BPM Change Planning Using the Matrix of Change and Discrete Optimization Methods

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Abstract. Every process-improvement initiative involves some kind of change. But the more complicated the efforts are the more they need tools for managing the change process. A lack of change management tools has been recognized as a substantial reason of low success rates of business process reengineering efforts. The Matrix of Change can help managers identify critical interactions among processes and deal with issues such as how quickly the change should proceed, the order in which changes should take place, whether to start at a new site, and whether the proposed systems are stable and coherent. But one of the disadvantages of the Matrix is its size limitation. The authors describe a way of overcoming the limitation, introduce a formal model of the matrix and formulate the problem of BPM change planning as a discrete optimization problem within the model.

Keywords: BPM, change management, planning, matrix of change.

1 Introduction

The need to consider interconnections during change planning in the enterprise is confirmed by multiple studies. As early as 1990 they were the central subject-matter of the study of the theory of complementary assets of P. Milgrom and J. Roberts [1].

According to [1] complementarity leads to formation of predictable relations between individual types of activity. Relations of complementarity between the changes of technology, demand as well as the structure and scales of an enterprise for the entire XX century kept on creating positive relation between them. Milgrom and Roberts give the following definition of complementarity: “Assets or activities are mutually complementary if the marginal return of an activity increases in the level of the other activity. In other words, if doing (more of) the activity x, the marginal benefits of doing (more of) the complementary activity y increases”.

In the studies of Eric Brynjolfsson and more recent sources instead of the notion “asset” notions “practice” or “organizational practice” are used, defined as a definite way of solving the task an organization has to solve [2]. In the case of BPM change management practices are business processes themselves as well as process groups, goals, principles or other business factors that influence business processes.

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Effective change management depends on recognizing complements among technology, practice, and strategy. In developing a theory of complements, Milgrom and Roberts showed mathematically how interactions make it impossible to successfully implement a new complex system in a fully decentralized fashion [3]. Instead managers must plan a strategy that coordinates the interactions among all the components of a business system [4]. The task of planning a change strategy considering these interactions is the major function of the Matrix of Change.

2 The Matrix of Change

As the authors of [5] note, the Matrix of Change is the only model which solves the problem of describing complementarities between practices. The Matrix was suggested by E.Brynjolfsson et al. in the article "The Matrix of Change" [4] (Fig. 1). It was developed on the ground of the theory of complements [6] and the concept of the House of Quality [7].

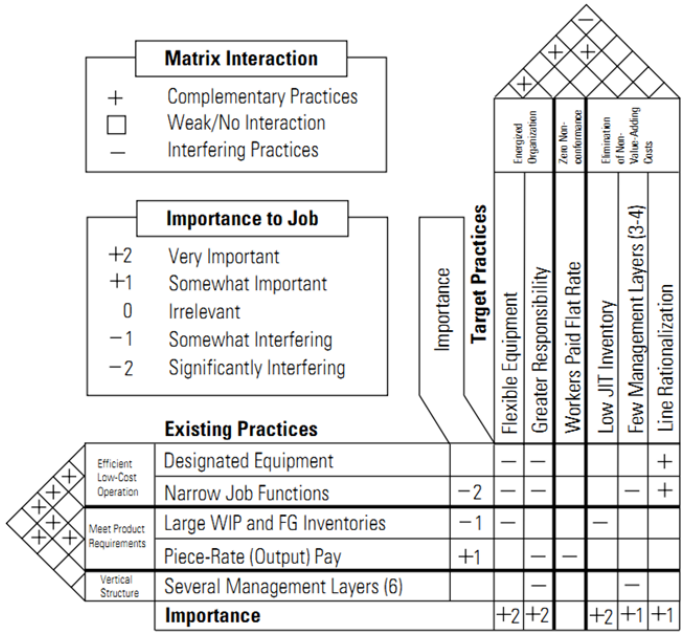


Fig. 1. The Matrix of Change

The Matrix is composed of two interlaid tables. Each consists of a rectangular part – the list of organizational practices and a triangular one, containing data on interactions between the practices. The sign "+" in the cells of the triangle means the complementarity of two practices, the sign "–" means that these practices act in relation to each other as competitors. The horizontal table describes existing practices, the vertical one – the practices that are to be implemented. These complementarities of

organizational practices are filled in using expert assessments of the organization's employees. The line and the column "Importance" describe significance of implemented practices under the Likert Scale (from -2 – significantly interfering to +2 – very important). The rectangular at the intercrossing of these two tables specifies the combinability of existing and implemented practices and, respectively, the difficulties of transition from "as is" to "to be".

