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Models of IT Projects KPIs and Metrics

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***Abstract* — models of key performance indicators (KPI) and methods for their measurement based on metrics for IT projects are proposed for consideration. Advantages and disadvantages of different KPIs and their applicability for various projects, as well as project implementation methodologies, are analyzed. A comprehensive KPI and metrics model is proposed for IT project team.**

***Keywords* — key performance indicator, metric, IT project, project team, effectiveness.**

I. INTRODUCTION

In any area implementation of a project involves engagement of several parties, at least two - business as a Customer and IT as a performer, as a maximum - many Customers and many executors, not only IT but also other service units or external companies. The goal of any project is either development of a new product or service or process [1]. As a rule, at the stage of project initiation, not only the project objective is determined, but also its deliverables. Less frequently, financial KPIs are declared as a result of project implementation in the context of the payback period [2]. From the point of view of PMO or other monitoring unit that monitors and controls the projects' implementation in the organization, at the time of project approval the time, budget and scope of the project are generally understandable and determined, including obligations for implementing financial model of the project (ROI, IRR, CBR). These are inputs for the project team, which is responsible for the project implementation [3]. As the project team consists of representatives of different parties of the initiators of the project, different groups of participants responsible for different stages of the project have different KPIs. This state of things in the project provokes imbalance of efforts aimed at implementing the project and violation of its integrity.

In the context of achieving the goals and deliverables of the project, project manager, the Customer and the Sponsor are interested more, while the project team is interested much less. This is due to the fact that at a particular time the project participants are interested in the successful completion of their work package and transfer of results to the next stage. Due to the limited budget and/or timing and/or technology, each group at a certain stage implements the maximum in its area of work, not caring about the limitations of the subsequent stage [4].

Ultimately, connecting different stages of the project, each of the groups is subsequently forced to find a compromise solution that will allow them to implement their work area. For example, the Customer prepares requirements that most closely correspond to the objectives and deliverables of the project, usually not taking into account the fact that only 20% of the functional result in 80% of the benefit. In turn, analysts based on the inputs formalize requirements, turning them into an ideal product or process, implementation of which can become inconsistent with financial metrics [5]. The next phase of development faces the problems on the level of resources, technologies and timing, which as a result leads to scope reduction or simplification of the product, service or process. To ensure the integrity of the product, service or process, project manager has to find a compromise between the results of all phases for the successful completion of the project - between "What?", "How?", "When?" and "How much money?". In any case, such a compromise is a flawed option because it represents only one of the variations in the course of the project. In this example, Customers and analysts wasted time on unnecessary details and formalization of the product, service or process, and developers spent resources on unnecessary functionality [6].

In the search for and implementation of such compromise options, the interests of the parties which will subsequently sell or use the product, service or process, are lost out of focus.

In the authors' opinion, this problematics can be solved by implementing project KPIs for the project team from initiation to completion, ensuring the integrity of the results at each stage of the project.

The subject of the article is the research and analysis of the development and implementation of KPIs to ensure a holistic approach to the project implementation, excluding implementation of a compromise option as the most unprofitable for the organization as a whole.

II. ANALYSIS OF RESEARCH AND PUBLICATIONS

The questions of applying different approaches to models of IT projects KPIs and metrics were considered in the works of Harold Kerzner [5], Rad, Parviz F., Ginger Levin [6], Daniel S. Vacanti [7] and other scientists.

The problems of using project metrics and KPIs for different projects were reflected in the works of following Ukrainian scientists: Yu.Teslia [8], I.Kononenko [9], V.Burkov, S.Bushuyev [10], V.Morozov [11], and others. In particular, the issues of the need to measure the key project indicators for various areas as well as the implementation of the KPIs of the project portfolio were highlighted [12]. However, using KPIs and metrics for the project team in order to achieve the maximum result has not been studied in depth to be practically solved.

Unsolved parts of the common problem. A large number of studies have been carried out in the field of innovative

projects management [13]. There are outstanding examples of successful completion of projects of scientific nature, but the peculiarity of using KPIs and the metric system for their regular measurement for the project team makes its adjustments to the classical project management. It is important to determine the main features of KPIs and metrics for their measurement in order to determine the most comprehensive and effective approach to project management to focus the project team's efforts on the project's outcome.

The purpose of the article is to study and analyze the various KPIs of the project team and metrics for regular measurement of the intermediate state of the project in order to achieve the maximum result due to effective use of resources and budget in the planned time frame.

