THESES OF DOCTORAL (PHD) DISSERTATION

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DOCTORAL SCHOOL OF ECONOMIC AND REGIONAL SCIENCES

DEVELOPMENT POSSIBILITIES OF THE PROJECT CONTROLLING METHODOLOGY

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Content

1. ANTECEDENTS AND OBJECTIVES OF THE WORK

1.1. Introduction

Nowadays, in the competition of global supply chains, businesses need competitiveness factors that can give businesses and thus the entire supply chain a competitive advantage in the long run. As a result of globalization and digital development, outsourcing has become widespread, both geographically and in terms of activities and functions. This outsourcing activity allows the companies to focus on their competitive advantage. At the same time, however, the risk of supply chain vulnerabilities increases. The Covid-19 pandemic highlighted this vulnerability, with disruptions in raw material supply and supply chains hampering production processes, thereby affecting global economic performance, the functioning of financial systems and rising inflation rates. Numerous studies point out that reducing the geographical scope of different supply chains, their vertical integration and reducing the interdependence of actors in the supply chain are becoming key factors. Automation of business operations and production processes, such as the development of automated production systems, customer service systems, administrative processes and agricultural technologies, as well as the development of digitalisation, can significantly increase business productivity and efficiency. In this way, repetitive and operational processes that have been outsourced to the supply chain can be transferred, as automation results in an environment and costs with which outsourcing is no longer necessarily a competitive advantage. The impact of the Covid-19 pandemic on supply chains also encourages the insourcing process and the emergence of geographically shorter supply chains.

In addition to the repetitive and operational process insourcing activity, a trend in the opposite direction has also been observed. This trend means outsourcing individual activities with specialized knowledge and high added value. These types of activities are outsourced mainly because they arise on a case-by-case basis and their implementation is a complex process. So automating these activities is a complex and costly task, and the knowledge and expertise required is special in nature. As these activities are unique and specialized in each case, it can be defined as projects. Organizations that meet these criteria and emerge as efficient and competitive actors in the supply chain will in most cases operate within a project organization structure. It should be emphasized that the project organization structure is used in many cases by small and medium-sized enterprises and that by operating project-type activities in a typically highly segmented niche market, their operations and operational processes cannot be standardized. The project organization structure provides an opportunity for flexible operation and agile response to environmental changes.

For project organizations, data asset management and effective performance evaluation can be the foundation of their competitiveness. Controlling as a function should create the structure of information in a form that adequately supports managerial decision-making and the achievement of organizational goals. The consideration of organizational goals in the case of project organizations is not always fulfilled at the level of projects, thus during the controlling activity, it has to deal with this feature arising from the organizational structure in some way. Consequently, project success can always be judged on the basis of the context. The difference between project and project organization success must be taken into account by the controlling system and always evaluated depending on the given context. This high subjectivity is effectively handled by modeling based on fuzzy logic and is therefore suitable for judging project success and project organization success. The controlling system should strive to integrate both financial and non-financial aspects in performance evaluation, regardless of the objectives set. This makes performance evaluation more detailed and realistic and multi-level, allowing project organization decision-making to be supported more effectively.

1.2.Objectives

The raising of the research topic was the result of my practical experience and the knowledge revealed in the literature. The research is based on the evaluation gaps arising from the performance evaluation of project organizations and the scarcity of mathematical models used for evaluation. It is especially important for project organizations to apply or create a controlling system that meets the characteristics of the individual organizational structure and the basic goals of controlling. All this in a form that can be effectively integrated into different corporate governance systems.

My research goal is to explore the management organizational processes and controlling methods and systems used by project organizations. I also map correlations between project performance and project organization performance evaluation. In my research, I aimed to illustrate the different methods of project organizations' performance evaluation through individual cases. Furthermore, my goal is to create a standardized controlling model to evaluate the performance of project organizations. The model is based on the analysis of the correlation of the methodological elements used in the literature and the synergistic integration of the advantages of the methods and systems explored in the case studies.

In my research, I describe my objectives in the following points, which served as the defining foundations of my research:

- To explore the management organization processes and the controlling methods and systems used by the project organizations.
- To map the correlations between the evaluation of the performance of the projects and the performance of the project organization.
- To map the methods used to evaluate the performance of projects and the project organization and the relationships between the methods through individual cases.
- Point out the possible differences between defining strategy success and project success.
- Creating a standardized performance evaluation controlling model for evaluating project organizations that supports managerial decision making not with exact values but with linguistic terms.
- To examine the performance evaluation of the base activity, the project and the organizational level not in isolation, but in an integrated system.
- The performance evaluation model I have created can be extended to different areas where high subjectivity in the definition of goals.

2.MATERIAL AND METHODS

I used a qualitative case study method as my research methodology. I conducted these case studies using semi-structured in-depth interviews. The method used in most cases in qualitative organizational research is the case study methodology (BRYMAN 1992). The research of many studies, such as EISENHARDT (1989) and YIN (1994), consider theory building as the most important function of case study methodology. Based on the study of BRYMAN (1992), it can be stated that the clear goal of case studies used in organizational research is to thoroughly explore and understand different contexts. In his research, STAKE (1994) highlights the differences between qualitative and non-qualitative case studies. In the qualitative case study, a thorough understanding of the analyzed case is essential. Along these lines, it can be stated that the researcher does not have an explicit goal of generalization, but even if this becomes necessary, an in-depth analysis of a case and the formulation of generalizations about it should be more reliable than general conclusions based on many cases. The focus of the qualitative case study is on the case under investigation, which according to STAKE (1994) is a system with boundaries. This boundary system can be, for example, an organization, a group, or an individual (STAKE 1994). In case-based research, it is also possible to delineate the study unit by defining the case as a concept (BABBIE 2012). In my research, I do not research the possibility of performance evaluation and its controlling system in a specific project organization. The case appears in my research as a performance evaluation method and control system of every project organization I examine, as well as its structured structure within the organization.

