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Proving Optimization by Comparison of Business Processes

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Abstract. **One of the biggest problems in the practice of any business process analyst is how to prove the process optimization they have performed to the management and/or the management of the company/organization, who are neither specialists in business process analysis (at least in most cases) nor specialists in higher mathematics (even more rarely).**

The problem is further complicated by:

- the fact that the introduction of changes in a business process can also change the related business processes (the so-called "process chain reactions"), which could lead to a change in the functioning of the entire business process system of the firm/company under consideration (and in the whole spectrum from "extremely positive development" to "total degradation" and even bankruptcy/closure) if not taken into account;

- the right-proportional "objectivity-complexity" ratio of the methods that could be used for the purpose (i.e. the more objective and accurate a method is, the more complex it is);

- overly complex (especially from a mathematical point of view) methods look unconvincing in the eyes of the management/management of the company/organisation;

- overly simple (especially from a mathematical point of view) methods look unconvincing in the eyes of the more mathematically and/or more analytically oriented leadership/management of the company/organization;

It is therefore necessary to find a method (or more than one) that meets the following conditions:

- allows the objective evaluation of business processes;

- allows the comparison of business processes before ("as-is") and after ("to-be") optimization;

- allows the consideration of business process changes that are related to the optimized business process - i.e. evaluates and analyzes process chain reactions;

- compares similar business processes - for example, the stocking processes of two different firms/companies.et.

Keywords: ***business process analysis, business process optimization, business process optimization proof.***

I. INTRODUCTION

The process approach to managing companies/organizations is emerging as a result of the ever accelerating and increasingly dynamic world around us - changes in it are becoming more and more intrusive, the reactions of companies/organizations have to be many times faster and more adequate as compared to the end of the 20th century and many times faster as compared to the beginning of the 20th century.

The process approach to managing companies/organizations consists of continuously optimizing the business processes of the company/organization. A correct association would be the famous Long Life Learning approach to personal professional development - both are based on:

- constant monitoring;
- continuous state/process evaluation "as-is";
- developing a "to-be" state/process;
- change;
- comparison of both "as-is" and "to-be";
- Correction;
- a new cycle starting with observation.

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The conclusion - both approaches obey Aristotle's rule "Life requires movement", i.e. to survive in the modern world of increasingly fierce competition, continuous development and improvement is necessary.

The methodology for the practical application of the process approach is business process analysis, the purpose of which is the continuous monitoring and optimization of the business process system of the company/organization.

There are a large number of definitions of business process analysis, but the authors of the article define it as "a cyclical set of activities to improve the business process system of the firm/organization".

Theoretically, business process analysis consists of the following activities (each of them is a separate stage of business process analysis):

- Observation;
- Description;
- analysis (including evaluation);
- Optimization.

In practice, there is a fifth stage - proving the optimization. There are several reasons why it is not described in the professional literature:

- First, it partially overlaps with the analysis phase, during which the optimization is prepared and proven through analyses, clarifications, flowcharts, business process maps, etc.
- Second, this stage is skipped in many firms due to lack of motivation and/or specialized knowledge (both process and mathematical) among management;
- Thirdly, this stage is also skipped in companies where the business process is the owner and/or senior manager of the company;
- Fourth, this stage is often skipped in order to save time and money;
- Fifth, this stage is skipped when management places very high trust in business process analytics.

Despite these reasons, this fifth stage poses a serious problem for business process analytics, especially if there is a lack of professionals with specialized business process and/or mathematical knowledge among the firm's senior management, as is very often the case, especially in developing countries. But what is the problem and why is it a problem specifically for senior management without specialized business process and/or mathematical knowledge?

The answer is - the problem lies in the complexity of proving the quality of business process optimization performed by business process analytics to senior management without specialized business process and/or mathematical knowledge.

Based on the analysis and optimization of the processes through the MUSCA method, business process analysts will be given the opportunity to present the results of their optimization activity to managers without specialized knowledge in BPA and higher mathematics.

