activity is described by using a verb phrase and an arrow is named by using a noun. We can use the following phrase to remind us of about how the IDEF0 method works: "Under control, inputs are transformed into outputs by mechanisms" (Marca and McGowan 1988).

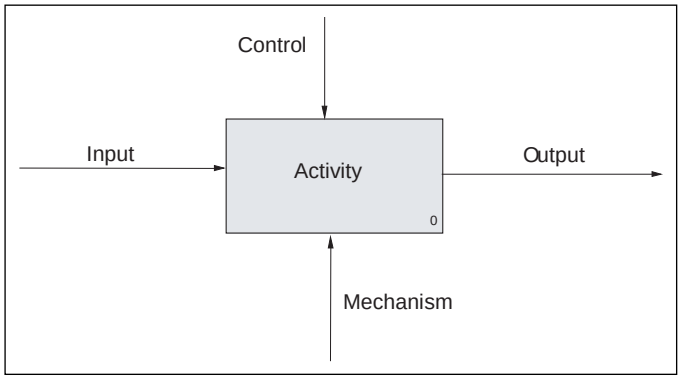

Figure 1. *The basic concepts of the IDEF0 syntax*

The IDEF0 methodology may seem complicated at the first glimpse, due to the effect of controls and mechanisms. However, this is more of an educational problem to understand how the method is used and what each arrow means in a process model.

IDEF0 uses a top down approach that encourages a holistic approach. A process can be analysed as a hierarchical set of interrelated activities, where the diagrams at the top of the model are less detailed than those at the bottom. Figure 2 shows the decomposition structure of an IDEF0 model.

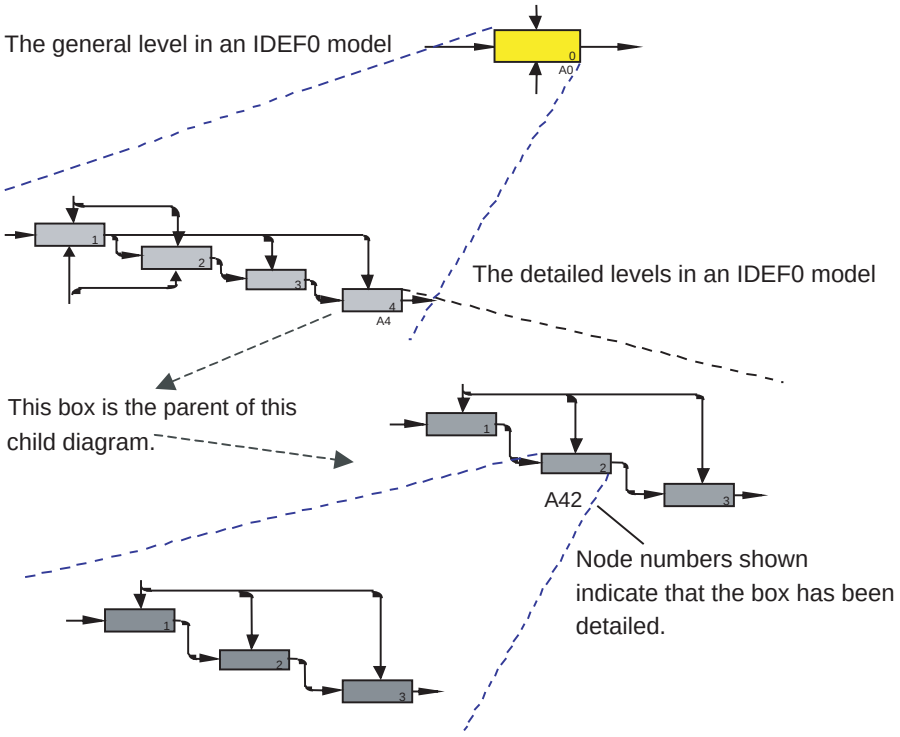

Figure 2. *The IDEF0 decomposition structure*

5 The modelling and validation process

The first version of the model was developed by the authors of this paper based on their own domain knowledge and by incorporating feedback from other members of the research team. This version was presented in two scientific conferences (Björk, Nilsson and Lundgren 1999), (Björk, Lundgren and Nilsson 1999) and encouraging feedback was received

The ProFacil process model was futher developed and refined in close co-operation with the participants of the MoPo project, domain experts and company representatives from three companies all working in the FM industry. The companies were the Karolinska hospital in Stockholm, Electrolux Facility Management in Stockholm and ABB Facility Management in Västerås.