In qualitative research, inclusion in the pattern is not predetermined, and the theoretical aspects typically define only the initial cases, but the next step is to focus on the research objectives and to define the first test results (GELEI 2002). When selecting and defining the pattern, based on KVALE's (1996) study, it can be stated that the researcher is able to rely on his intuitions, implicit knowledge and individual expertise on the basis of interpretive and qualitative criteria. In the qualitative case studies, data collection is carried out in an iterative manner. The circular structure of data collection lasts until the theoretical saturation point is reached (GLASER - STRAUSS 1967), until the point where the researcher's understanding and cognition is no longer greatly influenced by further data and cases.

I conducted my research based on semi-structured in-depth interviews. The semi-structured in-depth interviews made possible the interpretive nature of the research, for which the aim is to lay the groundwork for further exploration and further research. This character helps the researcher to reach his / her

theoretical saturation point, and thus allows the researcher to get a more complete and comprehensive insight into the individual's interpretation of the individual from the interviewee. I have already ruled out the use of a structured interview tool, as it would not have allowed me to have a complex insight into the different interpretations, and I would not have had the opportunity to explore the actual thoughts and processes behind the sentences and thoughts with a pre-formulated set of questions.

During the preliminary preparation of the applied semi-structured interviews, I highlighted the various relevant ideas, but I focused on the possibility of raising in the in-depth interviews areas that I did not think about during my preliminary preparation. For the semi-structured interviews, I used an interview outline with a loose structure in each case. During the interview, my clear aim was for the interviewee to provide a wide range of answers about the field, as this could provide a basis for my own researcher understanding of the organization and controlling system. In my research, after the processing of the relevant literature, I formulated the exploration of the areas that best supported the achievement of my research aim. As a result, the literature review and the empirical research support each other in a complex way to conduct my research and explore my research questions. My main interviewees were senior controllers, project managers and directors.

The semi-structured interviews were planned to cover the following topics: *Presentation of the management organization processes and methods operating in the organization. Description of strategic controlling system. Presentation of applied project management methods and tools. Project monitoring process.* In order to gain a deeper understanding, I formulated additional questions: *What mathematical - statistical, IT methods are used to measure the effectiveness of projects? How do the results of the processes related to the different projects get into the organizational controlling system? How do the effectiveness and performance of the project organization measured?*

In order to gain a deeper understanding, my goal is to explore the organizational processes and the controlling systems of project organizations. Furthermore, I try to find correlations between evaluating the performance of projects and the performance of the project organization. Therefore, it was necessary to explore the organizational structure and the applied corporate governance systems, as well as the applied controlling activities.

3.RESULTS AND DISCUSSION

1. **Case Study:** Mapping the controlling system of a project-oriented travel agency with emphasis on KPI aggregation

The controlling model described in the case study can provide adequate feedback to businesses in the tourism sector that operate in a project-oriented organizational structure. The basis of the controlling system is the KPI indicators, along which all levels of project organization operation can be mapped more efficiently and accurately. The company monitors its projects by defining different KPIs. The analysis is performed by creating three aggregate indicators. These aggregates go beyond project evaluation and focus on project organization activity evaluation. By applying the model, it is possible to monitor the effectiveness more accurately and extensively and to determine the various intervention points. One of the advantages of the model is that it does not only include financial indicators in the analysis. An additional benefit is that it uses evaluation categories and non-exact values for evaluation. This allows to judge the performance of the projects, aggregates, and business across multiple variables. One of the most significant disadvantages of the controlling model is that the evaluation method cannot be applied effectively in the case of extreme values. The other major disadvantage is that it does not have a peak indicator, thus not assessing the company 's real overall performance. The company does not integrate the monitoring of general administration, office management and accounting controlling departments or functions into the controlling system. This, in turn, can in many cases distort perception categories at higher levels. The model can be further developed by broadening the KPIs included in the analysis, by influencing performance indicators in other strategic and functional areas, and by including activities that cannot be integrated into different projects. An evaluation method involving different sustainability indicators may also be appropriate for monitoring the sustainability of tourism organizations. Another development opportunity is to extend the controlling model with predictive methods. Thus, it could be used not only as a feedback but also as a predictor model.

2. **Case Study:** Analysis of the controlling system of an auto parts manufacturing organization and further development of the applied controlling - BSC system

The company examined in the case study interprets projects and organizational effectiveness through the achievement of financial aims, but in recent years, meeting long-term strategic objectives has become significant. As the company's aims are included in the projects, the application and

aggregation of financial indicators is not necessarily sufficient to assess the effectiveness of the projects.

In the controlling system, two major project categories can be distinguished. (Project plan and Project). The two project categories are evaluated separately in the controlling system, or they can be evaluated as an integrated project. The organization's controlling system basically evaluates and monitors both its projects and the entire project organization based on the four BSC perspectives. BSC perspectives have standard weight values in all cases. Due to the uniqueness of the projects, the KPIs are always formulated according to the project specifications. The evaluation of KPIs in the controlling system is also determined on the basis of standard evaluation categories. These evaluation categories are also applied to the Strategic Performance Index. The definition of KPIs belonging to the BSC perspectives is subjective, therefore, due to the uniqueness of the projects, the determination of the weighting values of the KPIs is also determined subjectively. In each case, the values of the BSC perspectives are the weighted average of the respective perspectives, and the aggregate peak indicator for the given project plans or projects is also the weighted average of the given BSC perspectives. KPIs for organizational-level BSC perspectives represent aggregate values for a given BSC perspectives for all project categories.

The advantage of the model is that the performance of both the projects and the project organization can be evaluated along a single structure. The BSC provides an opportunity for grouped evaluation of different functions and standardization of different aggregations and weights. The model is also able to evaluate project milestones with the same structure, thus enabling the evaluation of a dynamic project and overall company performance. The model allows for the integration of the diversity of KPIs used, meaning that each project can be evaluated along different KPIs, but projects and overall company performance are evaluated along the same structure. This creates an accurate model that fits the project organization structure. The main disadvantage of the model is the standard definition of BSC weights, which makes the controlling system over-regulated. Another disadvantage is that the custom-developed software used by the organization can only provide a forecast of the expected performance of the projects. The system is unable to predict expected overall company performance. It is one of the most important features of controlling functions and aims, so it is only partially fulfilled in the model. Furthermore, the model does not fit into the accounting systems, which causes a kind of insularity between the accounting, controlling and financial systems. By implementing the integration, the controlling activity can become more efficient.