In order to fill in "as-is" and "to-be" tables managers should first list their goals, business practices, and ways of creating value for customers and then break current practices into constituent processes [4].

Armed with this knowledge of reinforcing and interfering processes, a change agent can use intuitive principles to seek points of leverage and design a smoother transition. The Matrix of Change is a useful tool to answer the following types of questions [4]:

1. Feasibility: Does the set of practices representing the goal state constitute a coherent and stable system? Is our current set of practices coherent and stable? Is the transition likely to be difficult?
2. Sequence of Execution: Where should change begin? How does the sequence of change affect success? Are there reasonable stopping points?
3. Location: Are we better off instituting the new system in a greenfield site or can we reorganize the existing location at a reasonable cost?
4. Pace and Nature of Change: Should the change be slow or fast? Incremental or radical? Which groups of practices, if any, must be changed at the same time?
5. Stakeholder Evaluations: Have we considered the insights from all stakeholders? Have we overlooked any important practices or interactions? What are the greatest sources of value?

3 Requirements and Objectives

The authors of the paper are concentrated on the second type of questions listed above - Sequence of Change. The approach to change sequencing using the Matrix is described in [4] in the form of recommendations. The main recommendations are the following:

- The most easily eliminated practices are those that oppose other existing practices.
- The most easily implemented practices to are those that complement existing ways of doing business (i.e. complement other existing practices).
- Strengthening the old system by new practices in ways that make dismantling the old regime even harder should be avoided.
- The larger the blocks of reinforcing processes, the more difficult they are to change.
- The hardest changes involve the installation of new practices that oppose the greatest number of existing practices. In fact, large new blocks may be impossible to install before the opposing practices are removed.
- In the ideal case, completely independent blocks may be identified and removed separately.

These recommendations may be easily used for small Matrices. But the larger the Matrix the harder its application in practice becomes. Despite the simplicity and efficiency of the approach comprised in the tool, its use in scale change projects is complicated with a large scope of data. Experience shows that one can use the Matrix intuitively only if it does not exceed the size of about 10x10 because the authors of [4] do not propose a ready-to-use formal method or algorithm for the Matrix of Change. Is it possible to build such a method?

Interactions between a practice to be changed and other practices let us judge about the easiness of the change. The recommendations above show that the easiness of separate changes is the main characteristic of the change plan developed using the Matrix of Change. The idea should be used to build a formal method of BPM change planning using Matrices of Change in case of large scale projects.

The objectives of the research may be formulated as follows:

1. Propose a mathematical model containing the data of the Matrix of Change.
2. Develop a formal method of building the best change sequence (i.e. plan of eliminating "as-is" practices and implementing "to-be" ones) according to the interactions between practices. Best sequence maximizes the easiness of changes.

4 The Mathematical Model of the Matrix of Change

First of all the Matrix of Change contains two sets of practices: a set of baseline ("as-is") practices $B = \{b_1, \dots, b_n\}$, where n – the number of baseline practices, and a set of target ("to-be") practices $T = \{t_1, \dots, t_n\}$, where m – the number of target practices, Fig. 2. $X = B \cup T = \{x_1, \dots, x_{n+m}\}$ is a set of all practices ("as-is" and "to-be") of the Matrix.