The objective for the validation activity was to find out whether or not the model represented a generic process in providing a facility or not. Representatives of the three companies participated in meetings and provided their knowledge of the FM area. The procedure of a meeting was the following; an IDEF0 diagram was presented to a company representative who reflected whether the activities in the diagrams where generic or not. The purpose of the ICOMs in the diagram was carefully explained and sufficient time was given to provide an answer. Each remark was written down in connection to the interview and was later sent for confirmation together with a new version of model.

The process of validating the model began at the Karolinska hospital in Stockholm. Two managers at the Karolinska Hospital facility management department participated in semi structured meetings during the development of the process model. The process model was discussed in three meetings and verified in one final workshop. One result of the interviews was for example the decision not to detail the conceptual design in further levels because further detailed activities would not be generic.

The model was further developed and refined together with the Electrolux Facility Management department in Stockholm. During the refinement one senior manager participated in three meetings based on semi-structured interviews. The refinement of the model continued by a dialog of the representativeness of each of the activities in a diagram. The final version of the model was verified at a workshop.

Finally the ABB Facility Management department in Västerås verified the generic properties of the ProFacil process model. One senior manager from the FM department participated in two meeting based on semi structured interviews. The latest version of the ProFacil model was presented and was approved as a generic model representing the FM process

A final workshop was held at two of the companies to verify the latest version of the model and to test the validity of the model. During these workshops the diagrams of the complete model where printed out and presented using a paperboard showing all of the diagrams at the same time.

6 The ProFacil model

The provide facility model (ProFacil) shows links between the facilities management process and the building end user's business process. Figure 3, which depicts the overall business process of any organisation, is the starting point for the modelling.

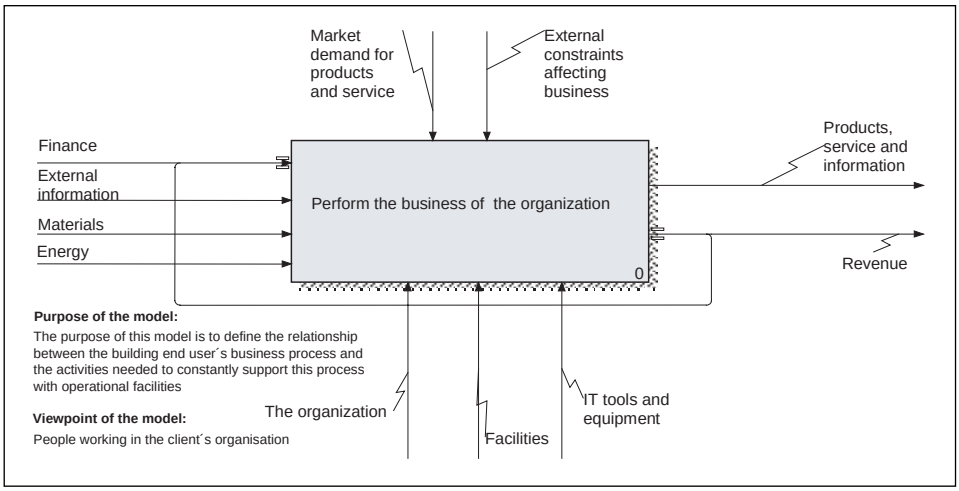

***Figure 3**. Perform the business of any organisation*

It is assumed that the purpose of the organisation is to produce products, services or information, which has value to some external customer. This diagram applies to any organisation whether commercial or non-profit. On the next levels, going down in the model hierarchy, the relation to the Facilities Management process will gradually appear. (Figure 4.)