3. **Case Study:** Examination of the performance evaluation - controlling system of a company operating in the tertiary sector

The main activity of the examined organization is personal sales, which is implemented in a project-based organizational form. The company uses a project-based organizational structure due to different sales licenses. The controlling system explored during the case study is special, as the main resource of the company is the salesman, therefore the main focus of the performance evaluation is also the analysis of the salesman's efficiency. Aggregate performance from salesman performance evaluation means the effectiveness of projects and the organization. Two different performance evaluation methods work simultaneously in the organizational controlling system. One is based on project-specific sales efficiency indicators, which are monitored primarily by assessing indicators that affect financial and non-financial performance. These metrics are pre-defined by the company and used when evaluating the performance of each salesman. These indicators can be used in most cases, independently of projects. The weighting of the indicators is equal, but the salesman's plan-fact analysis expresses a kind of weighting between the indicators. The different aims are set for each salesman in a unique way, based on the expectations of the salesman and the project. When evaluating these indicators, the company uses two different standardized norms. One such norm is the plan-fact analysis ratio, while the other is the comparison to the aggregate value of the plan-fact analysis ratios within a given project. In many cases, the two norms create different categories of judgment, thereby facilitating the evaluation of salesman's performance and the effective exploration of intervention points. The other performance evaluation system aims to measure the development of sales skills competencies. In the case of this system, however, the company now applies only one standardized norm. In each case, this standardized norm refers to the data of the examined salesman for the past period. Thus, it can be stated that the controlling system of the organization has two separate, island-like performance evaluation systems, which are not aggregated at the higher hierarchical levels. The three standardized norms used provide an opportunity for subjective and realistic performance evaluation.

One of the most significant shortcomings of the controlling system is that it is not predictive. By not using a predictive method, the controlling system is only used to analyze and report on the past. However, it is not suitable for predicting expected performance. The controlling system does not take into account the impact of marketing activities when evaluating salesman, which has a significant impact on the performance of salesman and projects through building brand awareness. Another shortcoming is that the organization does not express its effectiveness in an aggregate peak indicator. The lack of

aggregation of the results of performance measurement systems operated in parallel and island-like means that an aggregate peak indicator will not be generated. It should be emphasized that the subjectivity of the evaluator has a significant influence on the definition of the plan values and the evaluation. The organization clearly defines financial efficiency as a short-term goal or a short-term project success. Evaluating this effectiveness includes a controlling system for the sales efficiency of salesman. On the other hand, in order to achieve long-term financial profitability, the organization considers the long-term development of salesman and the development of soft skills to be the most important. By having the soft skills and competencies of salesman contribute to the success of the project, one of the organization's most important strategic goals is to retain the top 20% of salesman in the long run. For this, the controlling system that monitors soft skills has a decisive role to play. This is the reason why determining the success of a project does not only depend on financial success, and this is the reason why the two different controlling systems are applied side by side in an island-like manner.

4. **Case Study:** Exploration and modeling of the reporting activities of an industrial crane manufacturing organization

The organization in the research is an organization engaged in the manufacture and servicing of industrial cranes. The controlling system of anorganization is a system based on plan-fact analysis, which can be divided into two main pillars. One system focuses specifically on monitoring ongoing projects. In this case, the data is structured based on a report table that summarizes the KPIs. The indicators in the report table are valid for all projects, so they serve as a standard for evaluating projects. The units of value of the data collected are always expressed in currency. The other system is the accounting report and the reports based on the accounting report. Organizational performance is judged primarily on the basis of these reports. The limit values formulated during the evaluation and the calculation method are also standard. The company classifies the fulfillment of the indicators in the report tables into four evaluation categories. In addition to these four categories, it defines an additional evaluation category that provides feedback on project plan. The controlling system of the organization is predictive, therefore the values of the expected performance can be compared to the predefined plan values.

The main advantage of the applied controlling system is the effective monitoring of financial performance. The disadvantages are the low level of exploration of the correlations between the report tables and the accounting report and the consequent lack of a dynamic evaluation system. The lack of aim-orientation of the different functional areas and the exploration of more precise and deeper intervention points can be noted as shortcomings. To

explore these deeper levels of intervention, the process monitoring system should also be integrated into the controlling system and operated as a single system. The accounting report based on the financial reports do not always reflect the strategic objectives and can therefore only be used to evaluate the financial results of the financial year. The organization clearly defines financial success as a project success, and this is also reflected in the applied controlling system. However, the strategic aims of a business do not necessarily match this definition of project success. In the strategic aim, building a lean organization and increasing efficiency is the most important aim and not financial efficiency.

5. **Case Study:** Examination of the BSC system of a construction company operating in the form of a project organization

The organizational controlling system is based on project-specific KPIs. Performance evaluation, both at the organizational level and at the project level, takes place along BSC's perspectives. Indicators are aggregated along the four perspectives of the BSC. In each case, the formulated plan values associated with the indicators are project-specific, and the controllers and managers are responsible for formulating them. The organization's controlling system uses an extrapolation method to estimate the expected results, which function as fact data. Three different categories were formulated during the evaluation of the results. The basis for categorization is determined by the results of the plan-fact analysis. For the four perspectives of a company-wide BSC, the standardized norm is the aggregate values of plan-fact analysis ratios for project KPIs. The four perspectives of the BSC at the company-wide level can be compared to the values of the plan-fact analysis ratio for recent years or, where applicable, for a given period. In the controlling system of the company, it basically uses the average result of the last three years for a given point of view as a benchmark. The company's controlling system enables the evaluation of individual projects based on KPIs, and also provides an opportunity for performance evaluation at the organizational level. By using plan-fact analysis ratios, the data is standardized in the model, and comparisons can be made by defining the weights for the project and the organizational-level BSC. The main shortcoming of the applied controlling system is the operation of separate, island-like databases. A further shortcoming is that the performance evaluation of the project manager and the various subcontractors is not evaluated independently during the performance evaluation, but is only indirectly reported during the performance evaluation of the entire company.

