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**DEVELOPMENT AND APPLICATION POSSIBILITIES
OF AN EFQM-BASED INTEGRATED DECISION
SUPPORTING MANAGEMENT MODEL**

Theses of PhD dissertation

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1. Research motivation

The development and practical application of an integrated management model began in 2007 with the leadership of the Institute of Management of the University of Miskolc. A considerable amount of experience was gathered concerning the application of the model as the result of different projects and cooperative research, and therefore I started the development of a model. The first step was the detailed analysis of the evaluation factors of the model. The aim was to answer the question of how this strategic management tool could be adapted to an organisation during it manages a certain comprehensive decision supporting function.

To investigate the decision supporting role of such a model in more detail, I attempted to gain a more extensive idea of the attitude and experience of the companies referring to decision supporting. To perform this I conducted two empirical studies. The first was based on secondary sources: 100 international case studies were analysed to explore what possibilities were supplied by the market leader business information systems at that time. The major motivation of the investigation was to determine which functional or management fields are in the focus of such systems.

After processing the results I performed a primary investigation. The investigation involved 100 companies operating in Hungary. The focuses of the investigation were the following fields:

- The applied information system types and the degree of satisfaction with them,
- Functional and management fields supported by them,
- Sources of strategic decision making.

After completing the studies I carried out a literature review parallel with the model development in order to consider both theoretical and practical recommendations while building up the components of the model. My aims concerning the model development were the following.

Aims of model development

- Precise determination of the ways in which the basic model is inadequate, and collection of potential additional elements.
 - A more exact indicator system – I endeavoured to apply simplified but essentially logically structured indicators in the case studies.
 - Vertical integration – The model has to be applicable on several management levels. This was solved with the integration of an appropriate subsystem – Balanced Scorecard (BSC) – and with the description of mathematically formalized model linkage.
 - IT support – I endeavoured to make a mathematically formalized model base and data management system. It was not my intention to develop an informatics system.
 - Monitoring system of improvement project – see below.
 - Horizontal integration – I endeavoured to make an exact, mathematically formalized description of connections among the object system which forms the set of input data of the major subsystems of the model: BSC and the model of the European Foundation for Quality Management (EFQM).
- Collection of critical factors referring to the integration of subsystems of integrated management models and to decision support systems on the basis of recommendations in the literature. This helps in building elements and solutions into the model that make the integrated model efficient.
 - Requirements of integrated management systems.
 - System characteristics of integrated decision support.

- Exact description of development fields designated in this way; outlining what methods are proposed to realize the development.
- During the model development I considered the external and internal environmental boundaries of the BSC, EFQM and IT developments. Furthermore I supposed that consideration of all of these is enough to designate the boundaries of the system constructed with these subsystems.
 - Analysis of external environment (technological, economic, political)
 - Analysis of internal environment (factors of strategy and structure)
 - Analysis of stakeholders (consumers, suppliers, owners)
- Test of technical operation of the integrated decision supporting management model, partially with real and partially with simulated data.
- The model can be potentially applied by companies and institutions which fulfil the necessary requirements of operation of the Balanced Scorecard and run an advanced quality system which facilitates the applicability of EFQM. Although there are currently only a small number of BSC appliers in Hungary, companies that do not apply it were not considered as a target group of the model.

Aims of project monitoring and risk management

- Project monitoring
 - Implementation of a project progression qualifying system into the model on the level of indicators giving information on the level of fulfilment of project goals.
 - Not analysed:
 - The level of unacceptable indicators at which an improvement project is considered to be necessary.
 - Adaption of general, well-known fields (project controlling, connections of activities, uncertainties, financial calculations, scheduling, etc.) of project monitoring into the model.
- Risk evaluations
 - Implementation of the risk evaluation subsystem of an existing, successfully applied risk management system into the model.
 - On the level of indicators giving information on the level of strategic goals.
 - In the improvement project on the level of indicators giving information on the project results, and at the level of activities in the case of project activities.
 - Not analysed:
 - Application possibilities of the estimation method referring to the probability of supervention of risks and to the effects of risks.
 - Other fields of risk management, e.g. structuring methods of risk factors; risk manipulation.

2. Methods of investigation

As the result of secondary investigation performed on the basis of case studies, I composed the primary hypothesis.

H0/1: A significant proportion of companies supplying business information system software emphasise the latest elements of information technology and administration support referring to their solutions. The solutions which support the basic strategic management processes belong to the high level innovators at only a relatively low rate.