III. MODELS OF IT PROJECTS KPIS AND METRICS

A KPI is a metric measuring how well the organization or an individual performs and operational, tactical or strategic activity that is critical for the current and future success of the organization. The value of the KPI must be well understood in order for it to be used correctly and for it to provide the necessary information for informed decision making. The project manager and the appropriate stakeholders must come to an agreement on which metrics to be used and how measurements will be made. There must also be agreement on which metrics will be part of the dashboard reporting system and how the metric measurement will be interpreted. When coming to projects, metrics represent the measurement in time of specific numerical indicators according to the approved KPIs. The value of metrics is the ability and indeed the need of measuring them throughout the implementation of the project but not at the completion stage or after the implementation of the project, to take timely corrective actions [14]. Values of metrics on the key date of measurement should be an integral part of the status report for informing both stakeholders and members of the project team. It is important to remember that metrics are measurements and, therefore, provide project managers with opportunities for continuous improvements to the project management process. Selecting metrics without considering a plan for future action is a waste of time and money. If a measurement indicates that the metric is significantly far away from the target, then the team must investigate the root cause of the deviation, determine what can be done to correct the deviation, get the plan to correct the deviation approved, and then implement the new plan. Metrics also allow project managers to create a database of historical information from which to analyze trends and improve future estimating.

The authors consider the following classes of metrics for IT projects.

Metrics with full project duration measurements - metrics, such as cost and schedule variances, that are used for the entire duration of the project and measured either weekly or monthly.

An example of such type of KPI is a quality of planning KPI, which is the basis for measuring the compliance of the planned project completion date or phase in comparison with the actual one. This KPI is a complex one and is designed for the straight-line and consistent execution of project work, which in turn minimizes the use of overtime, uneven load on resources (both human and budget) in order to achieve planned deadlines when significant deviations are identified at the completion stages.

To measure quality of planning KPI, authors encourage to use the following metrics:

- measurement of the timely completion of the project's milestones and the timely commencement of the next block of work. Project milestones must be defined every 10-15 calendar days;

- measurement of manpower effort - the ratio of planned and actual labor costs to the key date of measurement:

$$KPI_{QoP} = \frac{\text{LabourCosts}_{planned}}{\text{LabourCosts}_{actual}} \quad (1)$$

-earned value management:

Another example of this type of KPI is the KPI of architecture control. The context of this KPI is the correspondence of business and technical implementation of the project to the development strategy of the organization [15]. To measure this KPI the authors propose to use the questionnaire approach:

- positive conclusion of enterprise-architect on the compliance with the target architecture of the IT landscape of the organization;

- positive conclusion of solution-architect on the compliance with the target architecture of the system (platform);

- positive conclusion of IT Architectural Committee on the implementation of a new system (platform) into IT landscape of the organization;

- positive conclusion of business owner of the system or process on the compliance with the business strategy of the organization.

The value of this KPI lies in the early detection of the inconsistency of the implemented project solution with the development strategy of the organization, as a result of which - exclusion of increased cost of solution due to the need of implementation of significant changes, in some cases - decommissioning of such a solution in short or medium term perspective. Serious consequences of this kind of inconsistencies can be significant investments in IT infrastructure to maintain the performance of the project solution.

It is important to take into account that the only exception can be those projects that were initially aimed at realizing short-term goals of the organization without long-term plans for using results of the project, which should be formally confirmed by the management of the organization.

Metrics with life cycle phase measurements - metrics that exist only during a particular life cycle phase. As an example, metrics that track the amount or percentage of direct labor costs used for project planning would probably be measured just in the project planning phase [5].

The basic KPI of this class for the project team can be an event KPI, reflecting the value expressed in money for each functionality of the product, service or process. The purpose of this KPI is to focus the project team on the implementation of the most significant parts of the

functional, providing the maximum value. Ideally, 20% of the functionality provide 80% of the value of the project solution. Essentially, this KPI is a guide for the project team, reflecting where significant part of the efforts of both the Customer and the project team should be spent.

The value KPI - event KPI, reflecting the value expressed in money for each functionality of the product, service or process - answers the question with “yes” or “no”. That is, is the project team provided with an assessment of the functionality of the solution being developed (product, service or process). It is important to note that in case of the appearance of new functionalities, they should be estimated and added to the primary evaluation of the scope. Otherwise, the KPI value is zero. The value of this KPI lies in focusing the project team and organization on the implementation of the core of the product, service or process, both in terms of business orientation and IT solutions. As a result of this balancing, the investment policy of both human resources and budgetary funds will be more effective for the organization as a whole, while respecting the principle of maximizing profits at minimum costs [16]. The next example is the KPI of development quality. The value of this KPI is manifested in the reduction of costs of the project solution due to the early identification of defects’ sources of origin and their elimination at the initial stages of design and implementation of the solution. The authors suggest the following approach to measurement: the ratio of manpower effort of eliminating defects that occur at different stages of the project (analysis, development, testing and productive operation during the pilot operation) to the overall manpower effort of the project.