6. **Case Study:** Mapping a controlling model for evaluating the performance of R&D activity

The organization in the case study is an agricultural research and development company. The company operates in the form of a project organization and defines all research and development activities as projects. It divides projects into two main categories, tender and research and development. In the event that the application project is successfully completed, it will be transferred to the research and development project category. The explored controlling system operates and evaluates performance along two different aspects and levels. One level is the project level and the other is the organizational level. At both levels, the organization uses KPIs and extrapolated plan-fact analysis ratios. In addition, it evaluates the results of the indicators in three different categories in each case. For projects, KPIs are designed according to the categories of the project triangle. Financial indicators are aggregated for each project, regardless of project category, at the organizational level. It also shows that although the strategic approach is especially important in the controlling system, short-term financial decisions are given more emphasis. Project success is thus defined by the organization on the basis of the project triangle, but organizational success is determined by financial results and strategy. Extrapolated ratios allow predictive evaluation and possible correction. The advantage is the standardization of KPIs at the organizational level, which makes the results of the given year comparable with the results of the previous period. One of the main disadvantages of the controlling system is the separation of projects and organizational operation and the lack of exploration of correlations. Because the company does not use a peak indicator, it is a complex task to draw clear conclusions based on the understanding of organizational-level analyzes. In the case of the project triangle, the weights of the aggregates are not specified, and the subjectivity is high in determining the weights of the project KPIs.

Conceptual controlling model evaluating project organization performance

Along the analysis of the structural correlation of the methodological elements revealed in the qualitative case studies and the applied models, I developed a conceptual model that can function as a controlling model of general application that can be effectively applied to organizations operating in the form of project organization. The model corresponds to the five basic controlling goals (ZÉMAN - TÓTH 2017). Consequently, the model focuses on the synergistic analysis and evaluation of different organization functions along the basic perspectives of controlling. The fuzzy logic that forms the theoretical and logical basis of the model makes it possible to manage the high

subjectivity resulting from the evaluation, which results from the unclear definition of organization success and project success, and from the unclear evaluation of the achieved results.

1. table: Development of the logical structure of the controlling model

1. step	Selection of KPIs measured by the organizational controlling system, which are KPIs that measure project and strategic effectiveness.
2. step	Definition of organization specific aggregates (projects, project portfolio, BSC aggregates) at different levels. Development of a logical structure based on Figure 1.
3. step	Determining the weights of KPIs and aggregates based on subjective expert opinion.
4. step	Evaluation of the results of KPIs and aggregates along the synergistic application of different standardized norms.
5. step	Developing a strategic performance index.

Source: Own editing

Detailed description of the model steps:

1. step: Among the KPIs measured by the organizational controlling system, KPIs expressing strategic and project effectiveness should be formulated and defined. These KPIs must fit or be classified into one of the four perspectives of the BSC. The basic condition of the model is that at least one KPI must be associated with the four perspectives of the BSC. The model is based on project-related KPIs, but additional KPIs can be formulated at different hierarchical levels, so in addition to project KPIs, project portfolio and organizational KPIs can also be defined in the model.

2. step: As a second step in the model, the goal is to create different aggregates and a hierarchical logical structure. Figure 1 shows the different aggregates, based in each case on project-related KPIs. The four perspectives of BSC used for aggregation are not hierarchically structured (Hierarchy is expressed only through weights). KPIs are aggregated by weighted averaging. Evaluation of KPIs at different hierarchical levels is possible along the synergistic application of different standardized norms. The classification of the peak indicator, the strategic performance index, follows the same evaluation logic.

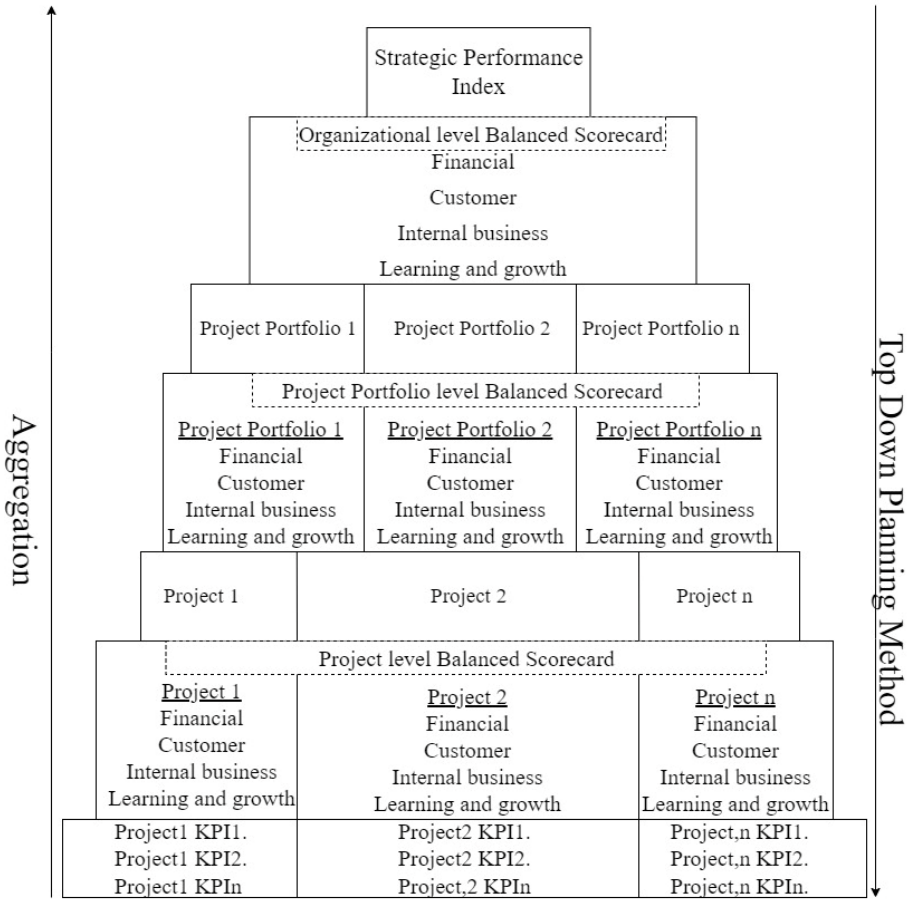

Figure 1: Hierarchical logic structure of the controlling model
Source: Own editing