To validate the hypothesis I performed simple statistic calculations after a detailed overview of case studies of companies applying information systems. Concerning the primary investigation, I composed two hypotheses corresponding to the goals of the study.

H0/2: Concerning the types of business information systems, the latest versions of ERP systems are in widespread use in companies. The relatively large amount of experience gained during operation of them could be the reason that satisfaction with these systems is significantly higher than with other types of systems.

H0/3: Concerning the strategic decision making, the sources of decision making are essentially the personal knowledge and experience of decision makers and the market analyses originating from external or internal sources.

To validate the hypotheses, after processing the surveys, I performed simple statistical calculations. Beyond the simple measurement of the variables of investigation I also analysed the correlation of two variables. The results were demonstrated in graphs and tables. After this I made deductions.

After performing the empirical investigations I concluded that operation of strategic level management models is not supported or supported only on a low level by information systems. To further investigate this assumption I carried out a literature review to thoroughly analyse the management and organisation subsystems relevant to the model. On the basis of the results of literature review and the shortcomings of the basic model I redesigned the model. I constructed hypotheses referring to the development in order to provide direction in the development process. In the final chapters of the dissertation I validated the technically appropriate operation of the developed model with case studies. The basis of the investigation was concrete self evaluation data. These data were processed for use in the model, and then the results were analysed. Considering all these facts I constructed five hypotheses in connection with the development and the testing of operation of the model.

Hypotheses related to the development of the model

H1: Collections can be found in literature that offer aspects for connecting the subsystems of the integrated management models referring to the management and structural implementation and to the implementation into information technology solutions. As the result of model development a user-friendly integrated model can be developed on the basis of appropriate chosen set of aspects.

H2: Connections of subsystems of the model can be described with mathematical formalism, which helps in information technological support. The strategic planning, the organisational self evaluation and the monitoring processes showing what has to be improved and initiated as a result of the self evaluation are clear and relatively simple to apply due to the system of elaborated model connections.

Recommendations in the literature were collected and logically structured referring to the integrated models and taken into consideration during the development of the model. The hypotheses that I formed were validated as to their adequacy for the development aspects of the model.

Hypotheses connecting to the technical operation of the model

H3: The conceptual aims of the developed integrated model make clear the self evaluation aspects of the goals of the applier organisation and the strategic indicators that are the basis of the investigations. The technical preconditions of the strategic planning connected to the self evaluation are realised by the strategic indicator system. This is the horizontal integration of the model.

- H4: The presence of the EFQM model as a basic subsystem of the integrated model acts as a key, because it ensures a number of possibilities referring to the aspects used in analyses. This means that the aspects of the strategic goals of an organisation with specific environmental and internal characteristics or the aspects of the goals of a project can be adapted easily to the EFQM subcriteria. At the same time the organisation can provide itself with the excellence model.*
- H5: The presence of the Balanced Scorecard as a basic subsystem of the integrated model acts as a key, because the indicator conception aids self evaluation in analysing only a subsystem of an organisation instead of analysing the whole organisation. It designates the fields – on the level of indicators – which require encroachment in the next strategic period. In addition, BSC facilitates the application and adaptation of scorecards referring to the different hierarchical management levels. This helps in realising the vertical integration of the model, which is important in decomposing the strategy of the company.*

To validate the hypotheses I performed a test in a focus group. I also summarised the results from the case studies. Actual values of indicators connecting to the self evaluation were part of the statistical analysis of real self evaluation data. The factors connecting to the model, which have to be weighted, were finalised by a group of experts. Concerning the fifth hypothesis I performed a data simulation and built it into the case study.

After the results and the demonstration of solution processes leading to the results, a primary thesis was constructed on the basis of the results of empiric investigations, and six theses were identified referring to the development and testing of the model.