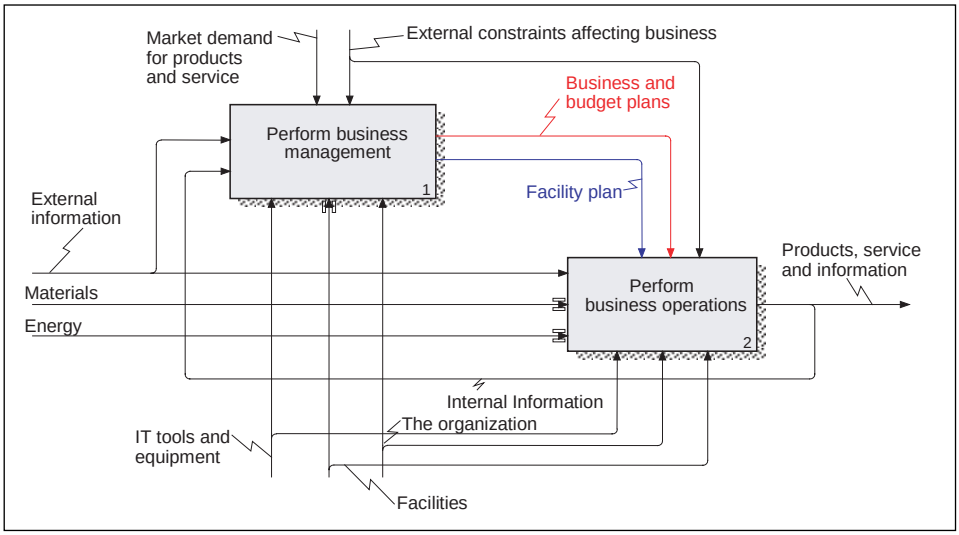

***Figure 4**. Perform the business of any organisation*

By business management we understand the planning activities in a company, which include studying both long-term market conditions of the company as well as the opportunities offered by technology development and the funding possibilities for investments. Such activities result in a strategic business plan for the business. Business activities include budgeting and long terms planning involving key issues such as the choise of new production systems or personnel and competence strategies. By business operations we mean the operations made by the core- and the support processes on a daily basis. (Figure 5.)

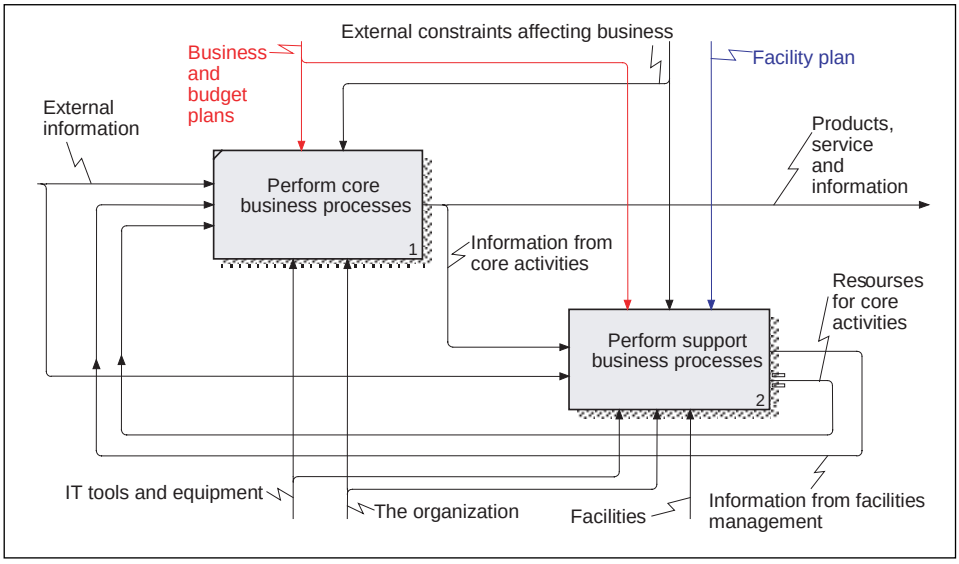

***Figure 5**. Perform business operations*

Examples of core business activities could be:

- In a university, teaching undergraduates and carrying out research, in a hospital, examining and treating patients, in a telecommunicating company, to develop and manufacturing mobile telephones.