Step 3: One of the most emphasized elements of the model is determining the weight values. It is not possible to define constant weight values due to the differences in project organization strategies and the uniqueness of projects. Weight values are not defined at all hierarchical levels in the model. Weight values are formulated for KPIs, project portfolios (projects) and organization-level BSC perspectives. No weighting values are directly defined for project and project portfolio level BSC perspectives. However, the weight values of the KPIs associated with the perspectives express and indicate the relative priority of the project and project portfolio-level aggregated BSC perspectives. In the case of organizational-level BSCs, similar to project and project portfolio-level BSC perspectives, the relative values are indicated by the weightings of the KPIs and the weighting values of the project portfolios. In addition, direct weights are assigned to these aggregates to increase the accuracy of the strategic performance index. These direct weights are

corrections that prioritize results that already contain weights relative to each other. This correction does not change the results of the perspectives, it corrects the result of the organizational strategic index. The adjustment is justified on the one hand by a more precise comparison with the organizational strategy goal, and on the other hand by the difference between organizational and project success that can be managed at the model level.

4. step: The results of the KPIs and the aggregates that can be developed alone do not have sufficient information content, so it is necessary to define standardized norms. The plan-fact analysis ratios that form the basis of the controlling model already provide an opportunity to evaluate the results of the indicators in a way. In the analysis, the plan values for KPIs are the standardized norm, so the fact values are evaluated against the associated predefined objectives. In this case, the evaluation of the results from the plan-fact analysis includes, in addition to the comparison with the plan value, at the given hierarchical levels, the priority of the project or organizational success related to the given indicators, expressed in weight values.

In the case of the standardized norm of the plan value (1 SN), the fact value and the extrapolated fact value of the indicators are analyzed using the following function.

$$Þ_i = \frac{\sum z \times \xi_i}{n}$$

where, z: $\frac{\text{KPI Predictive fact}_{ji}}{KPI\ \text{Terv}_j}$ / aggregate eigenvalue, i: serial number of the item included in the examination, n: KPI / Aggregate indicator item number (pcs), ξi: weight value

The results of the factual analysis (1SN) can be evaluated along the following five classes.

$$T_j \begin{cases} \text{Very underperforming} & \text{if } \sigma_j < 0{,}90 \\ \text{Inappropriate} & \text{if } \sigma_j \in [0{,}90;\ 0{,}95) \\ \text{Appropriate} & \text{if } \sigma_j \in (0{,}95;\ 1{,}0) \\ \text{Good} & \text{if } \sigma_j \in (1{,}0;\ 1{,}05] \\ \text{Distingushed} & \text{if } \sigma_j > 1{,}05 \end{cases}$$

The process of classification is thus based on conceptual definitions (linguistics terms). When applying conceptual definitions of classes, it is not

the value taken on a given scale that is affected, but the limits of the intervals and the standardized norm. The limits of the intervals of the membership function were determined on the basis of qualitative case studies. The fuzzy numbers generated by the membership function must be defuzzified for further analysis. A fuzzy number is a number that already contains a given value judgment, so it represents an interval. During defuzzification, an exact value specific to that fuzzy number is created from the fuzzy numbers. For standardized norms, it is possible to determine defuzzified values using the following defuzzification function. By defuzzification, therefore, recalculation and analysis with fuzzy numbers becomes possible. With the help of defuzzified values, it is possible to create further aggregation and integrated standardized norms.

$$\omega_i = \begin{cases} 1 \text{ ha } \alpha_i = \text{insufficient} \\ 2 \text{ ha } \alpha_i = \text{sufficient} \\ 3 \text{ ha } \alpha_i = \text{medium} \\ 4 \text{ ha } \alpha_i = \text{good} \\ 5 \text{ ha } \alpha_i = \text{excellent} \end{cases}$$

For the next standardized norm, defuzzified (1SN) values associated with KPIs and aggregates are analyzed. In the case of the 2SN analysis, the comparison with the past result is the basis for classification.

For a comparison to past classes (2SN), use the following function to create the value to be classified that appears on the rating scale.

$$\gamma = \frac{\omega_i^t - \omega_i^{t-1}}{\omega_i^t}$$

where, ω_i^t= defuzzified value of KPI/aggregate, ω_i^{t-1} = defuzzified value of previous period KPI/aggregate

The values (γ) taken on the evaluation scale can be classified into different classes based on the membership function below.

$$\mu_{\text{very deteriorating}}(\omega_i, -2, -\frac{4}{5}, -\frac{1}{2}) = \max\left(\min\left(\frac{-\frac{1}{2} - \omega_i}{-\frac{1}{2} - -\frac{4}{5}}\right), 0\right)$$

$$\mu_{\text{deteriorating}}(\omega_i, -\frac{4}{5}, -\frac{1}{2}, 0) = \max\left(\min\left(\frac{\omega_i - -\frac{4}{5}}{-\frac{1}{2} - -\frac{4}{5}}, \frac{0 - \omega_i}{0 - -\frac{1}{2}}\right), 0\right)$$

$$\mu_{\text{stagnant}}(\omega_i,-\frac{1}{2},0,1\frac{1}{2})=\max\left(\min\left(\frac{\omega_i--\frac{1}{2}}{0--\frac{1}{2}},\frac{1\frac{1}{2}-\omega_i}{1\frac{1}{2}-0}\right),0\right)$$

$$\mu_{\text{developing}}(\omega_i,0,1\frac{1}{2},4)=\max\left(\min\left(\frac{\omega_i-0}{1\frac{1}{2}-0},\frac{4-\omega_i}{4-1\frac{1}{2}}\right),0\right)$$

$$\mu_{\text{very developing}}(\omega_i,1\frac{1}{2},4,6)=\max\left(\min\left(\frac{\omega_i-1\frac{1}{2}}{4-1\frac{1}{2}}\right),0\right)$$

In this case, the defuzzification function is based on the pairing already described above, so that the result of the evaluation can be carried forward.