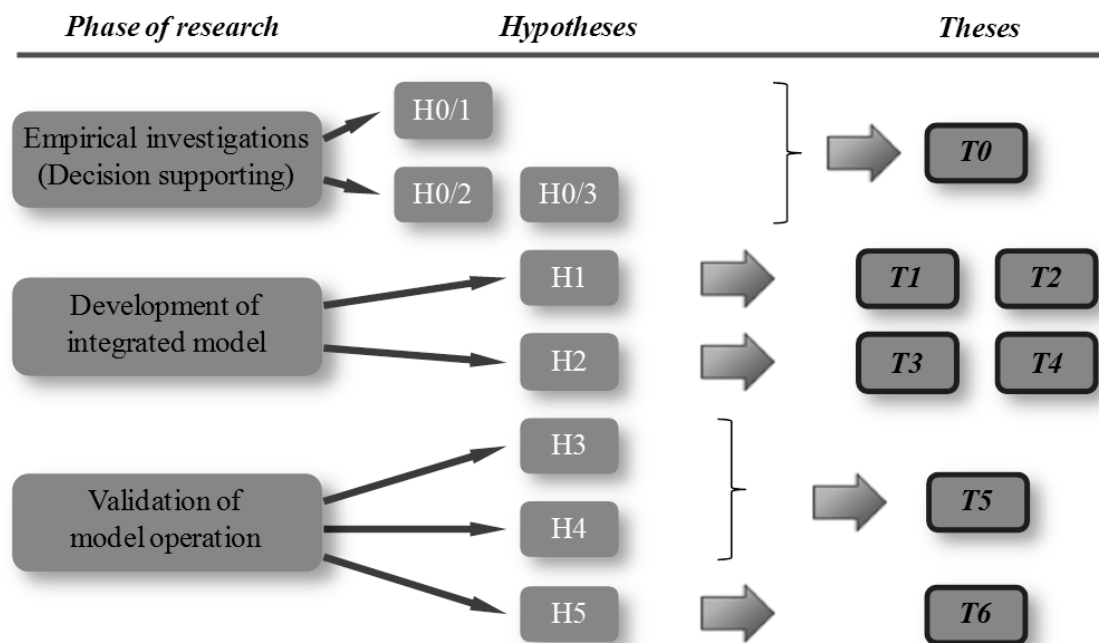


Figure 1. Structure of hypotheses (H) and theses (T)

3. New and novel findings

3.1. Summary of results

3.1.1. Results of the literature review

During the model development a determinant field of the literature review was the designation of conditions and methods of model integration. Table 1 summarises the literature on the basis of which a management model applied in an organisation can be nominated as an integrated model. In the table the integration on the basis of information technology and the integration of management techniques are separated.

Table 1. Literature review of integrated systems

Forms of integration		Literature
IT-based integration	conceptual frame	Kearns & Lederer (2000); Avison et al. (2004); March & Hevner (2007); Teubner (2007)
	integration aspects	Datta & Thomas (1999); Park & Favrel (1999); Wu et al. (2001); Chau et al. (2002); Hwang et al. (2004); Schneider (2008); Morales & Erazo (2009); Ariyachandra & Watson (2010); (El-Sappagh et al. (2011); Pardillo & Mazón (2012); Prat et al. (2011).
Integration of management techniques	conceptual frame	Kaplan & Norton (2004); Bezegh (2006a); Bezegh (2006b).
	integration aspects	Husband & Mandal (1999); Imre (2004); Oner & Saritas (2005); March & Hevner (2007); Liao et al. (2010); Saghaei & Didehkhani (2011); Malaysian Institute of Management (2012); Yukon Hospital Corporation (2012).

On the basis of the literature the essential aspects of a model which integrates management techniques and is supported by IT can be outlined. These aspects are useful for the realisation of development; their structure is summarised in Table 2. Among the collected aspects some were considered as determinant in the evaluation process of the developed model. Besides these, other aspects created from the lacking points connected to the basic model were also important. These are explained further below.

Table 2. Main aspects of IT and management techniques integration

IT-integration on the basis of data warehouse architect	
<ul style="list-style-type: none"> – Data selection – Data collection – Extraction-Transformation-Loading – Quality of data – conceptual data integration – Design of data warehouse scheme – Meta-model management 	<ul style="list-style-type: none"> – Method of information selection – Analysing models and tools – Models and tools of data mining – Training and support of end-users – Real-time update of data warehouse – Real-time strategic and operative decision making

Table 2 (continued). Main aspects of IT and management techniques integration

IT-integration /on the basis of data warehouse architect	
<ul style="list-style-type: none"> – Business intelligence – Supply chain integration 	<ul style="list-style-type: none"> – Business operation monitoring – Design of changes – Change management and version control
Integration of management techniques	
<ul style="list-style-type: none"> – Process-oriented work scheduling – Cohesion of organizing and management – Environment-orientation – Short communication paths – Clearance – Cohesion of different level and field strategies 	<ul style="list-style-type: none"> – Regular update of strategy – Cohesion of goals of individuals and organisation – High-level support of organisational learning – Strong IT-support – Evaluation of competencies – Evaluation of performance

3.1.2. Results of empirical research

The first of the hypotheses (H0/1) in connection with the empirical study is validated by the results of the secondary investigation. Information management (24%), marketing (13%) and administration (14%) reached relatively high values. This gives the answer for the aim of investigation: information systems are often applied successfully in the field of administration, and the degree of automation has increased (distributions in parentheses refer to the total number of mentions).

