A2MO and ETREOSys
Analyzing, Modeling and Validation of Enterprise Training Programs

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Abstract: Organizations and public authorities invest substantial sums in training, but rarely have data indicating the results of this investment. Because of the difficulties related to existing models, to the lack of valid instruments and workable models, only a few organizations evaluate their training project in depth.
In this paper, we propose an approach of training project evaluation, based on *Business Process Management* (BPM). This approach consists in *Analyzing* the needs, process *Modelling*, *Monitoring* the project progress and ensuring the expectation of the objectives, *Optimizing* the global and personal yield by a series of simulation (*A2MO method*). To facilitate the understanding and the use of A2MO, we develop a *Business Process Management System* named **ETREOSys** (***E**nterprise **TR**aining program **E**valuation and **O**ptimization **Sys**tem*). A2MO ensures the alignment between training activities and enterprise business objectives. It allows training project monitoring, calculating tangible and intangible benefits of training (without additional costs). It also allows making a training projects classification according to criteria bound to enterprise and employees, to optimize training activities in order to answer the enterprise objectives and employees needs.

1 INTRODUCTION

Individual and collective skills are the most important assets for an organization. They determine the productivity, competitiveness and ability to adapt and to be proactive in an uncertain economic environment. A report published, in 2011, by the *American Society of Training & Development* (ASTD) reveals that Businesses in the United States spent $171.5 billion on employee learning in 2010, 26% more than in 2009 (Green and McGill, 2011). The report confirms that, despite economic challenges, organizations understand that a highly skilled workforce is a strategic differentiator and they are willing to invest in the development of their employees skills.

On the other side, a study led by ASTD and the Institute for Corporate Productivity (i4cp), revealed that the *five-level Kirkpatrick/Phillips model* (Kirkpatrick and Kirkpatrick, 2006; Phillips and Phillips, 2003) of learning evaluation is the most common practice. According to this study, the barriers that prevent companies from using all the evaluation levels of Kirkpatrick/Phillips'model are: *the difficulty in isolating learning as a factor that has an impact on corporate results; the lack of a useful evaluation system within the learning management system; the lack of standardized data to properly compare across training functions* (Patel, 2010).

Thus, to bring a solution to enterprises needs, we present, in this paper, an approach of training evaluation and optimization, based on BPM.

BPM has become a critical success instrument to improve the enterprise overall performance (Mutschler and Reichert, 2013). The success registered by BPM solutions in managing enterprise processes has inspired us in using it to manage training activities. Such a scenario supposes considering training activities as being business process. In fact, the design and execution of a training program supposes a set of steps that go from the formulation of a demand up to the implementation of new skills. All these stages, enumerated by chronological order, constitute a process as any other business process, and can lead to a capital gain if everything took place correctly. So, they can be managed using BPM.

This paper presents a method of training project management (A2MO method) based on BPM: going from design to optimization, via the evaluation of the financial and non financial yield.

In the following, we present, in section 2, the Kirkpatrick/Phillips model for evaluating training programs in organizations, the advantages and disfa-

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vors of this model. Section 3 will be dedicated to a brief presentation of A2MO method and ETREOSys. In sections 3.1 and 3.2, we present, in details, the two first steps of the A2MO method and ETREOSys' corresponding modules. The section 4 is reserved for the conclusion.

2 THE FIVE-LEVEL KIRKPATRICK/PHILLIPS MODEL

Kirkpatrick's model began in 1959, with a series of four articles on the evaluation of training programs in the journal "Training and Development". These four articles defined the four levels of evaluation that would later have a significant influence on corporate practices (Kirkpatrick and Kirkpatrick, 2006).

Level 1 - Students reaction
How did the trainees react after the training? Did they appreciate it? Are they satisfied? What they thought and felt about the training?

Level 2 - Learning
What they learnt after the training? What knowledge, skills and/or attitudes have been acquired? Have educational objectives been achieved? The resulting increase in knowledge or capability.

Level 3 - Behavior
Do the trainees use what they learned in training at their workstations? What new professional behaviors have been adopted?