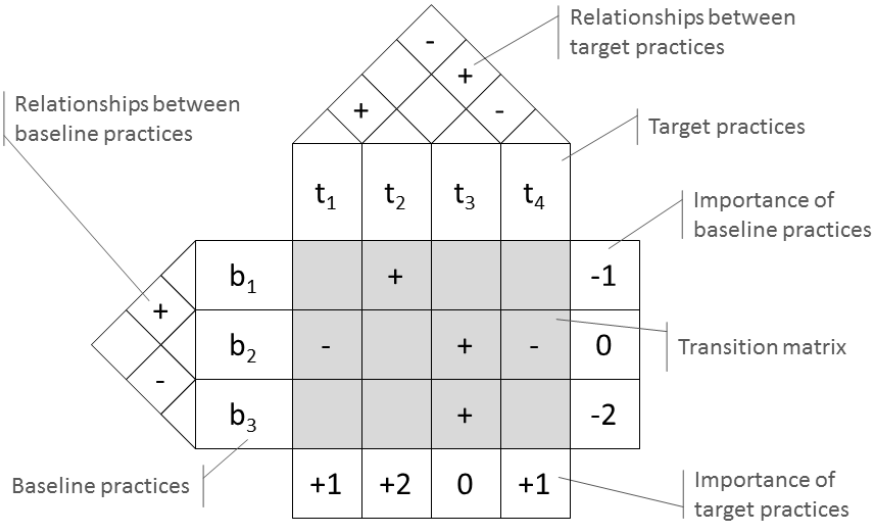


Fig. 2. A mock-up of the Matrix of Change

Let sets V_b and V_t contain the importance of practices of sets *B* and *T* accordingly:

$$V_b = \{v_1, \dots, v_n\}, \quad (1)$$

$$V_t = \{v_1, \dots, v_m\}. \quad (2)$$

Brynjolfsson's Matrix of Change does not contain the information about explicit replacement of baseline practices with corresponding target ones. For this purpose the authors propose the use of the scale of so-called "Extended Matrix of Change" described in [5]. Thus possible interactions can be described as a set $R = \{r_1, \dots, r_5\} = \{-2, -1, 0, +1, +2\}$ (the use of "-2" between a baseline and target practice imply explicit replacement).

Interactions between practices can be described as the function

$$r(x_i, x_j) = r_l, \text{ where } r_l \in [1,5]. \quad (3)$$

The Matrix of Change also does not contain the information about desired sequence of some changes that may be needed in practice. This desired sequence can be stated as relationships of partial order for the set *X*:

$$x_i \leq x_j, \text{ where } i, j \in [1, n+m]. \quad (4)$$

Taking into consideration designations entered above the Matrix of Change can be represented as a weighted undirected painted graph with practices as nodes and interactions as edges. White nodes belong to the "as-is" subgraph G_b and grey nodes belong to the "to-be" subgraph G_t (Fig. 3).

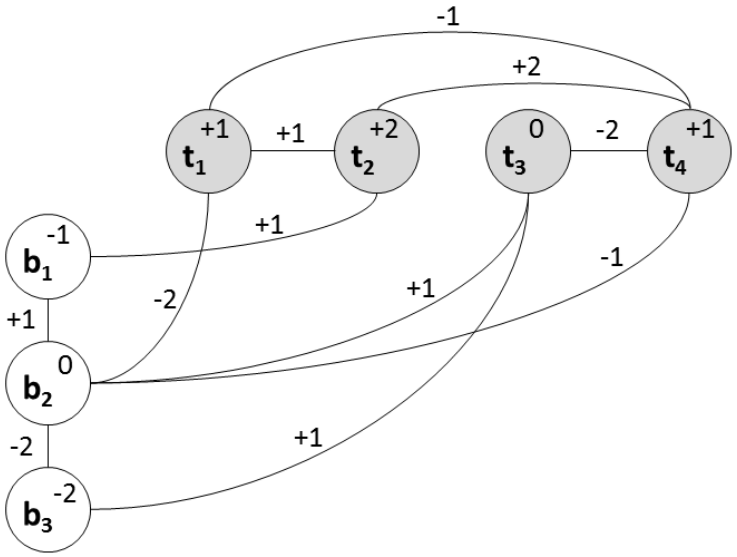


Fig. 3. The Matrix of Change represented as a graph

5 Discrete Optimization Problem Statement

Definition 1. An elementary transformation of graph of practices (or simply "elementary transformation") c_i is implementation of a target practice $t \in T$ or elimination of a baseline practice $b \in B$. The element of the set X corresponding to the elementary transformation c_i is determined by the function $X(c_i)$.

Definition 2. A sequence of elementary transformations is called trajectory $Tr = \{c_1, \dots, c_{n+m}\}, c_i \prec c_{i+1}$. $Tr(G_b, G_t)$ is a set of all possible trajectories from the graph G_b to the graph G_t.

