AN INTEGRATED MODEL FOR DESIGNING AND DEVELOPING A KEY PERFORMANCE INDICATORS SYSTEM

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Abstract: Performance management is based on adequate strategic goal-setting, monitoring its accomplishment and achieved results, and dealing promptly with any problems which may arise during the implementation of a plan. Key performance indicators systems (KPIS) are a powerful tool for organizational change. Reliable and efficient KPIS may be designed by employing an integrated model which combines the design of key performance indicators with the flexible development of business intelligence (BI) systems.

Key words: key performance indicators; business intelligence systems; business performance management

JEL: M15.

Introduction

Key Performance Indicators Systems (KPIS) are a powerful tool for organizational changes. Managers frequently employ performance indicators to establish strategic goals and to communicate them to the different teams and roles within the organization. Employees use

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performance indicators to focus their effort on major isues and to accomplish the goals which have been defined in their personal performance plans.

Organisations may choose different models when designing and deploying a performance management system. Those models aim at facilitating the establishment of metrics and key performance indicators that match the goals of their organisation and assess its performance reliably. Performance measurement models determine the major perspectives (or dimensions) in which multiple metrics and key indicators about the performance of an organisation should be structured.

The object of this research paper are the systems for managing the business performance of organizations. The subject of the research are the methodologies for designing and developing a system of key business performance indicators. We analyse two models of establishing the key indicators for measuring business performance.

The underlying thesis of the research is that it is possible to design more efficient and reliable key performance indicators systems by employing an integrated model which combines existing methodologies of Key Performance Indicators Systems (KPIS) development with the flexible design of business intelligence systems. A new model for establishing key performance indicators will not reject existing conventional methods. Instead, it will upgrade them by preserving their major characteristics and adding the advantages of the new generation of sofwtare tools employed by business intelligence (BI) systems.

By employing the presented model, organizations will be able to establish Key Performance Indicators Systems (KPIS) which both meet existing requirements and best practices and which managers can efficiently employ through the tools of BI systems.

Business Intelligence Systems and Corporate Performance Management Systems

Corporate Performance Management (CPM) systems are software systems designed to assist managers in the implementation of performance management activities. Gartner (Gartner, 2018) defines CPM systems as an umbrella term 'which describes the methodologies, metrics, processes and systems used to monitor and manage the business performance of an

enterprise'. He defines Business Intelligence (BI) as 'a technology for collecting and analysing the information referring to a particular organisation to improve business decision making'. The two terms are frequently used as synonyms due to their similar definitions. There is a substantial difference between them, however, and their focus is different, too.

Business Intelligence Systems and Performance Management Systems are complementary and mutually related, yet BI systems have greater functionalities. They provide adequate tools for improving the decision-making process within an organisation, yet, with no reference to the strategy of the organisation. The focus of CPM systems is on relating the strategy of an organisation to the measurement, process-design and the implementation of Business Intelligence. Corporate Performance Management relates to corporate strategies through the critical success factors and key performance indicators. Business Intelligence provides the technological basis for developing a Corporate Performance Management system. This paper analyses the development of a Key Performance Indicators System through Business Intelligence tools in close relation to the other components of Corporate Performance Management.

Methodologies for Developing Key Performance Indicators Systems (KPIS)

We will review two types of methodologies that are employed when building a Key Performance Indicators (KPIs) System.

The first type of methodologies describe the sequence of actions which executives at different management levels need to implement in the process of building a KPIs system. Those methodologies relate to a specific model for designing key indicators. The methodology based on the Winning KPIs model (Parmenter, 2015), offers a detailed description of the stages and actions which the managers of an organisation need to implement in order to build a Key Performance Indicators System (KPIS). The software implementation of the system is not excluded as an option, yet it is approached as a by-process performed by other people (programmers, operators) that does not significantly affect the problems which managers need to solve. Parmenter (2010, 2015) proposes a methodology for building a Key Performance Indicators System which is based on a Balanced

