Modeling Economic Aspects of Hospital Information Systems to Give Decision Support for Strategic Information Management

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Abstract. Information systems require strategic planning in order to adapt their functionality and quality to the needs of health care organizations. Next to effectivity, cost efficiency in supplying and operating information systems is a particular objective. Hospital information systems with their technical infrastructure, their application systems and the hereby supported business functions can be described with the help of the meta model $3LGM^2$ and the $3LGM^2$ tool. The meta model and the $3LGM^2$ tool are extended by a generic approach to show supply and operation cost for all components of the information system and for the cost calculation between these components. This leads to the fact that all executives in hospitals are enabled to get the cost transparent which were caused by the support of the functions by the information system. The effects of planned extensions and modification of the information system can be analyzed in term of cost. In a prototypical modelling, the information system of a hospital of regular standards has been evaluated in nearly all its components and cost. An evaluation could show that information managers and executives are now delivered relevant cost information for planning, operating and control of information systems.

Keywords: Economic values, Strategic Information Management, Information Systems, Modelling, Performance Indicator

1. Introduction

Through technical progress and increasing requirements, information processing in general as well as in hospitals has become more complex. Besides other developments, standardized payment systems of hospitals require an increasing economic efficiency. This can be achieved, among other measurements, by the use of efficient information processing. In order to reach this target, strategic information management as a continuing process consisting of planning, operating and control is required.

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Information managers in the health system are often faced with the problem to have to handle valid cost information for various questions. On the one hand, cost information can touch single components of the information system such as an application system or a hardware component. On the other hand, the information management can regard – analogously to the account of charges of hospitals – their internal customers and their company functions as cost units. This requires settling the cost of information system with the respective functions.

It is the objective of this work to deliver a performance indicator system of cost indicators to all those authorities who give directions in hospitals and to support their tasks. This way, the users shall be enabled to cut cost and to modify the information system functionally in a way it will support the business functions of the hospital efficiently and effectively. This paper presents a method and reports on first experiences made in a case study in one hospital. The method is based on the 3LGM², which has been used successfully to describe HIS ([1, 2]).

2. Material and Methods

The elaboration of a performance indicator system of cost indicators has been based on three steps:

The first step develops requirements, which are to be measured by the indicators describing economic aspects of information processing. The foundation is primarily on analysis of strategic information management plans and a study of standardized queries of information managers in the health system.

As a second step usual economic indicators and indicators of documented performance indicator systems are evaluated if they meet these requirements. These results lead to the development of a generic performance indicator system.

The third step comprises the implementation on the basis of the 3LGM². The 3LGM² defines ontology to model information systems using three different layers. The domain layer consists of enterprise functions and entity types, the logical tool layer focuses on application systems and the physical tool layer describes physical data processing components. In contrast to other approaches the 3LGM² also defines inter-layer-relationships between the layers to build integrated models of information systems. To obtain this, it was necessary to identify the indicator-relevant model section. This was followed by a specification of necessary expansion to verify the performance indicator system in the meta model. For the 3LGM² tool extensions were specified to apply the performance indicator system at the 3LGM² model.

The developed method was adapted and evaluated with the help of prototypical modelling.

3. Results

3.1. Requirements

Seven specific requirements of cost indicator systems were specified after this analysis: Efficient service delivery by the operator of the information system, Effective support of enterprise functions, Efficiency of in-house customer processes, Complete ascertainment of costs of information processing, Structuring in elementary types of costs, Considering of cost-cut factors, Reference of the responsibilities and operational competence of those in charge.

These specific needs are in line with general needs in terms of indicators, as e.g. formulated by KÜTZ ([3]).

3.2. Cost Indicator System for Information Processing

The cost indicator system developed for information processing consists of a hierarchical structure falling into four classes of calculation objects (see Figure 1). The cost indicators for the calculating objects of each class are in line which the generic cost types (see Table 1) which can be differentiated depending on the demand of concrete modelling. The settlement of cost figures through the hierarchy of calculation objects involves distribution keys. Through these distribution keys, the cost types (see Table 1) of each object of one layer (see Figure 1) can be added to the related objects of the upper layer.