Examples of support activities are:

- Paying salaries to the employees, supplying the personnel with IT-equipment, the supply of facilities or services to the core business, buying in the inventory and materials needed in the core business.

These support activities can be further broken down into the following sub-activities:

- Provision of Machinery services, Provision of Financial services, Provision of Material services, Provision of Personnel services, Provision of Facility Management services. (Figure 6.)

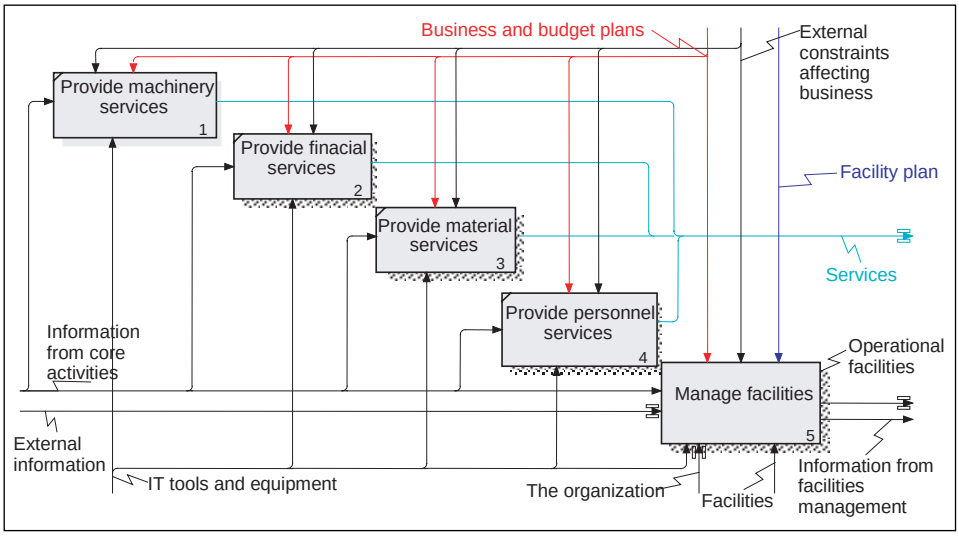

***Figure 6**. Perform support business processes*

From the organisations point of view, well-functioning spaces and buildings are only one of a number of resources needed as input to the core process. In larger organisations we often find specialised departments set up to manage these different categories of support activities.

The link between the business management of the core business and strategic FM planning is important to note. Signals to start planning for changes in stock of building and spaces responds to a predicted need for these resources, though an unforeseen change in the business environment can also rapidly change these plans.

Whenever such changes occur, these have to be carried out using a set of basic activities.

- provision of a new or existing facility,
- rebuilding of existing facilities,
- maintenance of existing facilities,
- operation of existing facilities,
- disposal of existing facilities.

As is seen in Figure 7, the business and budget plans and the facility plan stemming from the business management activies control when to start transforming inputs into operational facilities used for the core business processes. External constraints are for example public regulations or legal agreements with stakeholders connected to the business process.