$$KPI_{DQ} = \frac{\text{ManpowerEffort}_{defects}}{\text{ManpowerEffort}_{project}} \qquad (2)$$

It should be noted that this approach to monitoring and controlling of the project quality necessitates the following project works:

- testing the technical specification for compliance with the requirements of the Customer and the final beneficiary in terms of completeness and sufficiency;

- review of the program code before completion of the development of the functional for compliance with the standards of development in the organization;

- development of a test plan, test cases and creation of autotests based on requirements and technical specification before the start of development;

- development of a plan and test cases for user-acceptance testing before the start of the testing the technical specification.

Such an approach allows to ensure improvement of the quality of implemented solution by identifying defects in the "paper" project of solution before it is created on the level of program code, and accordingly allows to avoid increasing the cost of solution both from the point of view of investment and the timing of solution launch in pilot production, as well as negative client experience. Depending on the stage of defect detection, the cost of its elimination varies - the later the defect is identified, the more expensive its elimination is [6].

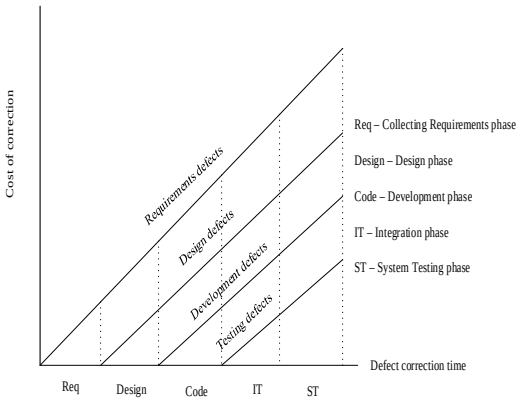

Fig. 1. Increase of cost of a defect in project timeline

A more specific representative of this KPI type is a KPI of quality of technical specification and is measured as % coverage of business requirements by technical specifications. For 20% of the functionality that ideally provides 80% of value of the product, service or process, the KPI value should be 100% before the development starts. Otherwise, eliminating the design defect of core of the product, service or process will be more expensive and longer with each subsequent stage on which the defect is detected. Another narrowly focused example of KPI of this class is the KPI of quality of testing and is measured as % coverage of the functionality by test cases. Similar to the previous one, the value of this KPI is in identifying and eliminating defects of a product, service or process at the stages preceding acceptance testing and pilot production. This approach ensures the effective use of investments aimed at development of an initially correct product, service or process, in contrast to investing budget funds in eliminating defects, up to rejecting the solution in consequence of financial inexpediency of its reworking. The coverage of test cases with a significant 20% of functionality should be provided at 100% while variation in coverage of test cases and/or autotests of 80% of functionality that generates only 20% of the product value may be allowed, sometimes leading to a technical debt.

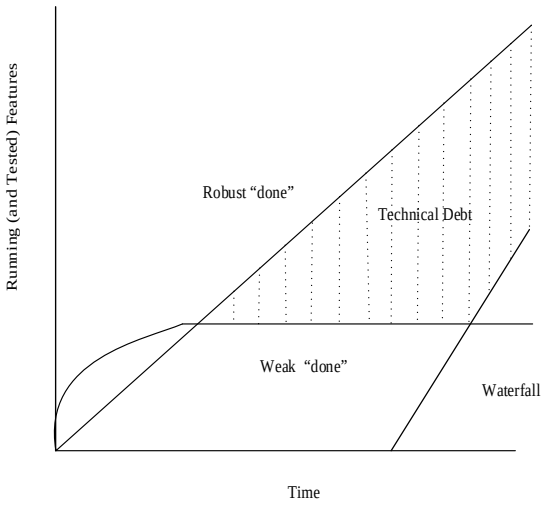

Fig. 2. Testing product features within time

It is important to note that all KPIs offered by the authors for consideration are based on the availability of the underlying value KPI, without the definition of which all the subsequent KPIs have no value for either the stakeholders or the project team.

Metrics with limited life measurements - metrics that exist for the life of an element of work or work package. As an example, we could track the manpower staffing rate for specific work packages or the number of deliverables produced in a specific month. This type of KPI, and accordingly metrics, is most applicable for projects using agile development methodologies. Examples of such KPIs can be the measurement of different parameters of agile projects - velocity of the project team, time to market of project deliverables, and the level of technology.