3.3. Requirements for the 3LGM²

Proofed by an analysis the 3LGM² supports the hierarchical structure of calculation objects from the start. What is needed for an overall settlement of information processing cost is a

Project Phase	Operation Phase	Life Cycle
Primary Performance Indicators:		
material cost (single)	material cost (periodical)	
internal personal resource (single)	internal personal resource (periodical)	
external service (single)	external service (periodical)	
planned operation time (number of periods)		
Secondary (Computed) Performance Indicators:		
project cost in total		
project cost per period	operation cost per period	➜ total cost per period
internal personal resource per period	internal personal resource per period	➜ internal personal resource per period

Table 1: Generic plan of cost indicators
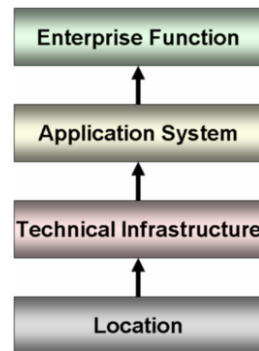

Figure 1: Hierarchical structure of the layers of object classes to calculate the settlement of information processing costs

relevant part of 3LGM² shown in Figure 2 along with the needed extensions.

In extending the 3LGM^2, the primary and secondary cost indicators as class attributes are important as well as distribution keys to settle the cost indicators between adjacent classes. Primary cost indicators are features which are directly allocated to calculation objects. Secondary cost indicators derive from primary ones.

7 Settlement functions were defined to calculate cost indicators between the objects of adjacent classes. A function for value-depending visualisation of calculation results had to be added.

To deduct efficiently the cost indicator system requirements for the 3LGM² tool were formulated:

- **Attribute editor** to define, enter and show the indicators as model specific attributes,
- **Visualisation of inter-layer relationships** to enter and show the partitions,
- Definition of modelling conditions which are able to specify the respective prerequisites to be able to use reusable cost models and to control their completion,
- An **attribute browser** to support the visualisation of indicators and to navigate through a model,
- **Import- and export functions** for data exchange with e.g. finance accounting or purchase systems.

3.4. Prototypical Modeling

The information system of a hospital of standard regular service was modeled with the help of the 3LGM² tool on all three layers as well as the relations between these layers. Consequently the primary cost data of all components of the information system were taken into account. The investment and operational costs were needed to evaluate the long term ef-
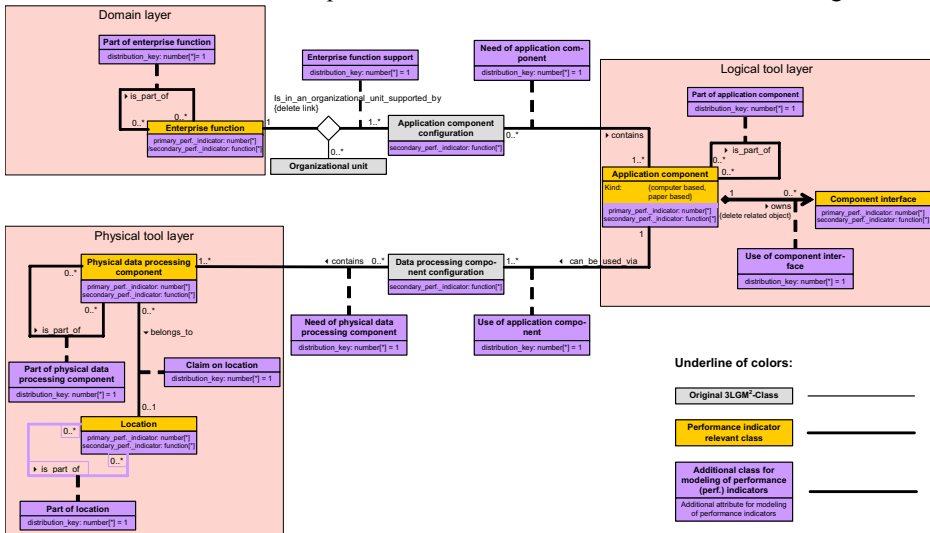

Figure 2: UML-diagram of the performance indicator relevant part of the 3LGM²-Meta model including extensions

fects of investments decisions in the model. Assuming that information systems have a limited duration of use and have to be substituted at the termination of the working life, the investment costs are based on the current replacement costs.

The replacement cost was calculated on account of present invoices, offers of comparable components or estimates of experienced consulters.