In the case of the last standardized norm, the classification categories derived from the plan-fact analysis (1SN), which have already been compared and corrected to the classification values of the past (2SN), will be evaluated. Thus, the evaluation will be classifications based on the plan-fact analysis and on the basis of past values in relation to the average of the given group. This also makes it possible to evaluate classifications derived from past values relative to each other, depending on the average value of the given group (2SN). As a result, past classifications (2SNs) are corrected and reclassified. In this case, the values recorded on the rating scale are judged on the basis of five different categories (Figure 2).

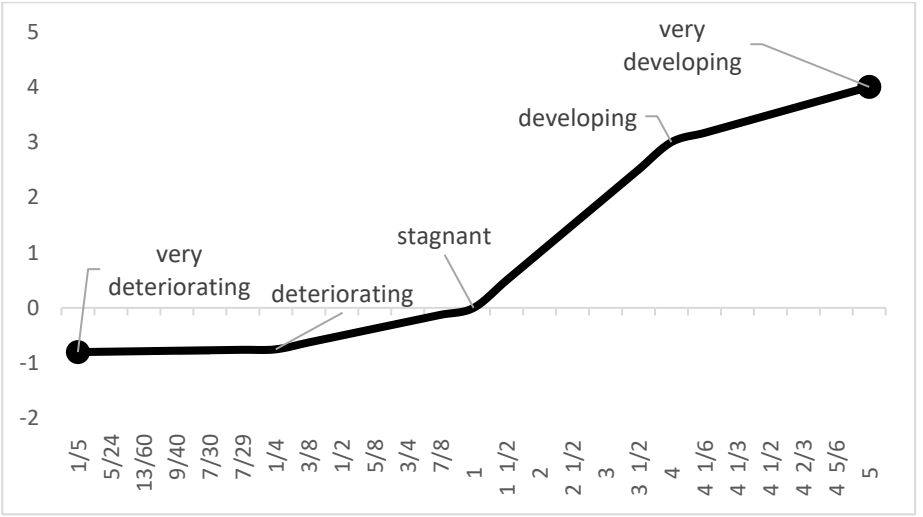

Figure 2: Membership function (3SN)
Source: Own editing

5. step: The Strategic Performance Index is a complex indicator that uniformly includes performance measurement standards derived from the difference between project success and organizational success. The strategic performance index makes it possible to evaluate project organizations at the organizational and strategic level in addition to various standardized norms. Because it expresses performance in a metric, it has an efficient and fast information content for management in strategic decision-making.

4. CONCLUSIONS AND SUGGESTIONS

1. Evaluating project success and organizational success from a controlling perspective.

The results of several studies highlight that the definition of project success is not clear. Due to the multiplicity and subjectivity of project success, project success and organizational success can be completely different. The possible existence of this difference means that project success does not or only partially contribute to organizational-strategic success. Regardless, however, the projects can be said to be successful due to the unique success criteria. This kind of differentiation, which stems from the difference in defining success, is also reflected in the case studies I have explored. The conclusion of my qualitative research is that in the short term, in most cases financial criteria are formulated for project success, while at the organizational level, strategic goals are formulated as success.

In my research, I highlighted that controlling as a functional area appears as a separate function in the case of project organizations. It does not appear as a separate function in project. As a result, it can be stated that many of the controller's tasks are performed jointly by the project manager and the company-level controllers. The aim of my research is not to assess the success factors in project organizations and to solve the resulting problems. Controlling does not even have the task of standardizing and generalizing success goals. This would be the responsibility of the managers and the project managers. The controlling system, on the other hand, must be able to adapt to the differences in success at different levels, otherwise the information content provided by the controlling system will be distorted and it will not be able to support management decision-making effectively. Thus, it can be stated that the essential criterion for controlling is not whether the project and the organizational goals are in line with each other in the organization or not.The main criterion is that any of the former is implemented in the project organizations, controlling must be able to handle it. Evaluated the performance of project organizations requires the creation of a system that is able to integrate the differences between this project and organizational goals.

2. Methods and tools of controlling used in business practice by project organizations.

In my research, after a comprehensive analysis of six different qualitative case studies, I came to the conclusion that the controlling methods used to evaluate the performance of project organizations, in addition to project controlling methods, can also be used as controlling methods for operational and strategic controlling tools. Based on this finding, it can be stated that no clear and

general methodological recommendation can be made for the performance evaluation of project organizations. The mixed use of different methods and the logical structuring and modeling of the methods are necessary for effective project organization performance evaluation.

The most frequently used method in the controlling system of the organizations I examined was the KPI management methodology. This methodology played an emphasized role in all case studies and formed the basis of different controlling systems. KPI management was applied in all cases based on the scope of activities and the organization-specific nature. The KPI management methodology also provided an opportunity for the organizations to evaluate island-like processes and projects, and to evaluate performance at the project level and at the organizational level in one of those systems. Due to the subjectivity and organization-specific nature of the definition of KPIs, the controlling system of a given organization can adapt different performance measurement methods to its own individual operation. In addition, objective evaluations of the various areas and processes to be assessed will be made available by KPIs.