II. Materials and methods

In this article the following optimization tools are discussed and classified:

- removing or adding an element from the business process;
- changing the sequence of business process elements;
- replacing a separate element of the business process;
- technical optimization - improvement/replacement of technical equipment to increase productivity
- staff training;
- miscellaneous.

In the given paper, the following methods for business process description and analysis are discussed and classified:

- Textual and tabular-textual apparatuses - such a method of description is, for example, the book-play type description;
- Graphical/symbolic language - such are UML (Unified Modeling Language), ARIS, BPMN (Business Process Model and Notation);
- Complex tabular methods - a representative of this type of methods is "BSC" (Balanced Scorecard)
- Complex mathematical methods - systems analysis, MUSCA, etc. at the time of writing this paper.

The criteria for proving business optimization are also discussed:

- financial measures - price, value, etc;
- time measures - periods of time (day, hour, minute, second, etc.);
- qualitative measures - what mistakes can be made and with what damage to the company/organisation, what waste is produced, etc;
- Risk - what risks can occur and with what consequences for the company/organisation ?;
- quantitative measures - quantity of output, etc.

III. Results and Discussion

Company problems/reasons for process optimization

A common practice among business process analysts is to view problems in an individual business process, as well as in a business process system, as process (or business process system) diseases whose symptoms and source need to be identified.

The problems (i.e. diseases) that may lead to the need for optimization of a process, the authors of the article classify into the following groups:

- Excessively high resource costs (symptom) due to a process imperfection (source);
- Excessively high resource costs (symptom) for technical reasons (source);
- Presence of viral business processes (source);

- Presence of a bottleneck (symptom of one problem and source at the same time) in a related process or in the process itself;
- Excessive losses caused by errors (symptom);
- Excessive losses caused by risks (symptom);
- Changes in a process brought about by through process chain reactions (symptom) that result from changes in another process (source);
- miscellaneous.

Cases reviewed:

For the purposes of the study, real cases from the practice of the authors were used. In order to preserve trade secrets, no data that would allow the identification of the companies will be disclosed.

First case - a logistics company operating in Bulgaria. The following company issues were identified:

- excessively high resource costs (symptom) due to a process imperfection (source);
- excessively high resource costs (symptom) for technical reasons (source).

Second case - company-distributor of parts. The following company issues were identified:

- Presence of viral business processes (source);
- Presence of a bottleneck (symptom of one problem and source at the same time) in a related process or in the process itself;

Third case - software developer company. The following company issues were identified:

- excessively high resource costs (symptom) for technical reasons (source).
- Presence of viral business processes (source);
- Changes in a process brought about by through process chain reactions (symptom) that result from changes in another process (source);

Process optimization tools

The tools for the optimization/improvement of a process can be categorized (in terms of a mechanistic approach) conventionally into several categories:

- removing or adding an element from the business process;
- changing the sequence of business process elements;
- replacing a separate element of the business process;
- Technical optimisation - improving/replacing technical equipment to increase productivity;
- staff training;
- other optimization methods - they are numerous, but they are rare and do not occupy a significant share among the tools used for business process optimization.

To solve/eliminate each of the categories of problems considered, there is a corresponding arsenal of tools from those listed above that is used to solve them.

Cases reviewed:

First case - a logistics company operating in Bulgaria.

In this case, the following methods are used:

- changing the sequence of business process elements;
- replacing a separate element of the business process;
- improving/replacing technical equipment to increase productivity;
- staff training.

Second case - company-distributor of parts. The problem of viral business processes is unique because there is no single solution. In this case, the following methods are used:

- removing or adding an element from the business process;
- changing the sequence of business process elements;
- staff training.

Third case - software developer company. In this case, the following methods are used:

- removing or adding an element from the business process;
- changing the sequence of business process elements;
- improving/replacing technical equipment to increase productivity;
- staff training.