Basic Agile Metrics [7]:

- Agile methods are based on traditional measures
- Size, efforts, and velocity metrics are common
- Top-notch shops use complexity and testing metrics

TABLE I. AGILE METRICS

Type	Example
Size	Story, Story point, Task, Function Point, LOC, etc.
Effort	Ideal or Actual Hours, Days, Weeks, Months, Years, etc.
Velocity	Story, Story point, Function Point, or LOC per iteration/Sprint
Complexity	McCabe, Halstead, Object-Oriented, Relational Database, etc.
Quality	Defect Density, Defect Removal Efficiency, Rayleigh, etc.
Testing	Tests Passed/Failed/Broken, Running Tested Features, etc.
Reliability	Mean Time to Failure, Mean Time between Failure, etc.

Measurement of these indicators of the project team is mandatory, and the feature of this class of metrics is the continuous improvement of the values of these indicators. Special attention should be paid to the adaptation of value KPI, characteristic for projects with classical approaches to project management, to the project backlog estimated by product owner from the point of view of financial benefits for ensuring correct priorities for the implementation of the product, service or process [17]. It is impossible to create and control quality of planning KPI without a regular measurement of the project team's velocity and the product owner's estimated backlog of the project, as well as the initial top-level assessment of the project's backlog by the project team in terms of labor costs for implementation. In the Agile philosophy it is impossible to form a burn-down of a project or sprint without the values of these indicators, and accordingly to provide monitoring and controlling of any project KPI.

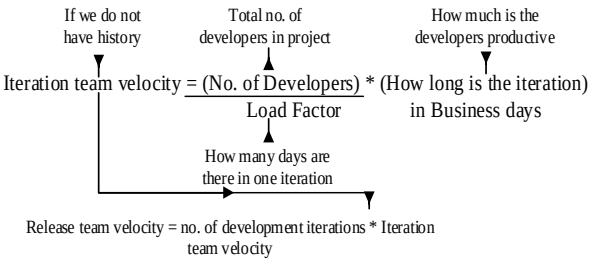

Fig. 3. Agile project indicators

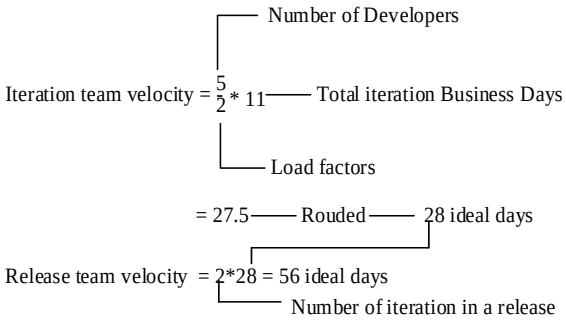

Fig. 4. Agile project measurements

The complex of described categories, and accordingly their regular measurement, provides the right product, its correct implementation and the correct process of implementation of the product, service or process, while ensuring the efficiency of investments and the reduction of effort to implement the project in a shorter period. This is possible only if the technological level of the project team is increased due to implementation of such engineering practices as auto-testing, auto-deployment, continuous integration and the construction of DevOps processes [19].

For projects using the Agile approach, most of the KPIs of quality described in the other KPI classes of this article are mandatory and initially focus both the Customer and the project team on their regular measurement and improvement, which significantly increases the quality of the product, service or process being developed, significantly speed up the start-up period for pilot production, and also force the project team to regularly improve the KPI process.

Metrics that use rolling-wave or moving-window measurements - metrics where the starting and finishing measurement dates can change as the project progresses. As an example, calculations for the cost performance index and schedule performance index are used to measure trends for forecasting. On long-term projects, a moving window of the most recent six data points (monthly measurements) may be used to obtain a linear curve for the trend line [5].

As an example of KPI of this class, authors propose to consider Customer's quality of requirements KPI. The essence and value of measurement of this KPI is shown in the sufficiency and readiness of the primary requirements to the product in terms of design and implementation to ensure the performance of financial indicators.

The measurement of this KPI is considered as the ratio of manpower effort for implementation of changes in requirements to overall manpower efforts for the project. Another indicator here is the shift in terms due to changes in requirements. Static deterioration of this KPI signals that the product is not ready for implementation and the need of taking immediate corrective actions, not excluding the suspense of the product, service or process development.

Preventive measures for this class of problems are the presence in the project plan of mandatory formal approvals with the Customer, Sponsor and representatives of end users of product requirements, functional and non-functional requirements, technical specifications of the product, service or process prior to the start of development, as well as early creation of plan and test cases in order to avoid detection of

critical inconsistencies at the user-acceptance testing stage. Otherwise, implementation of critical requirements for the product, service or process at the acceptance testing stage can lead not only to the need of significant additional financing, but also to the shutdown of the project due to financial inexpediency of launching such a product, service or process.