From the later performed primary investigation I found that 78 of the 100 companies use a decision support system. Of these, 51 use a “major” (meaning that the market share of the supplier is significant) information system. The chiefly supported field was financing/accounting (61). Further strongly supported fields were production, assembly, logistics and administration. Values of administration are also high similarly to financing/accounting. This is in agreement with the results of the earlier investigation based on case studies. Satisfaction values of companies applying information systems and supported fields were collated. The values of satisfaction were between; 2.85-3.27; value “3” means “mostly satisfied”.

On the basis of the earlier secondary investigation performed with the case study method and of the primary survey I constructed the following initial thesis (T0).

Initial thesis (T0):

Investigations performed on the use of information technology tools based on case studies and through questioning a group of decision makers gave the following authoritative results.

- Concerning the experience of market leading business information systems it seems on the one hand that solutions serving administrative organisational activities have a significant share on the market of these software products. However, strategic management support solutions are not the most widespread ones. These results were confirmed by the primary investigation carried out in Hungary.*
- Furthermore, the primary survey pointed out that ERP solutions of developer companies that have a relatively large market share are significantly more widespread at companies and the users also have a higher level of satisfaction than those who use solutions of smaller suppliers.*
- According to the primary survey performed in the group of decision makers of companies the sources of strategic decisions are mostly their own knowledge and market analyses.*

3.1.3. Results of development of integrated model

3.1.3.1. Point of views of development

From the point of view of quality it can be stated that the parallel application of management models is necessary because of the complexity of organisations and their processes. Aims and methods of that point out different organisational and leadership approaches. This is why adaptation of these models to each other, i.e. realisation of horizontal integration, is an essential task. There are several practical cases demonstrated in the literature about such integrated solutions. From the point of view of the issue of the dissertation, models that include the EFQM model as a determinant subsystem of such an integrated solution are essential. The utility of integration is demonstrated among others by the application of these models.

From the point of view of a strategic indicator system, it can be stated that Balanced Scorecard is a strategy support model applied widely in the world. According to several authors it forms a certain degree of integration in management even when individually applied. However, it is also applied successfully with other tools which are adapted logically to the BSC. An important advantage of the BSC is that vertical integration among the subsystems of an organisation is also supported using the hierarchical structuring possibility of indicators. A basic condition is the well-supported introduction of BSC (Papalexandris et al., 2005).

Thesis 1 (T1):

To the model development conception elaborated on the basis of gaps in the basic model, the concrete design and development aspect have to be given so as to retain individual application advantages connecting to the subsystems of the model. During development:

- *when implementing the subsystems, connections have to be exactly designated (horizontal integration of subsystems),*
- *the model has to be general enough, i.e. the operation of it has to be extendable to several hierarchical levels of an organisation (vertical integration),*
- *synergy expected from the integration has to be utilised with the consideration of the necessary system integration requirements.*

According to the recommendations of the literature, and based on practical experience, I structured the design and development aspects referring to the model. These aspects (solvable tasks) are:

Point of view of quality

- *Development of an EFQM-based model*
- *Horizontal integration of the subsystems of the model*

Point of view of Balanced Scorecard

- *Development of BSC-based model*
- *Vertical integration of the model*

Need for extension of the basic model

- *Help of IT support*
- *Possibility of project management*
- *Risk evaluation*
- *Differentiated analysis*

Point of view of integration

- *Process-oriented work scheduling*
- *Cohesion of organisation and management*

– Environment orientation

- *Cohesion of strategies*
- *Regular actualisation of strategy*
- *Cohesion of individual and organisational goals*
- *Direct support of organisational learning*
- *Realisation of IT support*
- *Evaluation of competencies*
- *Performance evaluation*
- *Support of data selection*
- *Quality of data*
- *Conceptual data integration*
- *Business process monitoring*
- *Support of planning of changes and support of change management*

From the point of view of integration the Balanced Scorecard and the EFQM organisational excellence model were evaluated on the basis of the requirements of integrated management systems and decision support systems operated with the data warehouse in order to designate the tasks of the model- and system integration needing to be solved during the model development (Table 4-2 of the dissertation, p. 60).