Scorecard. The most frequently used model to measure performance is the Balanced Scorecard Model (Kaplan & Norton, 1992). The model includes financial as well as non-financial indicators which are structured around four perspectives – finance, customers, internal business processes and learning and growth.
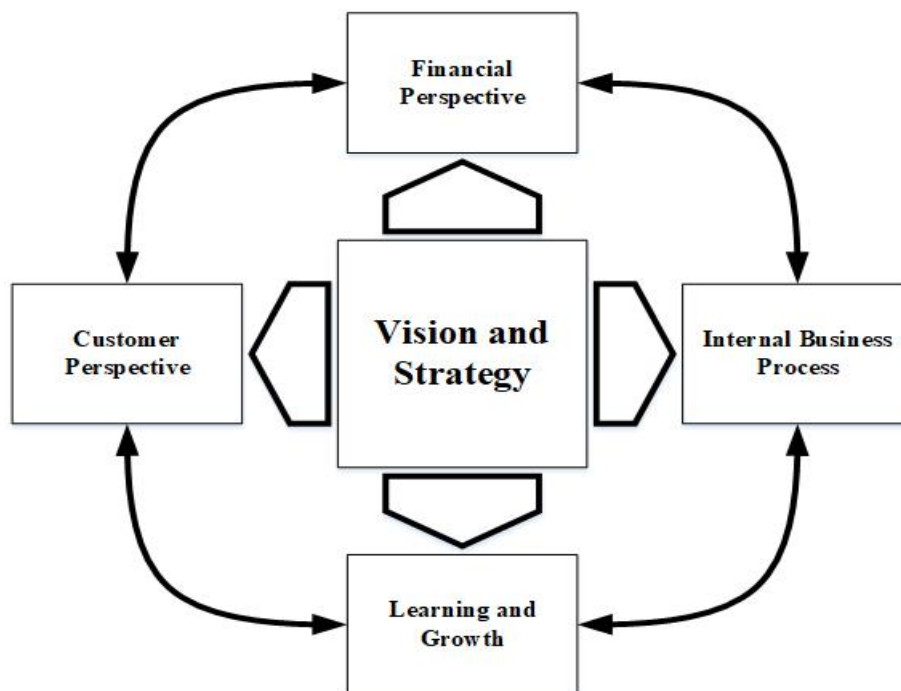

Fig. 1. The four perspectives of the Balance Score Card Model. Adapted after Kaplan and Norton (Kaplan & Norton, 1992)

With the Winning KPIs, model the Key Performance Indicators System is defined on the basis of the four perspectives of the Balanced Scorecard, by adding two additional perspectives: the perspective of staff satisfaction and that of environment and community.

Parmenter proposes two varieties of the methodology. One of them aims at developing a Key Performance Indicators System (KPIS) within large

organizations. With that option, the process of developing a KPIs system consists of twelve steps and its implementation requires from 20 to 30 weeks. The focus of the second variety of the methodology (Parmenter, 2015) is on small and medium-sized organisations. The development of a KPIs System consists of 6 stages that should be implemented within 6 to 8 weeks. The table below illustrates the similarities between the two varieties of the methodology.

Table 1
The Winning KPIs Model

A six-stage methodology for developing KPIs in small organizations (Parmenter, 2010)	A twelve-step methodology for developing KPIs in large organizations (Parmenter, 2015)
S1. Getting the CEO and senior management committed to the Change	Step 1. Senior management team commitment Step 4. Setting up a holistic KPI development strategy
S2. Up-skill in-house resources to manage the KPI project	Step 2. Establishing a "winning KPI" project team Step 3. Establishing a "just do it" culture and process
S3.Leading and selling the change	Step 5. Marketing KPI system to all employees.
S4. Finding your organization's operational critical success factors	Step 6. Identifying operational critical success factors
S5. Determining the measures that will work in your Organization	Step 7. Recording of performance measures in a database Step 8. Selecting team performance measures Step 9. Selecting organizational winning KPIs
S6. Get the measures to drive performance	Step 10. Developing the reporting frameworks at all levels Step 11. Facilitating the use of "winning KPIs" Step 12. Refining KPIs to maintain their relevance

Source: (Parmenter, 2015)

The second type of methodologies approach the development of KPIS as an instance of designing a software system. When developing a KPIS through BI tools, the focus of attention is on the methodologies for designing BI systems. The most detailed and elaborately designed methodology is the Roadmap for designing Business Intelligene systems, developed by Moss and Atre (Moss & Atre, 2003). Their methodology of constructing a Business Intelligence system comprises 16 steps which the authors group in six major stages.