The relations between information system components describe which physical data processing components are used for the application systems and which application systems can be used to support the enterprise functions. The cost could be transferred onto the objects of superior layers according to these relations.

Technical data, single cost as value quotas as well as estimates as consensus of several executives were used as distribution keys.

3.5. Case Study

The method proposed has been applied during a case study in a 155 bed German hospital. The result is shown in

Figure 3. Five indicators are shown in this graphical model for information system in total and as an example for an enterprise function: PC: Project Cost, recalculated per year of usage; OC: Operation Cost per year, TC: Total Cost per year, PR: Personal Resources per year, WL: Planned Working Life.

These indicators had been computed for each model object. The drill down function of the 3LGM² tool enabled information managers as well as executives of the hospital to control the information system, its components and its development.
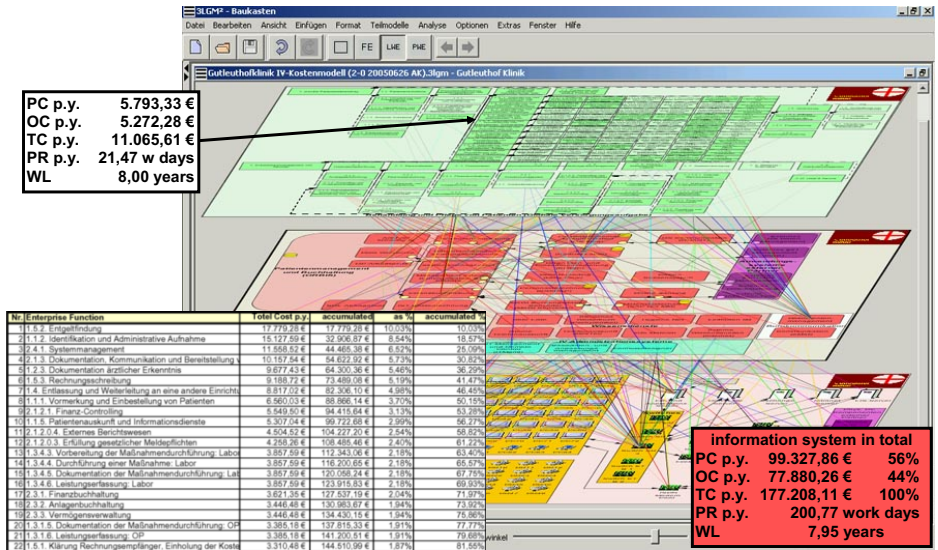

Figure 3: 3LGM²-model of the information system taken from a 155 bed hospital with realized inter-layer-relationships that shows calculated cost indicators and a statistic presentation

The ABC analysis over all enterprise functions is an example for feasible analysis.

4. Discussion

The specifications to model and the experiences of the prototypical use concluded in a process reference model. It is based on the 3LGM² and further more practicable to model cost for information systems in facilities of health service. The process reference model describes 14 successive activities to model cost and divides them in areas information system modelling and cost modelling. For each activity, the description could be supplemented by tools to apply for implementation and work usage as well by control instruments to check the completeness, the consistency or the plausibility of the task done.

5. Conclusion

The prototypical modelling and evaluation of a hospital information system could be proved by completely materializing the configured performance indicator system
- that the performance indicator system is applicable completely, practicably and non-contradictory,
- that this leads to cost transparency which backs up decisions on the change of information system components,
- that the expenditure for the information system - and cost modelling - justifies the profit of the model and
- that - basing on the cost model - ongoing initiatives to improve efficiency of information processing (e.g. by benchmarking) were feasible.

It could also be proved that the $3LGM^2$ to model the indicator system can be extended and can answer questions concerning the raise of costs, the origin and reduction of costs. Papers concerning the balanced scorecard ([5]) also show that finance indicators themselves are not the only reason for decisions about settlements of further cost indicator types. The $3LGM^2$ extensions were thought to serve settlement of further cost indicator types such as quality indicators types or safety features of the information system components. Respecting performance indicator systems could not yet be found and practicability could not yet be proved.

Furthermore, $3LGM^2$ models according to the set-up of this paper could be suitable to underline benchmarking projects that compare facilities. Thus, the results are a basis of further going research.

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