In the dissertation the tasks to be solved during the development are detailed as the three points of view (Chapter 4.4, pp. 61-64). The first thesis (T1) is constructed on the basis of the above literature review and the solutions connected to the point of views of development.

3.1.3.2. The integrated decision supporting management model

The basic model (Szintay, 2005) is demonstrated in detail in Chapter 4.1 (pp. 52-54) of the dissertation. Elements and connections of the developed model are demonstrated by the figures below. Figure 2 emphasises the coherencies of subsystems of the model. Its essential features can be summarised as ordering a previously elaborated but controlled BSC indicator chain to the elements of the value map of a strategic project or other goal system, taking into consideration the EFQM criteria and aspects.

During the self evaluation, several investigation aspects and many more qualifying indicators have to be defined. Furthermore, depending on the system of goals different elements have to be built into the analysis in every period of evaluation. These include the need for IT support in order to facilitate the work of managers with the increase of efficiency. The connection of the subsystems of the model forms the conception of a decision support system. This is demonstrated in Figure 3.

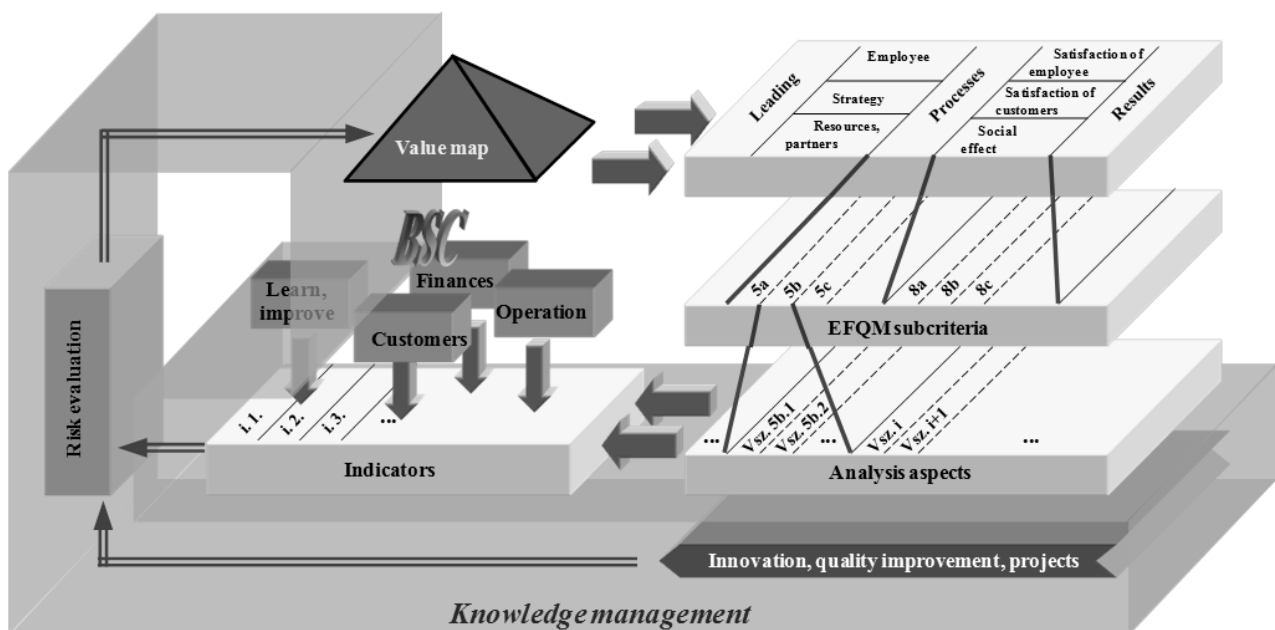


Figure 2. Subsystems and connections of the integrated decision supporting management model (own edition)

To solve the task of decision support, construction of a mathematic model is essential in order to realise the IT support. The model describes the support of simple database operations formally. In the model, which can be easily supported from the point of view of IT, it is possible to perform the expected level of self-evaluations. During the self-evaluation, data processing can be followed by the elaboration of change actions, projection of quality development actions, risk analysis and management – in parallel, if necessary. The result of realisation of improvement projects can be that weights of realisation of strategic or other goals shift, meaning that the result of evaluation is a

Concerning the basic model the elaborators of it have pretended the construction of differentiated analysis.