Table 2
Stages and steps of the construction methodology for developing Business Intelligence Applications

Stages	Steps
Stage 1: Justification	Step 1: Business case assessment
Stage 2: Planning	Step 2: Enterpise infrastructure evaluation Step 3. Project Planning
Stage 3: Business Analysis	Step 4: Project requirements definition Step 5: Data analysis Step 6: Application prototyping Step 7: Metadata analysis
Stage 4: Design	Step 8: Metadata repository design Step 9: Database design Step 10: Extract, transform, load design (ETL)
Stage 5: Construction *Includes testing*	Step 11: ETL development Step 12: Application development Step 13: Data mining Step 14: Metadata repository development
Stage 6: Deployment	Step 15: Implementation Step 16: Release evaluation

Source: (Moss & Atre, 2003)

The Business Intelligence Systems roadmap makes it possible to simultaneously implement some of the steps. The sequence of implementation of the different stages, the correlation between them and the steps to be implemented at each stage are illustrated in figure 2 below.
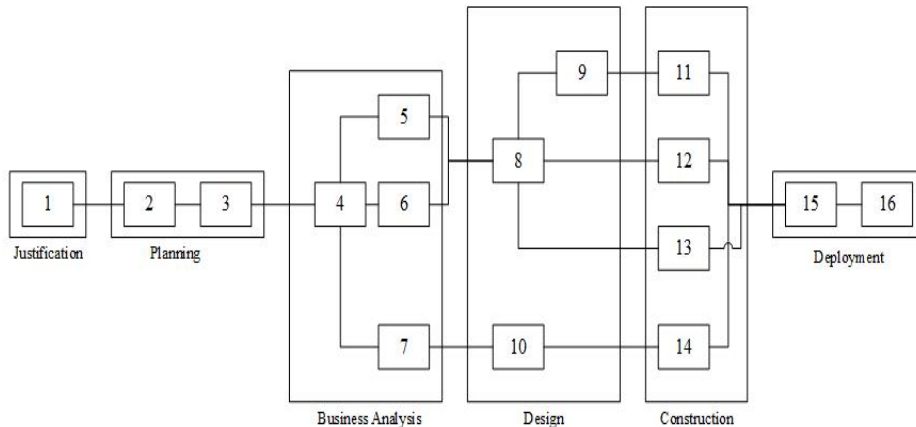
Fig. 2. Roadmap for developing Business Intelligence systems. Adapted after Moss and Atre (Moss & Atre, 2003)

Benefits and Shortcomings of Reviewed Methodologies

The methodology for constructing BI applications focuses on the implementation of software, data extraction and structuring, the planning and the execution of the project, in compliance with the goals of the organization and available resources. It offers steps which ensure the successful implementation of the BI system in line with organizational objectives. Designing or constructing a system of key performance indicators is not an element of the methodology. When BI applications are developed, there is no mechanism to guarantee that established key performance indicators will match the strategy of the organization or will facilitate the decision-making process at a managerial or tactical level. Similarly, there is no process to verify if established key performance indicators have the features which will render them useful and efficient to the organization.

The Winning KPI methodology focuses on the alignment of the organizational strategy and the KPI system. The emphasis is on the different approaches for identifying critical success factors, appropriate metrics and the establishment of KPI based on accumulated data. The methodology suggests steps which the managers of an organization should examine upon the deployment of the KPIS so as to ensure its efficient operation and the

accomplishment of the KPIS characteristics which have been established. The Winning KPI methodology only gives general recommendations about the software implementation, which results in isolating the operation of IT specialists. Furthermore, the methodology does not describe the relation between establishing the KPIS requirements and the implementation of the project, which may result in major differences between projected and ultimate results.

The review of the benefits and shortcomings of the two methodologies indicates that their focus and efficiency relate to different aspects of the same process, namely, relating data to the strategy and the decision-making process of an organization. The implementation of each of the methodologies seems to separate the process of establishing a key indicators system from the software implementation of the KPIS, i.e. they are approached as totally independent activities which are performed by two different teams and bear no relevance to each other. In other words, the two teams follow two different methodologies that are in line with their tasks.