Level 4 - Results
What is the impact of the training on the results of the company? Example: decrease of the rate of absenteeism, occupational accidents, growth of turnover, the productivity, customer satisfaction, etc. The effects on the business or environment resulting from the trainee's performance improvement.

According to Phillips, training yield calculation is made by means of a process by stages which supplies a plan detailed for *the planning, the collection and the data analysis*, which includes the calculation of *Return On Investment* (ROI). So Phillips suggests the inclusion of a fifth level (Phillips and Phillips, 2003).

Level 5 - Return On Investment
Comparison between the profit obtained from the training and the training costs. Profits and/or savings realized are they superior to the total cost of the training (direct and indirect costs)? Did the training generate a return on investment?

The ROI calculation process begins with a planning for training evaluation: where objectives are defined and decisions are taken on the way the data will be collected, treated, and analyzed. The data collection is made according to the training evaluation levels 1 to 4.

However, in the literature, several criticism are raised with regard to the Kirkpatrick/Phillips model. According to Mumma and Thatcher (Mumma and Thatcher, 2009), the entire notion of the Kirkpatrick/Phillips model may not truly measure the impact of the learning function on the organization, even under the most optimistic scenarios. It measures only the possible impact of isolated training events. Nagle (Nagle, 2002) reports a series of criticism towards the ROI calculating process: *difficulty to have a faithful measure, expensive process, complex process, process that can take up to one year, presence of other factors (independent from the training) that influence the performance of the organization.*

Concerning the methodological problems, McCain (McCain, 2004) has established a list of bias being able to have an impact on the observed results and of which a professional of the training does not always think. We can quote the bias of a sample (selection of a non representative sample or too small one), bias in the interviews, bias of acquiescence or neutrality according to the presentation of questions.

Thus, to bring a solution to the enterprise needs, we present, in the following section, an approach of training yield evaluation, based on the business process management.

3 A MODEL OF TRAINING EVALUATION BASED ON BUSINESS PROCESS MANAGEMENT

All performance problem is not a problem of training, but a judiciously applied training can stimulate skills and improve the performances of persons in their jobs. The reality in most enterprises is that they need to know how to calculate and improve the impact of their spending on training more important on the enterprise overall performance. When training costs are considered with a critical eye, many organizations realize that they simply did not have enough money to train all employees. They need to focus their training spending on the roles which are most essential for the success of the enterprise and which return more value to the organization. For that purpose, managers in training and development should collaborate with

managers to clarify the essential points on which depends the success of the organization, establishing performance criteria and focusing training on these criteria. By comparing the performance before and after training, the value of learning activities can be calculated on the basis of the impact on the business.

Thus, we propose a four-step approach of enterprise training program management. This approach consists in *Analyzing* the need, process *Modelling*, *Monitoring* the project progress and guaranteeing the expectation of the objectives, *Optimizing* the global and personal yield by a series of simulation (Fig. 1).

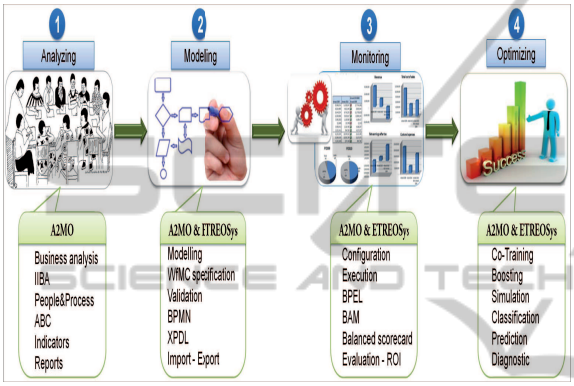

Figure 1: The stages of A2MO method.

To facilitate the understanding and the use of A2MO, we develop a *Business Process Management System*(BPMS) named **ETREOSys** (***E**nterprise **TR**aining program **E**valuation and **O**ptimization **Sys**tem*), characterized by the following architecture (Fig. 2).