Another example of this class is the KPI of project risk identification - an event KPI reflecting the identification of all project risks at the planning stage. A mandatory condition for the positive value of this KPI is the availability of a response strategy for each identified risk. It should be noted that the qualitative aspect of this KPI, in addition, is the regular revision and actualization of project risks. However, it is important to take into account that the regular increase in the list of project risks with each subsequent stage, especially with the failure of Customer's quality of requirements KPI, may indicate serious problems on the project. As a consequence, the completion of the project is likely to require additional financial investment, which in turn will require an analysis of the financial feasibility of implementing the product, service or process [6].

An important KPI of this class, according to the authors, is the KPI for closing the project risks. This KPI is extremely important to monitor on a regular basis and in dynamics, since the value of KPI is in regular monitoring of the overall risk of the project.

From the point of view of measurement, KPI is proposed to be considered as % of risks taken place to the total number of identified risks, taking into account the impact on the financial component of the project in the form of additional financing and/or project losses.

The reverse side, a positive aspect, can be the identification of positive project risks that allow using them as a potential opportunity to reduce investment in the project or improve the quality or functionality of the product, service or process.

In general, working with project risks is a rather complex but important part of the implementation of any project. This topic is not the subject of this paper, but from the KPI perspective of the project team is considered to keep focus on regular work with project risks.

Alert metrics and measurements - metrics used to indicate that an out-of-tolerance condition exists. The metrics may exist just until the out-of-tolerance condition is corrected, but they may appear later on in the project if the situation appears again. Alert metrics could also be metrics that are used continuously but are highlighted differently when an out-of-tolerance condition exists.

From the authors' point of view, one of the essential KPIs for the project team is the KPI of the process, which shows how the project team follows the development process approved in the organization without deviations.

The value of measuring and tracking this KPI is the timely monitoring and controlling of the implementation processes of the organization in order to prevent skipping key development stages intended for the implementation of the right product, service or process and in the right way. In addition, it is important to note that following the process is one of the ways to ensure compliance with the principle of maximizing profits while minimizing labor costs and financial investments of the organization.

KPI of the process is integral and demonstrates an integrated and holistic approach to measuring key project indicators that are necessary to properly focus the project team and maintain a balance of financial feasibility of implementing the product, service or process for the organization as a whole.

Considered classes of KPI with the corresponding metrics for their measurement, in the opinion of the authors, are sufficient to focus both the Customer and the project team on the successful implementation of the product, service or process.

Regular inclusion of these KPIs into the project's status report allows early identification of the inadequacy of requirements for a product, service or process, identification and elimination of product, service or process defects, and ensuring the required quality and functionality of the product, service or process within the project budget in target timelines.

IV. Conclusion

As a result of the study of the use of KPIs for the project team, various KPIs were analyzed, as well as metric classes for their regular measurement. For each stage of the project relevant KPIs are considered, the application of which maximizes the focus of the project team on achieving the final result of the project - implementation of the product, service or process.

It is important to consider the complexity and integrity of using KPIs for the project team, otherwise focusing only on one of them can lead to an emphasis on a particular stage or characteristic of the product, service or process to the detriment of others, which ultimately does not lead to the maximum effect.

Another important aspect of using KPIs is their regular measurement to track the dynamics of indicators, in other words - the state of the project at a particular point in time. The definition of the measurement system, metrics, for the project team is a key aspect for achieving KPI.

Determining KPIs for the project team will not be effective in measuring KPI values at the end of the project, since we will not be able to apply any corrective actions aimed at eliminating the terms of implementation, increase of the budget or improving the quality of the product, service or process. In order to timely influence and apply corrective actions to the project, metrics are used to periodically measure the project, and then develop and apply corrective actions, both from the side of the project team, the Customer and the project Sponsor.

The values of metrics that measure the intermediate state of achievement of KPIs on a regular basis should necessarily be included in the project status report to inform the project team, the Customer and the Sponsor, as well as corrective actions that will be applied to eliminate project problems.

Additional monitoring and controlling by using KPIs is also the implementation of a group of mandatory control works into the project's schedule. Examples may be the approval of requirements by the Customer, testing the

technical specification, development of a test plan including test cases for testing by the project team and end users.

The concept of an integrated approach to the use of KPI and a system of metrics for a project team is based on the principle of implementing the right product, service or process with the right architectural, technological solution in the planned timeframe and with defined project budget in favor of the client and/or end users.

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