The fact is that the construction of a BI system and a KPI system are interrelated processes which take place is parallel, therefore their activities need to be aligned and integrated by a common model. Otherwise, the performance of the BI system and the quality of the KPIS might be deteriorated.

An Integrated Model for Designing and Constructing a KPI System

Based om the research we have conducted, the benefits from and the shortcomings of the two models for designing and constructing KPIS, and the conclusion we arrived at in the previous part of the research paper, we propose an integrated model which covers the complete life-cycle of the KPIS. That model aims at:

1. Aligning the stages of the methodologies we reviewed earlier.

2. Upgrading existing models by adding the necessary stages for developing modern BI applications, so that the KPIS constructed by the proposed intergrated model will be in line with global trends.

3. Aligning the activities performed by managers and by IT specialists during the development cycle (Analysis – Design – Construction– Testing – Deployment), including the iterative execution of all these phases.

The first step towards building an integrated model for the design and construction of a KPIS is to establish how the stages of the two methodologies should be aligned. Table 3 presents the different steps in the two methodologies and their alignment.

Table 3
Aligning the activities for developing BI applications to the stages
in the methodology for developing a Winning KPI system

Stages and steps in the KPIS life-cycle as a BI application (Moss & Atre, 2003)	Stages and steps for developing a KPIS using the Winning KPI methodology (Parmenter 2010, 2015)											
	S1	S2		S1	S3	S4	S5			S6		
	1	2	3	4	5	6	7	8	9	10	11	12
Stage 1: Justification (Step 1)	+											
Stage 2: Planning (Steps 2 and 3)		+	+	+	+							
Stage 3: Business Analysis (Steps 4, 5, 6 and 7)						+						
Stage 4: Design (Steps 8, 9 and 10)							+	+	+	+		
Stage 5: Construction (Steps 11, 12, 13 and 14)							+	+	+	+		
Stage 6: Deployment and maintenance (Steps 15 and 16)					+					+	+	+

In terms of developing a BI system, steps 1-5 proposed by Parmenter belong to the stage of the preliminary conceptual analysis, i.e. the justification and the planning of developing a KPIS as a new BI application. Step 6 belongs to the phase of analysis. Parmenter's S5, Determining the measures that will work in your organization (steps 7, 8 and 9) includes the establishment of key indicators as a software subsystem. Accordingly, the activities in steps 7, 8, 9 and 10 need to be divided into: a) design, b) construction and c) testing. The last two steps (11 and 12) refer to the activities which are part of the deployment and maintenance stage. Table 3 presents both processes,

the '+' sign is used to indicate the relation between the activities from both perspectives.

The phases and stages of the integrated methodology for designing and constructing a KPIS are established on the basis of the alignment illustrated in table 3. The integrated methodology also employes iterative implementation of the phases in the development cycle. In contrast to the conventional method, in which stages are implemented in a strict sequence, the iterative implementation of activities in this method allows for greater flexibility in the process of developing the system, thus ensuring that it matches the needs of the organization more fully.

KPIS Initiation and Planning Phase

The KPIS Initiation and Planning phase includes a preliminary conceptual analysis and the initiation of the project for designing key performance indicators. It comprises eight major stages.

Initiation
Stage 1. Getting the CEO and senior management committed to the project
Stage 2. Defining the strategy and formulating manageable measurable strategic goals
Stage 3. Establishing the scope of the project
Stage 4. Establishing a project team
Stage 5. Business case analysis
Stage 6. Justification of the project
Planning
Stage 7. High-level project plan
Stage 8. Marketing the plan for the design of a KPI system to all employees

Stage 1. Getting the CEO and senior management committed to the project. Managing corporate performance is a process which involves the entire senior management of an organisation and is the responsibility of the Chief Executive Officer. Therefore, the managers of the organsiation should be committed to the process of defining the key performance indicators. Experts in performance management need to present to corporate executives the objectives of and the potential benefits from improving the existing performance management system.

Stage 2. Defining the strategy and formulating manageable and measurable strategic goals. Key performance indicators are designed based on the organizational strategy and its goals. The strategy of an organisation refers to the manner in which it plans to materialize its vision. Those two components are an essential requirement for starting the project of designing a KPI system. Most organizations have a clearly defined strategy and goals, yet those should be revised and, if necessary, amended when defining the key performance indicators with the project, so that the strategy would be balanced and the goals – measurable. In their book, 'The Balanced Score Card' Kaplan and Norton (Kaplan & Norton, 1996) point out that the strategy should be well balanced and strategic initiatives must reflect that balance. This is the foundation of a well-designed KPI system.