Like KPI management, plan-fact analysis is a common method. KPI management and plan-fact analysis were appeared for each of the project organizations examined in an integrated manner. In addition to the factual values related to the different indicators, a plan-target value must be defined in each case. This creates a plan-fact analysis ratio that helps standardize various indicators and projects. This standardization provides an opportunity to compare and evaluate indicators with different units of measure and different success factors. In the case of plan values, the method of extrapolation has appeared in many cases. This method also makes it possible to evaluate the expected performance, one of the most important controlling goals. Expected performance can be expressed not only at the project but also at the organizational level using extrapolation methods. The weighting method is the other basic key method that allows the evaluation of the priorities and, consequently, the aims derived from the evaluation of the various indicators, projects and organizational functions. Indicator systems with plan-fact analysis ratios can form the basis of a project organization performance evaluation system, as the weighted, aggregated, and logical structure of these indicators effectively provides an opportunity to address subjectivity and integrate project success and organizational success.

The Balanced Scorecard method also played an emphasized role in terms of strategic controlling in the case of the examined project organizations. It can be seen that the different areas of application are different and it can be stated that the BSC methodology can be effectively applied by the organizations

tailored to its own unique operational nature. The BSC, as a system of perspectives and a method of professional aggregation, in many cases appears not only at the strategic level, but also at the project level and at the operational level. Consequently, it can be concluded that it can form a kind of general bridge between the project level and the organizational level. The prioritization of the four different perspectives related to the BSC method is not the same in all cases as in the examined project organizations and in the literature. Thus, the hierarchical BSC method can only be used as an optional method in project organization performance evaluation. By weighting the BSC perspectives, however, the hierarchy can be generalized, and in addition to the hierarchy of perspectives formulated in the literature, other hierarchical perspectives can be created that must match the success of the project or organization.

The method used to evaluate the results of the different indicators was, in most cases, along several different classification categories. The threshold values associated with the classes ranged on a different scale in each case study. From this it can be concluded that the thresholds and the degree of subjectivity of the classification are high. The judgment of the various indicators is organization, project, KPI specific and is also influenced by the perceptions and professional opinions of the judge. Consequently, these judgments can be considered as subjective expert opinions.

My results highlight that the performance evaluation of the core business, the project and the organizational level should not be treated separately by the controllers, but should be examined and reported in an integrated, complex system. Such a system provides an opportunity for more efficient and accurate decision-making, exploring different causal factors as well as intervention points and sensitive areas.

3. Developed conceptual model

In order to develope a general controlling model for project organization operation, it is necessary to define and map project organization operation. The mapping should identify the nature of the projects and the groups and methods that can be used for different aggregations. The difference between the projects and the organizational success that determine how the model works can have a high impact. This difference can be integrated by assigning different weight values to the indicators. This, in turn, requires an evaluation of the various project and organizational success factors. A questionnaire method may be an appropriate method for this. However, the determination of the weight values for the different indicators in the questionnaire involves a high degree of subjectivity. This is due to the fact that managers and project

managers and operational managers may not be able to clearly determine the weights and different managers may have different weights. To address this subjectivity, a questionnaire with fuzzy weights is recommended. This questionnaire provides an opportunity to adjust weight values to human thinking. In addition to the subjectivity of the weight values, the developed model can also handle the subjectivity arising from the measurement of processes, the relative nature of projects and organizational perspectives, and evaluation thresholds. An excellent way to do this is to use fuzzy logic. It follows from the fuzzy logic that the developed model works not with exact values but with fuzzy numbers. The different classification categories are present at all levels of the logical structure. Because of the ambiguity that comes from evaluation, however, a number of evaluation contexts can be incorporated into the model. In the model I developed, I integrated three different contexts into an evaluation system. It follows that the accuracy of the model has increased, and different results from different contexts do not distort but clarify information, managerial decision-making. In the literature, external standardized norms are used in many cases in performance evaluation based on fuzzy logic. However, only internal standardized norms can be used in the developed controlling system, due to comparability. The standardized norms used are based on plan-fact analysis, past performance, and a group average of past performance.

The developed model, using the BSC as a kind of general grouping method, makes performance evaluation comparable at all hierarchical levels, project and organizational levels. Project portfolios and organizational-level BSC aggregates, as well as their respective weights, make it possible to integrate organizational and strategic success and expectations into the model, in addition to different project successes and expectations.

The model developed along a hierarchical logical structure is able to evaluate project organization performance regardless of the number of horizontal and vertical levels created, the number of predefined KPIs, projects, and project portfolios. The model makes it possible to evaluate and manage an infinite hierarchical level and aggregate. The peak indicator of the hierarchical structure is a strategic performance index in each case. This index is able to illustrate how an organization has met or is expected to meet its strategic objectives during the period under review. On the other hand, the model not only provides information and feedback on this one cumulative indicator, but also monitors and provides feedback on performance in detail at all hierarchical levels as well as at a given horizontal level. It evaluates the performance analyzed at different levels against the objectives based on different standardized norms. From the extreme values of the model, it can be concluded that a change or revision of the objectives is necessary for the given

indicator or area, which may also mean an overestimation of the mechanism used to determine the applied plan-aim values. Consequently, the aim can be formulated as the most significant bottleneck in the model.

4. Suggestions for further development of the conceptual model

Due to the conceptual model developed during my research, it is not possible to use the results of the examined organization external, for example direct competitors, industry players or other companies, as standardized norms or benchmarks. The model would require a common set of indicators based on standard and not necessarily KPI indicators that are universally accepted and applicable by all organizations involved in the analysis.

Prediction by linear extrapolation can be used in the conceptual model, but to increase the efficiency and accuracy of the prediction, the model could be extended with prediction methods based on ARDL or neural network or genetic algorithms, thus further strengthening one of the basic aims of controlling, future orientation.