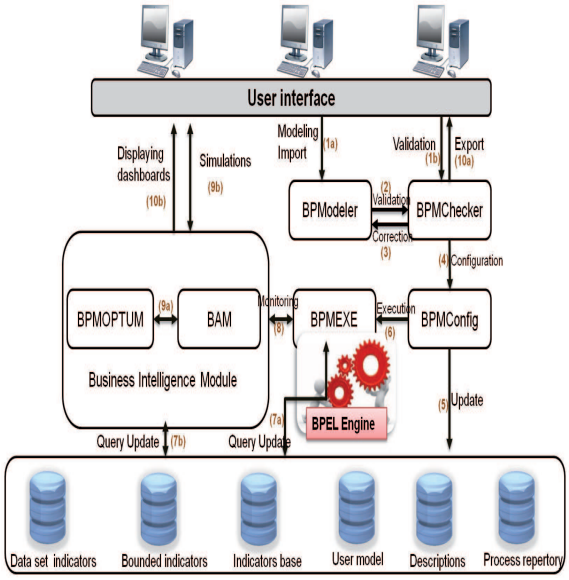

Figure 2: Architecture of our enterprise training processes management system.

In the sections 3.1 and 3.2, we present the two first steps of the A2MO method and ETREOSys' corresponding modules.

3.1 Stage 1 - Analysis

The training in enterprise consists in a series of specific actions intended to resolve a problem with which the enterprise is confronted. Thus, the first stage of A2MO focuses on analyzing the demand for training and associating it to performance elements of the enterprise. This stage is translated by a certain number of actions such as: *conversations of demand exploration, definition of a change plan, needs analysis, definitions of the objectives, choice and definition of performance indicators*. Therefore, we use a business analysis process combining the guide of *International Institute of Business Analysis* (IIBA), the method *"People&Process"* and the method *Activity-Based Costing* (ABC method).

IIBA maintains and publishes a referential containing a description of the activities of the business analysis. The referential is published as a book entitled *"A Guide to the Business Analysis Body of Knowledge* (Brennan, 2009)". This latter provides a description of a typical business analysis activities into six chapters: *Analysis of enterprise initial situation; Planning and management of prerequisites, needs and expectations; Harvest of the information; Analysis and documentation of needs and expectations; Communication of information to stakeholders; Evaluation and validation of the proposed solutions.*

The development of systems and their components is based on needs description. The needs determination depends on the form and the structure of the demand. IIBA provides an initial classification of forms of expression of needs and expectations into six levels (see IIBA guide (Brennan, 2009)).

The analysis of the current situation produces a report containing a structured presentation of harvested information and details of *the objectives, the means and available resources, improvement proposals, risks and potential impacts.* Managers evaluate *the strengths, weaknesses, opportunities and risks for the organization.*

A business process model is therefore based on the identification of key elements in the conduct of affairs such as *endogenous and exogenous factors directly acting on the fluctuations of the functioning mode of the enterprise*. This last point solves the problem of isolation of training impacts on the overall performance of the organization (highlighted in the Kirkpatrick/Phillips model, see section 2). Indeed, using the process of IIBA, we define the indicators related

to the expected effects of the training and the factors that may influence these effects. This means that we also define the situations and indicators that can produce the same effects as training.

The second method that we use at this stage is the "People&Process" method (Briol, 2008). The managers fixe the high-level objectives according to their visions. These objectives are then formulated in the lower level objectives. An achieved goal answers the criteria of successes expressed with indicators offering a means of measuring and verifying the gaps to the initially set values. The Objectives formalized in dashboards are used in the design and supervision of business processes.

The translation of an objective in indicators form depends on its formulation. For example, the objective "*... make more results next year ...*" could possibly be subject to diverse interpretations. Generally, these interpretations are reflected in several indicators distributed among the entities or functions of the organization such as finance function, production, human resources, etc. There are two types of performance indicators in a cause and effect relationship:

- Indicators directly allocated to outcome of actions already executed such as financial or social indicators of the enterprise.
- Indicators influencing or controlling the indicators of the first category. For example, the "*number of products sold*" directly influences the indicator "*turnover*".