Stage 3. Establishing the scope of the project. One of the most difficult tasks in designing key performance indicators is establishing the scope of the project. At the first phase of the project, requirements are defined at a high-level and are frequently subject to major amendments in the course of the project. This is another reason for selecting the flexible approach in the presented methodology. One of the significant challenges at this stage is establishing an overly ambitious scope of the project, which frequently results in the lack of focused effort or the impossibility to achieve a specific result in the short run. Identifying the key prioroities of a company on the basis of organizational goals and strategy is a stepping stone on which the project scope should be based.

Stage 4. Establishing a project team. The team of people who will be involved in the project needs to be established as early as possible, so that they will be able to contribute to designing the high-level plan and conducting the preliminary conceptual analysis. All stakeholders need to be notified and involved in the communication from the very start of the project. This will lower the risk of omitting some major aspects that would take a lot of time if identified at a later stage.

Stage 5. The business case analysis. This analysis refers to several major components: the hardware platforms used in the company; the network avalailble and its capacity; an analysis of data sources and the systems using those data; existing database management systems; the tools employed in data analysis by the organisation.

Stage 6. Justification of the project. The justification of the project has 4 major components (Moss & Atre, 2003): (1) Establishing the critical success factors for the project; (2) Identifying business analysis issues and the information required for achieving the strategic goals of the business by reviewing requirements at senior management levels; (3) Cost-benefit analysis; (4) Risk assessment.

Stage 7. The high-level project plan. The model employs the flexible approach for designing software systems and applies that approach to the development of a BI application. Therefore the steps of those methodologies are followed in the process of planning, too. Flexible project management methodologies require that high-level project planning is made at the beginning of the project, while current tasks are planned and decribed in detail at the start of each iteration. The high-level project plan includes: a description of major tasks; a time schedule for their completion; the resources which are required and the correlation between activities. The alignment of tasks between teams at the iteration level is faster and easier.

Stage 8. Marketing the plan for the design of a KPI system to all employees. This stage involves communicating to employees the goals of the project, the high-level plan and the benefits from developing a KPIS. This activity is essential for increasing the probability of successfully implementing the project, obtaining valuable feedback from company employees and ensuring the commitment of a larger number of people.

The Development Cycle Phase (Analysis – Design – Construction – Test – Deployment)

Employing the flexible approach requires that the analysis, design, implementation and testing activities be performed in an iterative manner, i.e. activities are closely related; analysis and design are frequently implemented simultaneously since the design modules of some BI systems generate processing programmes automatically. The performance of the system that is being developed is increased and improved at each iteration.