As it was shown above the objective function should reflect the easiness of changes (or elementary transformations).

The easiness of an elementary transformation c_i is measured in relation to the current state of the system of practices represented by the graph $G_i = (X, V)$. The graph G_i corresponds to G_b in which transformations $c_1 .. c_{i-1}$ are already made. By this the easiness of an elementary transformation c_i that corresponds to a new target practice can be calculated as follows:

$$l(c_i) = \sum_{j=1}^{n} r(X(c_i), b_j) + \sum_{j=1}^{i-1} \begin{cases} -r\left(X(c_i), X(c_j)\right), \text{if } X(c_j) \in B \\ r\left(X(c_i), X(c_j)\right), \text{if } X(c_j) \in T \end{cases} \quad (5)$$

The easiness of an elementary transformation for elimination of a baseline practice is the same function but with "minus". The function calculates for an elementary transformation c_i the sum of all interactions between the practice $X(c_i)$ and all practices of the current system of practices G_i (Fig. 4).

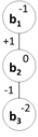
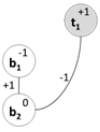
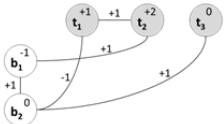
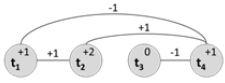
Step No	0	1	2	...	i	...	n+m
Graph	G_b	G_1	G_2	...	G_i	...	G_t
Sequence of graphs							
Trajectory $\{c_1, \dots, c_{n+m}\}$		b_3	t_1	...	t_3	...	b_2

Fig. 4. Transformation of the baseline practices graph into the target one

Consequently, the total rate of the easiness of change for a trajectory Tr_i can be defined as

$$L(Tr_i) = \sum_{j=1}^{n+m} \begin{cases} l(c_j), \text{if } X(c_j) \in B \\ -l(c_j), \text{if } X(c_j) \in T \end{cases} \quad (6)$$

Therefore, taking the formula as the objective function we can formulate the task of finding the best sequence of change for a Matrix as the problem of finding a trajectory $Tr(G_b, G_t)$ for which the total easiness of transformation $L(Tr_i)$ is minimal and minimal easiness of an elementary change $l(c_i)$ is maximal. The latter criterion is introduced in order to eliminate leaps of hardness of an elementary change that can be represented as (-$l(c_i)$).

Let us determine constraints of the optimization task.

As it was shown before some practices have partial order relationships:

$$x_i \leq x_j, \text{ where } i, j \in [1, n+m] \quad (7)$$

Also we should ensure elimination of a baseline practice right before the corresponding target practice if there is a relationship "-2" between them (an explicit replacement). This means that between these two changes there should not be any other changes or for every couple b, t, when $r(b, t) = -2$, there should be a constraint:

$$X(c_i) = b \text{ and } X(c_{i+1}) = t. \quad (8)$$

Eventually the task may be formulated as the following discrete optimization problem:

$$\textbf{Find a trajectory } \boldsymbol{Tr_i \in Tr(G_b, G_t)}\textbf{, where}$$
$$\boldsymbol{L(Tr_i) \longrightarrow max,}$$
$$\boldsymbol{min_{1 \leq j \leq n+m}\, l(c_j) \longrightarrow max,\ c_j \in Tr_i,}$$
$$\boldsymbol{x_i \leq x_j,\ i, j \in [1, n+m],}$$
$$\boldsymbol{X(c_i) = b \text{ and } X(c_{i+1}) = t\ (b, t:\ r(b, t) = -2).}$$

6 Conclusion and Further Work

The authors of the paper develop the approach to business process change management using the Matrix of Change proposed by E.Brynjolfsson in order to overcome the limitations of the tool.

The Matrix of Change is formalized as an undirected weighted graph (practices are nodes and interactions are edges) with two subgraphs (for "as-is" and "to-be" accordingly). The problem of choosing change order is formulated as an optimal "as-is" into "to-be" graph transformation problem. The objective function reflects total easiness of eliminating old and introducing new practices along transformation.

Current work is focused on solution development based on the Branch-and-Bounds method for the problem stated above. In the process of solution development statement

of the problem should be complemented with the use of the importance of practices. Further work includes development of corresponding software and detailed description of the method.

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