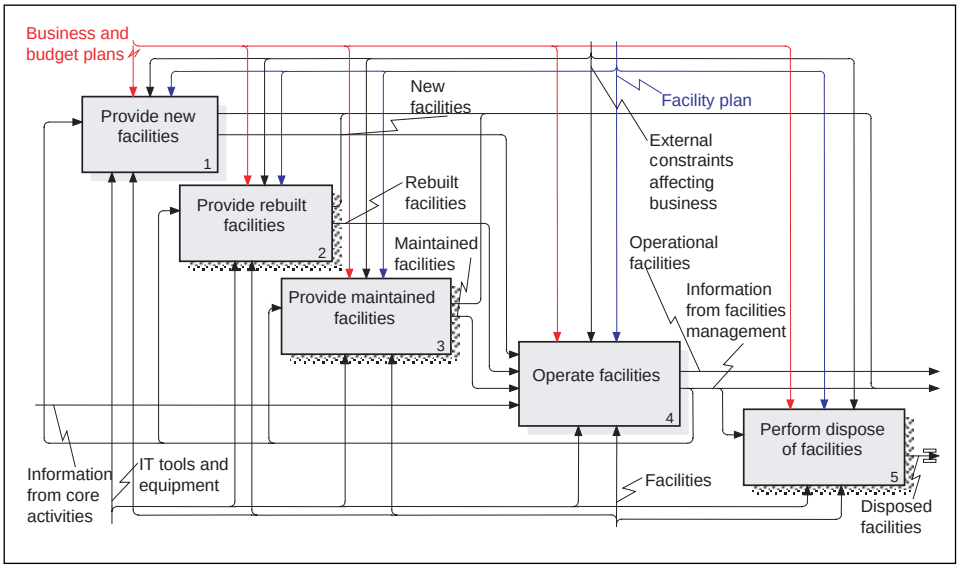

***Figure 7**. Manage Facilities*

Information from different sources in the core process are used by the FM activity in providing facilities to core processes, and information produced by FM activities becomes an input to each of the activities in the process of changing the continuing use of facilities. Resources used by this process are facilities, IT tools and equipment needed in the daily operations. (Figure 8.)

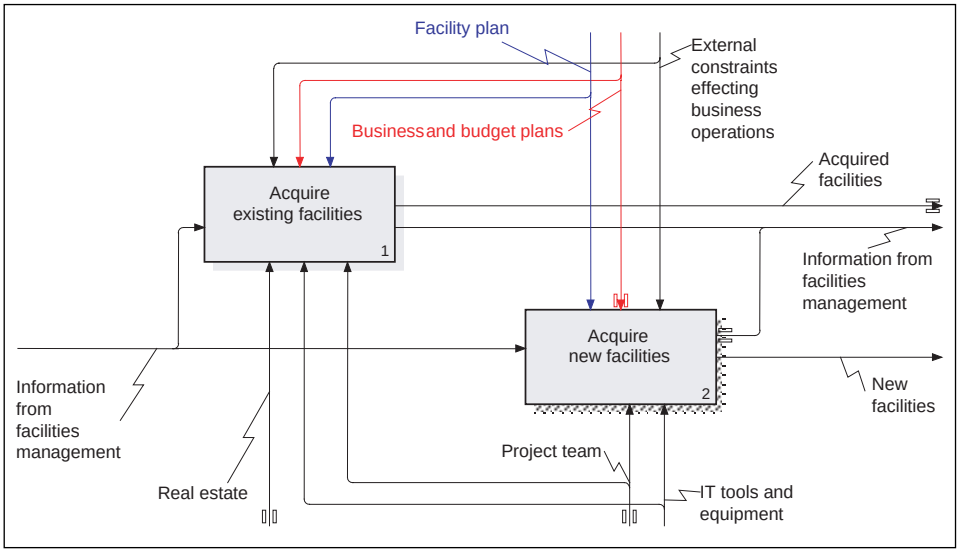

***Figure 8**. Provide new facility*

The provision of a new facility can be accomplished in two separate ways. By acquiring an existing facility or by acquiring a new facility. An existing facility

may be acquired through buying a built facility on the real estate market or renting facilities on the property market (Figure 9).