Figure 3 illustrates the development cycle phase (Analysis – Design – Construction – Test – Deployment).
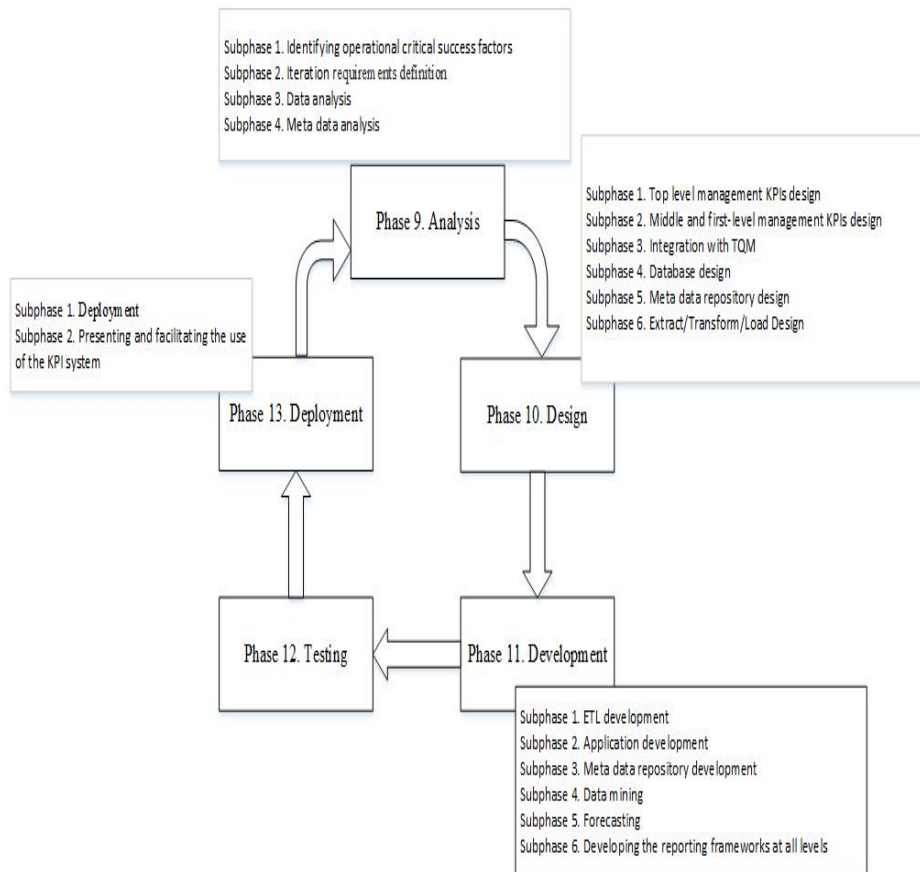
Fig. 3. The development cycle phase

Stage 9. Analysis. At this stage, critical success factors are identified based on the strategy of the organisation, to be followed by the establishment of key performance indicators (KPI). If the critical success factors are selected properly, KPI will be easy to establish. This stage also involves the design of an integrated model which reveals the correlation between the strategy, the critical success factors and the key performance indicators. An integrated model is presented in Figure 4.
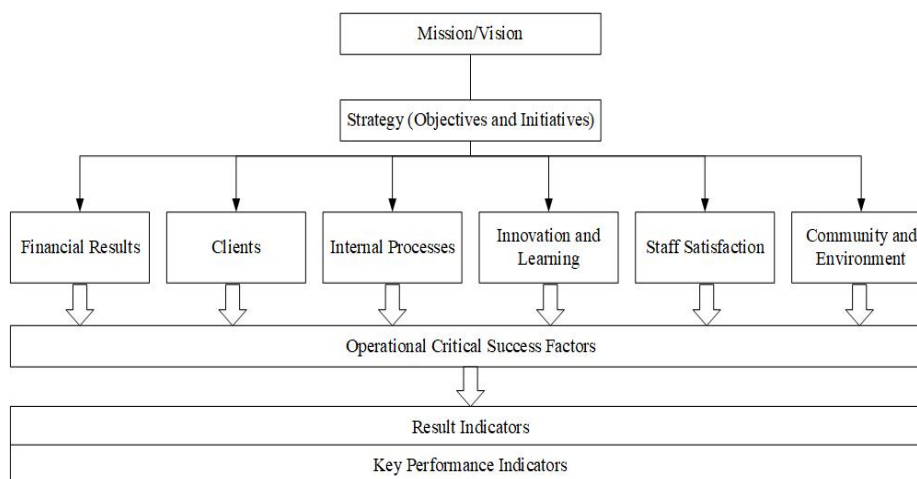
Fig. 4. An integrated model

The stage involves analysis of the data required for establishing a KPIS. Data sources and their reliability are examined. The requirements to metadata storage are also defined at this stage. Those are the major functionalities on the basis of which technological solutions at the next stage will be evaluated. The requirements should be prioritised in line with organizational needs.

Stage 10. Design. This stage involves the establishment of KPIs at all levels of management. There are three levels of management in many organisations: senior (or top) management (level 1); management of the different business departments, units and maintenance departments within the organization (level 2) and team management (level 3). The term 'lower management levels' is used to refer to level 2 and level 3.

The design of key indicators relates directly to the previous two substages. Both the system of key indicators and the database are constructed in an iterative manner. They are expanded and modified at each iteration. The data required for the design of key indicators are loaded into the database of the BI system. A major consideration at this stage is the predicted volume of data, the frequency of loading new data, the period of

time for which historical data will be stored, the details of key indicators that should be visible, database performance speed, etc.