Business process description and analysis tools

The toolkit for description and analysis is relatively limited - it can be classified by the presence of certain "apparatus" in a given analytical instrument:

- Textual and tabular-textual apparatuses - such a method of description is, for example, the book-play type description;
- Graphical/symbolic language - such are UML (Unified Modeling Language), ARIS, BPMN (Business Process Model and Notation);
- Complex tabular methods - a representative of this type of methods is "BSC" (Balanced Scorecard)
- Complex mathematical methods - system analysis, etc.) at the time of writing this paper.

Textual apparatuses are a limited set of rules for describing the business processes under consideration. The advantages of this type of apparatus are:

- are simultaneously the easiest both from a technical point of view and to learn;

- least preparation time before use - only a piece of paper and a pen or computer and a text document are needed;
- accessible to individuals without specialized business process skills.

Text-table apparatuses use a more extensive set of rules to describe the business process under consideration in a preprepared tabular apparatus, which is a set of tables in which information about business processes and their features is entered and synthesized.

The advantages of this type of apparatus are:

- a bit more complicated both from a technical point of view and to be learnt;
- require a bit more preparation - pre-prepared tables, usually electronic spreadsheets;
- accessible to individuals without specialized business process skills.

Graphical apparatuses are a set of graphical symbols, each of which address a particular element/aspect of business processes. The graphical apparatuses are diverse enough, which is the reason we had to limit ourselves to Unified Modeling Language (UML), ARIS, Business Process Modeling Notation (BPMN). The reasons the authors choose them are:

- they are the most applied graphical notations by business process analysts;
- UML is the most widely used graphical notation in the IT industry;
- ARIS is the most preferred graphics notation among business users;
- Each of the three notations has its own concept that differs significantly from that of the other two graphic notations.

UML defines a notation and a meta-model. Notation are the graphical symbols used in diagrams, and meta-model are the 14 types of diagrams that define the concept of the language and are specialized in particular aspects. The advantages of UML are:

- It is universal;
- Extremely easy to learn, incl. by staff without specialized knowledge of business process analysis
- It requires no special technical preparation - just a pen and a piece of paper;
- do not require specialized knowledge of business process analysis to read already made flowcharts/business process maps.

BPMN has a rich set of different graphical symbols based on the principle of hieroglyphics - a separate symbol for each individual need that may arise when describing a business process and a hierarchical business process system. Additional elements that carry information, such as colors, etc. are also included.

The main disadvantages of BPMN are:

- BPMN process maps are huge in size;
- the huge amount of highly specialized symbols make BPMN unintuitive and harder to learn;
- the use of BPMN is done only through software because of the huge amount of symbols and the huge size of the process maps

The advantages of BPMN are:

- It is universal;
- Reflects clearly the hierarchy of processes in business process systems
- It describes the processes in great detail.

ARIS is based on the event-process chain methodology The business process is viewed as a single, integral element of the organization's system. The logic of "event/fact - action/process - event/fact" is followed, where actions can be viewed as "the initial event or fact for a given process or action" and "the final event/fact that results from the action/process".

ARIS uses a limited number of symbols (similar to UML), each of which is responsible for a specific element of the process. ARIS addresses each process element in detail, but without going to the extremes of BPMN with highly specialized symbols based on the hieroglyphic principle. It also takes an extremely qualitative and intuitive look at the hierarchy of processes in a business process system.

The main disadvantages of ARIS are two:

- The main one consists in the necessary technical preparation for the use of BPMN - it is done only through software;
- ARIS process maps are large in size (though significantly smaller than BPMN).

The advantages of ARIS are:

- It is universal;
- Reflects clearly the hierarchy of processes in business process systems
- It describes the processes in great detail;
- Intuitive and easy to learn, including by businesses;
- Attractive in appearance.

The most prominent and recognizable representative of complex scorecard methods is the "BSC" (Balanced Scorecard), which was developed in 1996 by Harvard professor Robert Kaplan and the business consultant. The idea of a system of balanced scorecard measures that look at the firm/company in a comprehensive way. It defines 4 whole aspects of the firm - Financial, Organizational, Customer, Learning and Growth Perspective, i.e. financial measures are only one of the aspects.