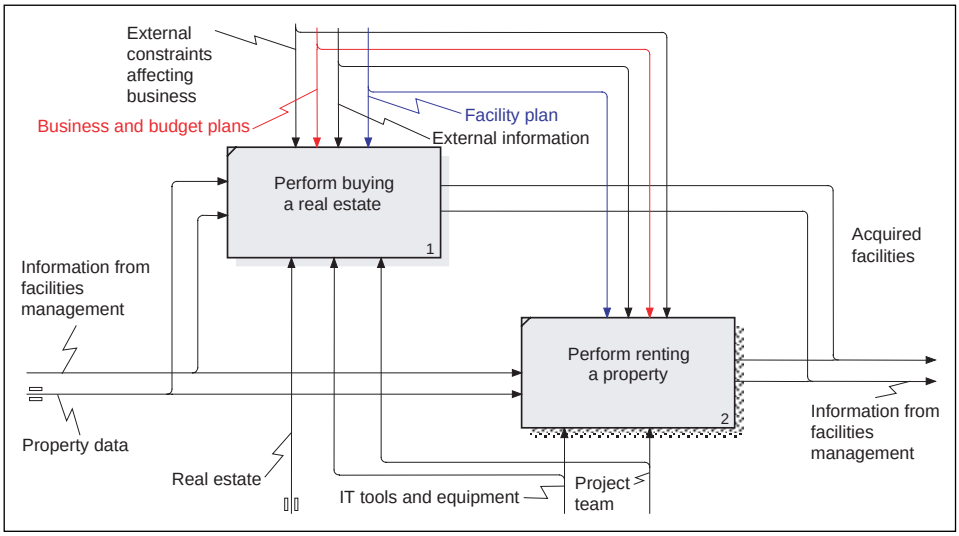

***Figure 9**. Acquire existing facilities*

By acquiring land and constructing a building or rebuilding a building already owned, new facilities may be supplied, but only after a long period of time. It is only by breaking up this level, that we can find the familiar categories design and construction, which so often are found as central in construction process models (Figure 10).

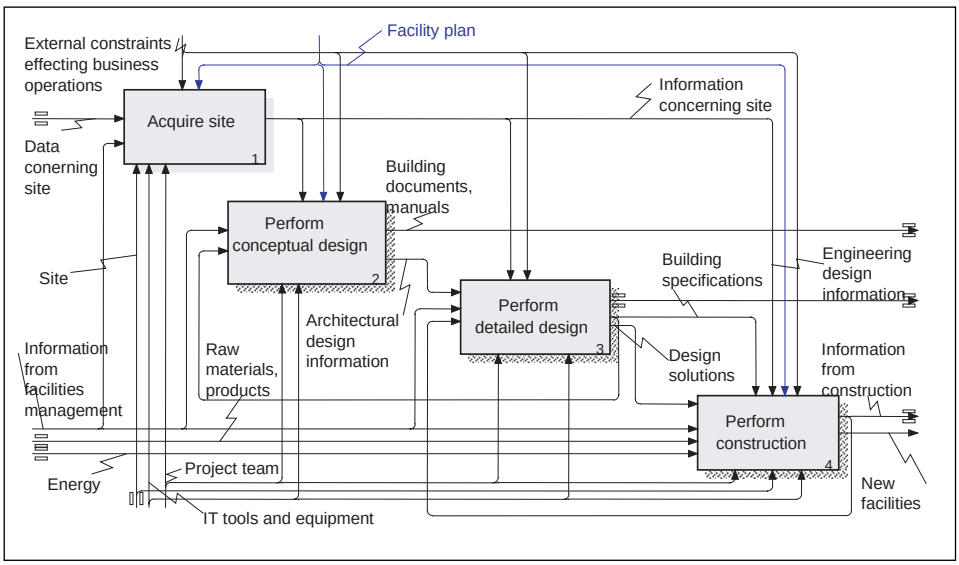

***Figure 10**. Acquire new facility*

The information in the facility plan provides for decisions involved in the activity of providing a site and these decisions are forwarded into the conceptual design, detailed design and to the construction of the building itself. Data and information about sites, such as their location, their surrounding and amenities are inputs to the activity of acquiring a site. Structured and unstructured information given by facility managers are used in all the activities involved in the acquisition of a facility. (Figure 11.)