The design of metadata repository is based on the analysis conducted at the previous phase and involves upgrading the findings of that analysis by specifying further details in terms of the technical solution. Each data source needs to be established and described in order to define data loading with the extract, transformation and load (ETL) tools. Some of the data required for establishing the key indicators or the links between those data might not be initially available, which will mean that additional operations need to be designed in order to collect those data.

Stage 11. Construction.

ETL development. At this stage of the implementation, data are extracted, transformed and loaded into the data warehouse. ETL software may be included in the data warehouse software or it might be purchased as a separate module. An essential consideration during the implementation is the production environment of the ETL process and the manner in which it will be performed in that environment – for example, whether it will be run by several servers or by a single server only.

The most important element of ETL development is the transformation of input data. The technical and business requirements to that transformation are established at the stage of defining project requirements, data analysis, the prototyping of the application and the analysis of metadata repository.

Application development. When developing the BI applications, it is necessary to take into account current trends in the development of the technology. Access to information and navigation dashboards and search via web-portals and mobile devices are a major requirement to many of the contemporary BI systems. Daily and weekly reports must be accessible to users through their mobile phones and tablets.

Data mining is an essential element of KPIS construction. Modern BI systems provide efficient tools for performing this activity.

Another key activity at the construction stage is making predictive analyses. Forecasts are based on historical and new data and in most cases are made by analysing trends. When KPIS are constructed, usually short-term (one-year) and mid-term (two-to-five-year) forecasts are prepared

about selected key indicators. Predictive analyses are employed to establish sales volumes, to ensure the necessary resources (materials, finance, etc.), to upgrade products, in the construction of new sites, plants, etc.

Developing the KPI at all management levels is the final step at the phase of implementation. After the requirements of all stakeholders have been collected and analysed; the necessary data have been extracted, transformed and loaded into the database and related metadata have been produced, the development of a KPIS begins. It is necessary to design a report framework which will specify which reports will be accessible to whom and how frequently the data in those reports will be updated.

Stage 12. Testing. The aim of this stage is ensuring that the KPIS which has been developed meets the requirements of the business as well as those of the organisation. All components of the BI solution are tested at this stage.

Stage 13. Deployment. This is the final stage in the development of the BI system when the key performance indicators system becomes accessible to all employees of the organisation. The integrated model implies that the system will be implemented incrementally after each iteration.

The Evaluation and Maintenance Phase

This is the last phase in the development of a BI system. At this phase, results are evaluated and the course of the future development of the system is determined. The evaluation and maintenance phase involves two stages:

Stage 1. Release evaluation
Stage 2. KPIS Maintenance and improvement

Advantages of the Integrated Model for Desiglning and Constructing a KPI System

The advantages of the integrated model for designing and developing a KPI system are summarized below:

- It is a modern model that meets organisational needs for designing and developing flexible BI systems and efficient KPIS.

- Successful implementation of a KPI system in line with the goals of an organisation.

- Aligning the organizational strategy to the KPIS.

- Designing and developing a reliable BI system on which the KPIS is based.
- Key performance indicators which are in tune with the best practices for efficiency.
- Aligning the activities related to the development of a BI system and the establishment of key performance indicators.
- A BI system which meets all current needs of the organisation and can easily be upgraded in future.

Organisations will benefit from the proposed integrated model in several ways. First, it helps develop quickly and efficiently a reliable high-performing KPIS, raises the competitiveness of organizations, facilitates the accomplishment of their goals and the transformation of their management. Second, all employees and executives in the organisation are committed to the project of developing a KPIS. The responsibility for the key performance indicators is delegated both to the managers of and to the teams within the organisation.

Conclusion

The scientific and practical findings of this research are as follows: (1) We have analysed two models for establishing key performance indicators. (2) We have designed an integrated model for designing and constructing a system of key performance indicators which covers the entire life cycle of a KPIS. The model aligns the activities related to the development of a BI system to those related to designing a KPIS and employs flexible project development practices. (3) We have outlined the major benefits of the model. The new integrated model offers a holistic approach to KPIS design and development and refers to the activities of all participants, which is a prerequisite for the quick and efficient development of a reliable and high-performing KPIS. The integrated model of KPIS design and development enables organizations to be flexible and competitive and to transform their management practices.

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