The BSC method includes:

- several different types of tables that are arranged hierarchically from top to bottom - aspects, indices (KPIs), values;
- for each of the aspects, measures/indices are defined, the value of which is calculated on the

basis of formulas involving values/parameters that are objective and verifiable.

The Balanced Scorecard has no serious drawbacks that need to be commented on, apart from the need for technical training, i.e. spreadsheet software is needed.

However, its advantages are serious:

- the method is objective because it is based on provable quantities and predefined formulas;
- the method is complex and does not rely solely on financial measures;

The most recognizable representative of complex mathematical methods is systems analysis. It is a sophisticated and complex method for mathematically describing systems of business processes and individual processes using formulas from higher mathematics. An entirely mathematically based engineering approach, systems analysis is an extremely objective and versatile method for business process analysis. Its only drawback - it appears to be accessible only to people with specialized knowledge of higher mathematics, i.e. to a relatively limited contingent of users.

A relatively new method is MUSCA, which is simultaneously a complex mathematical and tabular textual method for the description and analysis of business processes. It describes textually and mathematically in tables business processes and business process systems, including hierarchically at all levels - business process element, business process, process group, system-wide level.

Its mathematical apparatus is complex and relatively simple, and examines business processes and business process systems in detail through provable quantities and mathematical formulae.

MUSCA has no serious shortcomings that need to be commented on, except:

- the need for technical training, i.e. spreadsheet software is needed;
- Training in business process analysis is needed to be used effectively but it is not necessary to rely on the results obtained from its use.

Each of these tools has its uses and advantages, but what is their evidential power, (i.e. can they be used and if so how effectively?) to prove optimizations.

Cases reviewed:

First case - a logistics company operating in Bulgaria.In this case, Unified Modeling Language (UML) was used for process description.

Second case - company-distributor of parts. In this case, the Table-Textual method was used for process description.

Third case - software developer company. In this case, Architecture of integrated information systems (ARIS) was used for process description.

Proving optimizations

Both the business process optimization toolkit and the business process description and analysis toolkit were briefly discussed above. At the intersection of the two toolkits lies the question - "How to prove the optimization performed?" Current practice is by comparing business processes „as-is“ (before optimization) and “to-be” (after optimization).

To substantiate our conclusions, this section will discuss the applications of the different options.

When used methods are removing or adding a business process element, changing the sequence of business process elements or replacing a single business process element, two options are most valid:

- the use of graphical methods (ARIS, UML, BPMN) to map the process before and after optimization as illustratively as possible;
- the use of mathematical methods (BSC, system analysis, MUSCA) to analyse the specific characteristics of the process before and after optimisation, and to monitor for the presence of a business process chain reaction;
- the combination of these methods.

The option of using only graphical methods is only advisable in cases where management, for one reason or another, does not want to go into detail and unnecessary numbers (or has very high confidence in business process analytics).

When technical optimization or staff training methods are most valid are methods with mathematical apparatus (BSC, system analysis, MUSCA) to analyse the specific characteristics of the process before and after optimization, as well as to monitor for the presence of a business-process chain reaction.

When the problem is presence of viral business processes or presence of bottleneck, it is best to use the methods to with mathematical apparatus (BSC, system analysis, MUSCA) to analyse the specific characteristics of the process before and after optimization, as well as to monitor for the presence of a business-process chain reaction.

Cases reviewed:

First case - a logistics company operating in Bulgaria.

In this case, Balanced Scorecard was used for process assessment and analysis (was made special type of specialized for the logistics industry Balanced scorecard).

Second case - company-distributor of parts. In this case, the MUSCA was used for process assessment and analysis.

Third case - software developer company. In this case, system analysis was used for process assessment and analysis.

Criteria for proving optimizations

As discussed in the exposition above, the most up-to-date and applicable methods for proving process optimization are those with complex mathematical apparatus. Which leads to the following question - "What criteria for comparison of processes before and after optimization should these methods use to be as correct as possible in proving the optimization performed ?".