Furthermore, there are two categories of indicators: qualitative indicators such as social values and quantitative indicators taking a digital or symbolic form.

The indicators, by measuring performance of the organization, play an important role in verifying its alignment with enterprise strategy. They are deduced either directly from objectives or key success factors influencing the strategy success.

In A2MO, the description of the training intangible yield is based on the values of qualitative indicators. As these indicators are directly linked to some objectives, then the reached (or the not reached) of these objectives will be deducted from the values of the corresponding indicators. The same reasoning applies to the calculation of financial yield of training. This yield is calculated by mathematical formulas (cost/benefit ratio), after deducting costs associated with quantitative indicators values. For that purpose, we use the ABC method (Activity-Based Costing).

The ABC method allows to determine costs associated with a set of business activities prior to a change and the gain due to the change (Richard Orwig and Flather, 2012).

The ABC method considers the goods and services as objects of costs in exchange for a definite and organized effort. This method is structured by answering three questions: *What is spent? How it was spent? What has been produced?*

The activity concept is at the center of ABC method. An activity is a set of elementary tasks performed by an individual or a group,appealing to specific set of cognitive capacities (knowledge, know-how, skills), more or less homogeneous from the point of view of their performance behavior. An activity is described using an action verb followed by an object (ex. make something). Each activity has a recognizable production (an output), one or more customers and uses identified resources. The impacts of an activity, on the growth of the enterprise, can be quantifiable or of social order.

The performances of the organization depend directly on resources consumed at the origin of the costs. The resources cost takes into account the expenses associated to the human effort, raw materials, equipments of production, indirect costs of production and to the overheads. The *inductors of resources* are used in the affectation of the costs in the activities by associating the resources with the activities. The inductors of resources are expressed in cost per minute of activity. It can be also expressed by qualitative values (qualitative indicators) spread over several periods of observation. Each type of resource used in an activity becomes a cost element. The cost elements associate an activity with an inductor which measures the utilization level of these elements in the activity. The ABC method offers the means to verify the resources consumption of business processes in the organization.

This first stage of A2MO supplies the process model, the information required to configure this model, the initial values of indicators. It ensures the alignment of the training program to the growth strategy of the enterprise.

At the end of this stage, we shall have isolated all the indicators associated to the problem. As example of indicators we can quote: *cost of the delivery delay, the number of item (or service) delivered late, accumulated delay ....*

We also isolate the indicators which can influence those quoted previously (with or without training program). For example: *rate of staff turnover, rate of employees absenteeism, number of absence per employee, cause of absence, cost of the rotation, cost engendered by absenteeism, cost of absence per employee, degree of job satisfaction, degree of personal initiative, staff productivity, level of collaboration between employees within the enterprise, level of col-*

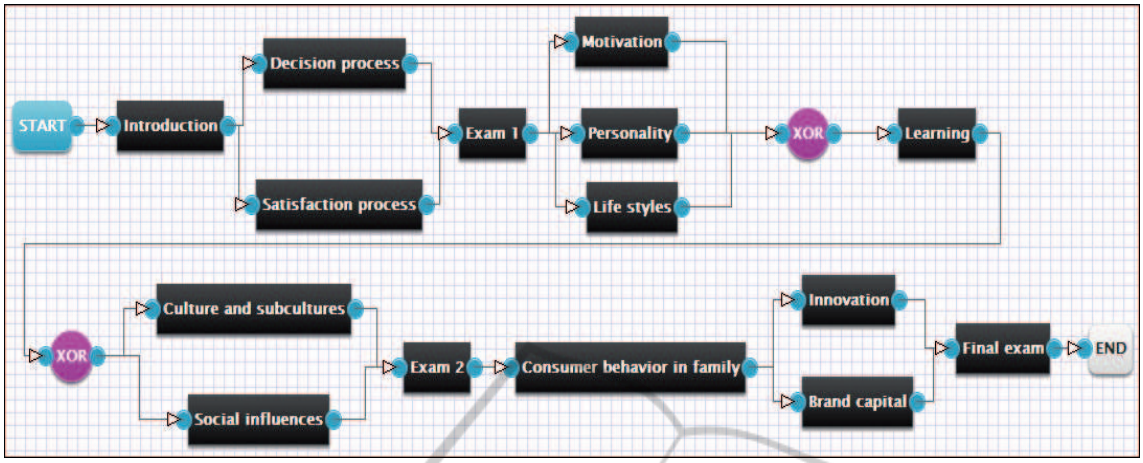

Figure 3: A possible process model for training planning "*Consumer behavior*".