The structure of project monitoring system is demonstrated in Figure 4. Risks are connected to the indicators that have to be improved, the indicators measuring the goals of the project and the activities of the project. Designation of these indicators and evaluation of the effects of risks require the input of an expert (Fekete, 2000, 2009). Concerning the project monitoring system of the improvement project I elaborated a method connecting closely to the developed model on the level of indicators. Concerning risk surveying, the risk evaluation with scenario method was implemented into the model. The method has been successfully applied in practice. In Chapter 5.4 of the dissertation (pp. 110-113) the technical mechanism of the risk evaluation is demonstrated by a case study.

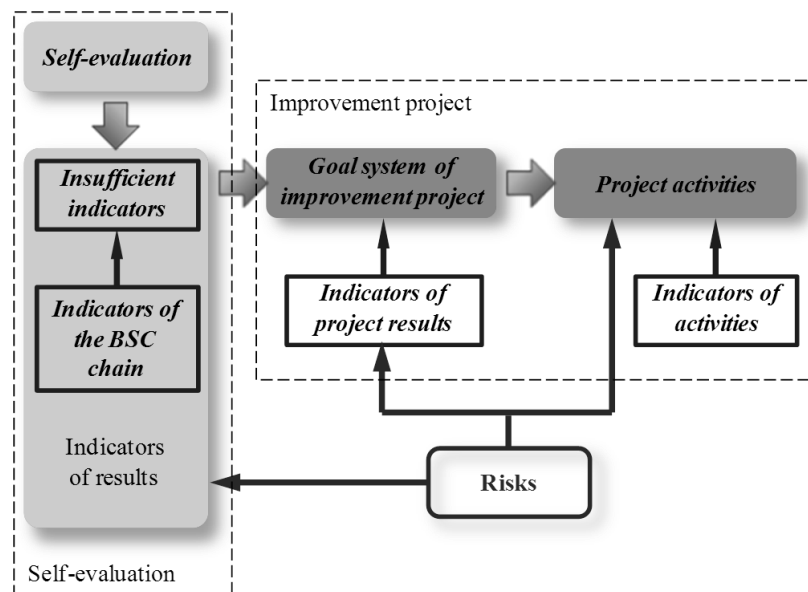


Figure 4. Structure of project monitoring system

I formed the next thesis (T2) on the basis of the evaluation of fulfilment of the development aspects and tasks elaborated before the development of the model. The summarising evaluation is demonstrated in Chapter 4.6 (pp. 88-93) of the dissertation.

Thesis 2 (T2):

The realisation of aspects and tasks of model development shows a heterogeneous picture. The reason for the existence of non-realised elements could be that additional subsystems or the connections among the subsystems are needed to ensure the realisation. Six of the 23 aspects were fulfilled when an individual system or a new subsystem was implemented into the model. The model and the methodology of missing tools facilitate that.

On the basis of qualification of realisation after development, it can be stated that realisation of the integrated system is strongly supported by the mathematical model. In the case studies it can be remarked that data processing is easy. Accordingly, the third thesis can be constructed. The feasibility of the progress evaluation of an improvement project is supposed by the second part of the second hypothesis. Starting from the project monitoring system, more exactly from the operation of its risk evaluation subsystem, the obtained results in connection with the developed subsystem and the implementation into the whole model were summarised on the basis of the structure of the development tasks, leading to the next thesis (T4) on the monitoring system of the improvement project.

Thesis 3 (T3):

Operation of the integrated model was described with mathematical formalism. Forms that describe the calculations and the connections among the subsystems facilitate the completeness of application of data structures and data types of the model (connection matrices, absolute values and percentages, weights).

- a. Necessary conditions of the decision support characteristic of the model are made by the connections realised among the subsystems and by the possibility of implementation into the informatics system.*
- b. Fulfilment of sufficient conditions of the decision supporting feature characteristic depends on the correct choice of data and the designation of application aims (i.e. strategic directions and goals) of the model.*

Thesis 4 (T4):

The self evaluation method of the integrated model and its mathematically formulated description are realised on the level of indicators of the evaluation.