As can be seen the project team is involved as one among several resources in the provision of new facilities. The information flow being produced as a result of the activities above are used in the decision making process and to describe the artefact itself – the facility.

The generic property of the ProFacil model provides for an origin from where specialisation of detailed process models can take place. Several perspectives can be adoptedin the process of acquiring a facility by using the diagram in Figure 10, be it the information technology perspective, the decision making perspective or the material flow perspective.

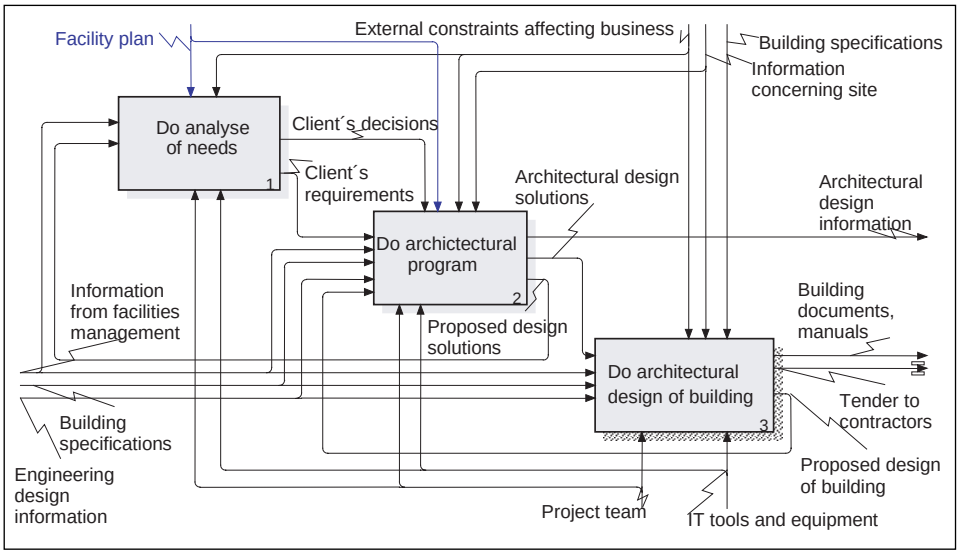

Figure 11. *Conceptual design*

At this level, the decomposition of the model is taken one step further and the details of the activities in the previous diagram are visible. What is seen in Figure 11 are the activities of making an analysis of the client's needs providing input into the architectural programme, the activity of making the architectural program, and the actual building design.

The information flows into the architectural program and the architectural design are building specifications and engineering design information. Information is also provided by the facilities management function.

Figure 12 shows the detailed design including five basic activities describing this process.