The qualities these criteria need to possess are as follows:

- be measurable;
- be provable;
- be objective, i.e. not ambiguous.

Such criteria may be:

- financial measures - price, value, etc;
- time measures - periods of time (day, hour, minute, second, etc.);
- qualitative measures - what mistakes can be made and with what damage to the company/organisation, what waste is produced, etc;
- Risk - what risks can occur and with what consequences for the company/organisation ?;
- quantitative measures - quantity of output, etc.

Financial metrics have some very serious advantages:

- they have the greatest proof for business and management - "Whatever they tell you, it's always about money";
- all the other criteria listed can be reduced to financial measures (e.g.: the process takes 1 hour, the only cost is the worker's wage, there are no possible risks and errors, the hourly wage of the worker is 10 euros, therefore the cost of the process is 10 euros).

Also, financial metrics have some very serious drawbacks - they can be extremely misleading in several cases:

- when they are linked to exchange rates and their values change, which subsequently lead to a change in the value of the process;
- when they are linked to the prices of consumables and their prices change, subsequently leading to a change in the value of the process;
- when they are linked to wages and their values change, which subsequently lead to a change in the value of the process;
- etc. beyond process changes that subsequently result in a change in process value.

In these cases, it is possible that fluctuations in the value of the process under consideration arise that have nothing to do with optimization and can lead to misleading.

Time metrics are some of the most preferred, both by business process analysts and by businesses in general. The reasons for this are:

- they are a very accurate optimization metric when accurately measured;
- the time criterion can be reduced to a financial criterion (e.g. the process took 1 hour before optimization, after optimization it takes half an hour, the only cost is the worker's salary, there are no possible risks and errors, the hourly pay of the worker is 10 euros, therefore the cost of the process is 10 euros before optimization and 5 euros after optimization, i.e. the process is optimized by this measure by 50%).

Also, time measures have one serious drawback - they can hardly be accurate enough for the following reasons:

- It is difficult to prove the exact value of the time spent for an action/process before and after optimization - multiple measurements are needed to be able to claim a real measured average, even then 100% reliability cannot be guaranteed;
- It is difficult to prove the exact value of time spent on an action/process when it is performed by staff - values can vary considerably depending on their temperament, chronotype, stress level, fatigue level, motivation, experience, knowledge and skills etc.
- also the risks and errors affect the execution time of the action/process.

Risks and errors can hardly be a stand-alone measure without being bundled with other measures, but are an extremely strong corrective to financial and time measures. The methods for measuring them, and calculating their impact on financial and time measures, are the subject of separate analyses (risk analysis and error analysis, respectively).

The only more serious disadvantage - it is almost impossible to foresee all possible risks and errors that may affect the implementation of an action/process, because some unforeseen may appear later (after the analyses).

Quantitative measures (e.g. output) are extremely accurate and demonstrable. They can be correlated with other measures:

- with financial measures - unit value;
- with time measures - time to produce a unit of output
- with risks and errors - what risks and errors can impact the production of a unit of output.

Quantitative measures have two drawbacks:

- they are not always applicable;
- they are not a sufficiently accurate stand-alone criterion.

Results from cases reviewed:

First case – Logistics Balanced Scorecard was designed specially for logistics process assessment and analysis. Result: processes was evaluated and analyzed successfully at a user-understandable level.The problem is that it only reflects the final results of the processes and changes in them, but without looking into their details/elements.

Second case - company-distributor of parts. In this case, the MUSCA examined the entire system of business processes in detail at all levels at a user-understandable level.

Third case - software developer company. In this case, system analysis examined the entire system of business processes in detail at all levels, but not on a user-understandable level - results were only available to users with a specialized education in higher mathematics.

IV. Conclusion

The serious problem of proving the performed process optimizations to managers who do not have specialized knowledge of business process analysis and higher mathematics is solved best through the application of the complex mathematical method MUSCA.

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