- a. Aspects of evaluation; strategic goals which are the basis of the evaluation. These and the criteria of the EFQM model which facilitate the integration can be evaluated on the basis of data obtained about the fulfilment of indicators.*
- b. The possibility of formation of an improvement project which aims to improve indicators assessed as insufficient by the expert group was built into the model. The project monitoring system can be operated similarly to the self evaluation method – with different weighting and connection characteristics – as an EFQM-based subsystem which ensures a long-run strategic approach.*
- c. A monitoring system of the improvement project operating on the level of indicators was elaborated. IT aspects were completed with a risk evaluation system.*

The practical utility of the self evaluation system is that the integrated model is thus equipped with a knowledge management support system.

Testing of the operation of the developed integrated model referring to the whole static self evaluation was carried out. The basis of the test was a set of concrete self evaluations. From these, I drew the conclusion stated in Thesis 5.

Case studies (Chapters 5.2 and 5.3 of the dissertation, pp. 114-127) demonstrating the differentiated analysis introduce the method of practical use of the developed integrated model first of all from a technical point of view. Thesis 6 highlights the advantages of differentiated analysis. This method is desirable to use to assess the efficiency of a narrow organisational function or management field.

Thesis 5 (T5):

The EFQM model is a key in model development because it stimulates decision makers to apply aspects during the self evaluation that facilitate success in the long run. With the elaboration of a sample case study referring to the whole static self evaluation the following statements were validated (according to the interpretative approach):

- a. Because of the strongly general EFQM subcriteria, the EFQM ensures a relatively flexible frame for the formation of aspects. This flexibility ensures the efficiency of adaptation to the goals of the organisation.*
- b. Connections of the subsystems of the developed decision supporting integrated management model are clear and logically constructed, and thus its operation can be realised with simple technical tools. This supports the efficiency of decision making.*

Thesis 6 (T6):

With the elaboration of the sample case studies referring to differentiated analysis, validation (according to the interpretative approach) was obtained that the application of Balanced Scorecard facilitates:

- a. The fit of self evaluation results at a lower management level to the results of a higher management level with the management of all input data (weights, indicators, goals) in the same system. Thereby the investigations needing to be carried out can be extended in a fast changing market to narrower fields in which the self evaluation possibilities of the integrated model can be realised, with lower costs and less time consumption.*
- b. Clear designation of further indicators which were not part of the self evaluation previously. These can change with organisational development and improving measures.*

3.2. Application fields of research findings

Testing of the basic model in institutional environment was carried out, among others, on the University of Miskolc and in the organisations of the Hungarian Police. It has been successfully applied to the University of Miskolc since then. At the same time the gaps of the model are clear too. The developed integrated decision supporting management model can be implemented into institutions like these because of the modification of subsystems, first of all the modification of the structural basis of the strategic indicator system.

Reinforcement of flexibility in connection with the use of the model and the automation possibility can be increased with the mathematical model if simple IT support is adapted to it. Thereby in the case of appropriate software support the efficiency of managers' decision support can be increased. Extension of operational possibilities of the model – differentiated analysis, vertical analysis – facilitates the resolution of further strategic level problems (e.g., evaluation of an educational specialisation).

Further subsystems can be connected to the developed model, e.g. a detailed knowledge transfer model, project management or risk management model. Moreover, further quality management solutions (e.g. an environment management system) or special evaluation criteria (e.g. the Bergen criteria) can be connected to existing subsystems, too.

Concerning the direct utilisation, fast and totally quality-oriented evaluations can be realised using the databases of the management information system or the career following system of graduated students created at the university. This can help the strategic development of the institution.

Further utilisation possibilities include adaptation of the model by any enterprise or non-profit organisation or public institution to their management processes without significant investment. The major tasks concerning the implementation are: an appropriately constructed strategic plan, and decomposition of the strategy so that evaluation aspects and indicator system can be elaborated to its elements. Besides these, an indicator system has to be formed that facilitates the connections among the vertical management levels. An organisation holding to the Total Quality Management (TQM) philosophy can evaluate its achievements in a structured system from time to time and can get feedback in order to inspect its strategy.

Model application can be utilised in project management, too, because the goals connected to the project results have to be reached and the indicators connected to the project's progress can be strongly related. Therefore the model can be used as a decision support system of a project.

4. List of publications of the author

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