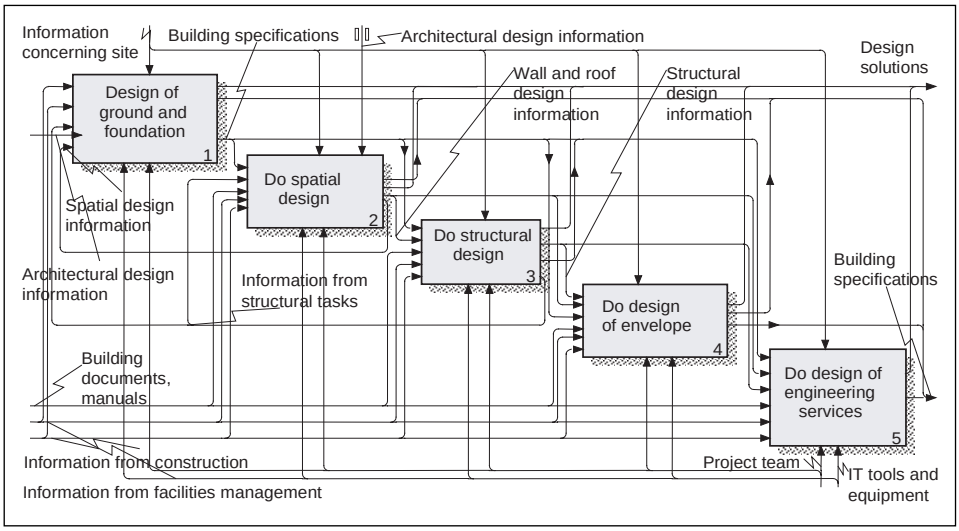

***Figure 12**. Perform detailed design*

The design of ground and foundation produces basic information formalised into the building specification as one of the several inputs to the spatial design activity which provides information about the design of walls and roofs into the structural design.

The final diagram in the model (Figure 13) shows the stages of the actual construction process, finally resulting in the building ready for use.

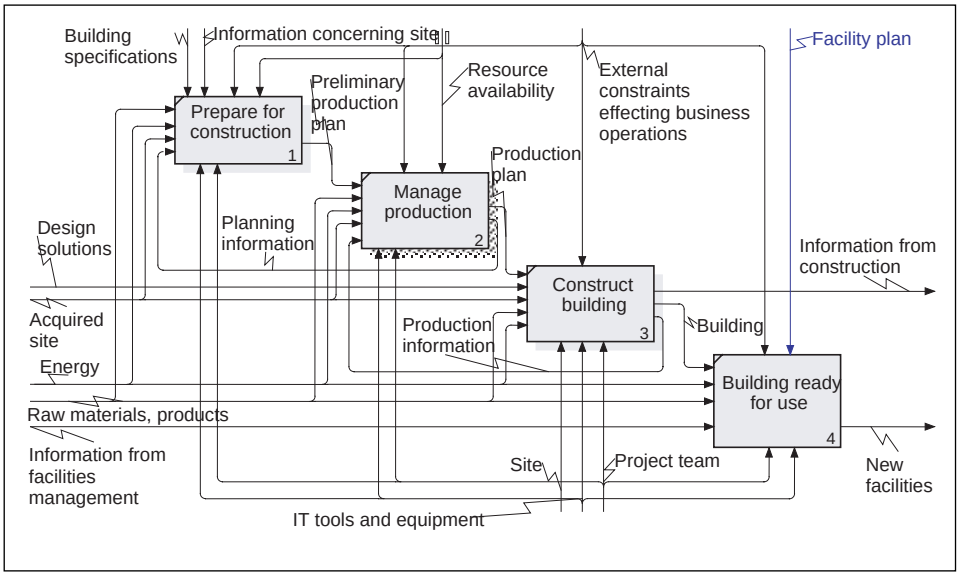

***Figure 13**. Perform construction*

7 Conclusions

A problem shared by many building and construction companies today is unclear processes in the provision of products and services within their organisations and to their customers. Unclear processes and working procedures tend to propagate into highly individual ways of working, and although some organisations do benefit from an unstructured way of working, mostly this is not the case.

Unknown processes result in the uncertainty of what is being produced and delivered by the organisation at a specific time to their customers. Process analysis supports the design of products, services or information systems, by shortening the time frame of production and increases the likelihood of discovering eventual malfunctions in a prevailing process.

In the project presented a generic process model for the FM and construction process was developed and validated with industry practitioners. A key feature of the model is that it puts the FM and construction processes in a wider perspective of core and supporting activities in any business enterprise, rather than view them as isolated processes in their own right (which has been the case for most earlier process modelling efforts in the construction sector). The idea is that companies, through a process of specialization, could use the Profacil model as a basis for their company specific modelling work.

The feedback received during the validation of the model was encouraging and the researchers hope that these types of methods would become more commonplace in the facility management and construction sector.

Acknowledgements

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