The subjectivity created by the applied fuzzy logic and the calculation with non-exact values are a major drawback of the model. This disadvantage can have a significant impact on the final results and thus on the accuracy of decision-making. As a result, the model is not suitable for accurate integration of project organizational success and accurate evaluation of performance. The model can only formulate an estimate using approximate, vague values. An appropriate method to reduce blur may be to use the Takagi-Sugeno-Kang membership function. The defuzzified value of the membership function strives for accuracy while reducing vague, while reducing the fuzzy nature of the model and its identity to human thought patterns. The model can also be extended with a neural network, which, when used in conjunction with a Mamdan membership function, would create a neurofuzzy hybrid evaluation model that can increase accuracy so that the model continues to conform to human thought patterns. Such a system based on artificial intelligence could make it possible to clarify standardized norms and possibly integrate standardized norms in a logically complex or unrelated way. The model may also be suitable for the subjectivity of the determination of weight values in the model. However, one of the main criteria for the neurofuzzy hybrid model is the exceptionally high amount of input data, which is rarely available in business practice.

The standardized norms used in the model can be developed and extended with other norms. Among the standard norms, the group average performance of the examined period should be highlighted. This norm is not logically related to the norms I apply, so direct integration is not possible. But this norm

can be similarly equivalent to the other norms used and still provide different results. The incorporation of this norm or other logically non-integrable norms can be realized if the results of the integrated and individual non-integrated norms are defuzzified with the help of a special, fitting function. The result obtained after aggregation of the defuzzified values is reclassified according to a general standard norm. With this method, an unlimited standardized norm could be integrated into the model and evaluation.

In cases where the relative values of different standardized norms cannot be determined precisely, the fuzzy AHP method may be a solution. The method uses a matching process from different norms to determine different rankings and values. Pairing allows for the relative proportions and subjective classification of each norm. One of the disadvantages of fuzzy AHP is that it works well in only a few areas to be evaluated due to its high combinatorial potential. Fuzzy AHP can also be an excellent way to determine BSC weights in the model, as in this case the four different perspectives are paired and evaluated. This may result in a more accurate result than the result of the fuzzy questionnaire.

The conceptual performance evaluation model developed in my research can be applied in many other areas as well. These areas must meet the following key eligibility criteria:

- The area to be evaluated has a high degree of subjectivity. The evaluation and classification categories are not clear and can be considered as subjective expert opinion.

- Causal relationships are clear, meaning that a logical structure can be developed.

- The evaluation of the resulting results is highly dependent on the evaluation context and the relative proportions of the contexts are almost equivalent. Objective valuation values and standards cannot be interpreted or will not be established within the expected time.

- Different expectations and aims can be formulated at different hierarchical levels. So the aims are different at different levels.

- The priority relationship between the indicators and the levels set shows a high degree of subjectivity and the definition of weightings is not clear. Weight values can also be considered as subjective opinions.

- The end result should be aligned with human thought processes, thereby facilitating decision making.

Based on the applicability criteria, it can be concluded that the model can be properly applied to measure money market liquidity and to evaluate stock market indices and other complex investment portfolios. The evaluation of the success of the various funding and application systems can be described as a similar area. This method can also be effective for sustainability evaluation, but only in cases where the ultimate aims are unclear. The model can be used to evaluate the performance of different marketing methods and campaigns. In addition to the areas listed, the model can be successfully implemented in a number of societal and scientific fields, as well as in all areas where projects place a strong emphasis on processes and operations.

5. NEW SCIENTIFIC RESULTS

1. **Due to the subjectivity of project success, project success and organizational success are not necessarily the same. The controlling system must take this difference into account and integrate it.**

In my research, I highlighted the subjectivity of project success already formulated in the literature. Based on my research results, it can be stated that due to the subjectivity of project success, project success and organizational success are not necessarily the same. Consequently, the controlling system must take this difference into account and integrate it. Based on the literature and case studies, it can be stated that the task of controlling in the case of project organizations cannot include prioritizing aims. The controlling system must handle the differentiation resulting from prioritization by implementing the relevant methodological elements.

2. **I developed a controlling model suitable for evaluating the performance of project organizations. The model handle the difference between project success and organizational success by aggregating indicators and determining weights. Fuzzy logic is the basis of the model evaluation method. Due to the nearly equal prioritization of different standardized norms, fuzzy logic allows for the integrated application of multiple standardized norms.**

The model I have developed is made up of different controlling and mathematical-statistical methods, which together create the possibility of extensive performance evaluation of project organizations. The model addresses the difference between project success and organizational success by aggregating indicators and determining the weights of the indicators. Project and organizational level performance evaluation are evaluated together using the weighted average as an aggregation method. Defining the weights of the indicators based on fuzzy logic makes it possible to implement the subjectivity derived from the judgment of the weights in the model. Furthermore, fuzzy logic forms the basis of the evaluation method of the constructed model. Due to the nearly equal prioritization of different standardized norms, the application of fuzzy logic allows for the simultaneous application of multiple standardized norms. The model effectively addresses the lack of accurate judgment resulting from different standardized norms, possibly from different evaluations. The model addresses this problem through the integrated application of different standardized norms.

3. **The results generated by the model fit effectively into patterns of human thinking by evaluating with linguistic terms rather than exact values.**

The most important task of the controlling function is to support managerial decision-making, therefore the information content revealed must fit the thinking of the decision-maker. The results generated by the model fit effectively into patterns of human thinking by evaluating with linguistic terms that are not exact values but fuzzy numbers. This creates an exploration of the information content from the point of view, along which a high level of interpretability of the information can lead to effective managerial decision-making. In my model, in addition to fitting human thinking, the evaluation of information is also adapted to the operation of the project organization. In the case of project organizations, evaluation at different levels is of paramount importance, as in many cases responsibilities and decision-making are shared. This requires a multi - level evaluation and reporting system that provides information that matches the thinking of the people.

4. **The applicability of the model in other areas is the fulfillment of the applicability criteria, among which the high subjectivity of the studied area and the difference of goals should be emphasized.**

The developed model can be implemented in many different areas. The basis of the implementation is the fulfillment of the application criteria of the model, among which the high subjectivity of the examined area and the difference of aims should be emphasized. The model can be extended to global and local analysis and evaluation of sustainability. It can also be used in a number of financial areas, notably the analysis and evaluation of the liquidity of investment portfolios and financial markets. It can be used to evaluate the efficiency of the use of various grants, including European Union funding sources. It is also in a number of social and natural sciences with a high degree of subjectivity.

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