laboration per employee . . . .
In the next sections, we present the second stage of A2MO. This stage is strongly related to ETREOsys.

3.2 Stage 2 - Modelling

This stage is supported by modules ***BPModeler*** and ***BPMChecker*** of ETREOSys. To model a business process, **BPModeler** uses graphic objects developed by Workflow Management Coalition (WFMC, 1999). In this modelling language, we use two object types: *node and flow*. The nodes are classified in two categories: *task and choice (condition)*. A task, graphically represented by a rectangle, represents the work to be made to achieve some objectives. A choice, graphically represented by a circle, is used to build conditional structures. A flow links two nodes in graph and is graphically represented by an arrow.

The use of invalid process models (bad combinations the objects) leads to syntactic errors. Semantic errors happen because of the non-compliance (lack of strategic alignment) at the expected business needs.

For checking the syntactic validity, we analyze the structure of the process graph. In order to insure the structural validity of process models, we use the hybrid algorithm of Touré et *al*. (Touré et al., 2008).

On the other hand, to check the semantic validity, we need to analyze the information treated by the tasks and the behavior of the latter (if the first stage of A2MO, see section 3.1, is made with precaution, the semantic errors will be avoided).

For the training project management, there are at least two process models: the *process model related to training planning* and the *process model related to the stages of data collection and training performance evaluation*.

The training planning is a graphical representation of the training organization (course outline). To illustrate this concept, let us take the example of an enterprise which would like to improve the performances of its customers service department. For that purpose, the enterprise would like that the employees of this department can make a complex analysis of consumer behavior and communicate results to managers and strategic advisors. This means that employees must be trained on *consumer behavior*. Figure 3 shows a process model of the planning of this training.

It is possible to have more granularity depending on the task (for example, there might be a process model corresponding to the decomposition of the activity *Decision process* (see Fig 3). Ditto for the activity *Perception* (see Fig 3)).

In A2MO, we associate to this graph (see Fig 3): the *actors* of each activity and their roles, the *description* of incoming and outgoing data, the *temporal aspect* and the *performance indicators* related to training (see section 3.1). As indicators, we can quote: *average emotional state by learner, average emotional state by training session, general emotional state by training, satisfaction of the organization with regard to the training program, Employees' satisfaction with regard to the content, satisfaction towards the trainer, relevancy of perception, the usefulness of training, training capacity to reach enterprise objectives, the notes of the examinations, the average score of the learning*. . . .

The planning of the collection and training evaluation is a representation of the steps of collecting information before, during and after the training (Figure 4). In A2MO, for each step (activity of the process in the Figure 4), we define the means of collection, dates, the objectives, the actors and the corresponding indicators. All these informations are kept in ETREOSys to facilitate the management of the training pro-

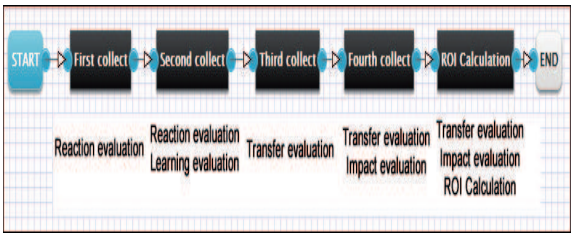

Figure 4: A possible process model for training evaluation planning.

gram. Consequently, besides the already mentioned indicators, we define other indicators allowing to estimate the achievement of the training objectives in the enterprise. These indicators relate to the employees' lives in the enterprise before and after the training. We can quote as indicators: *increase of the innovation degree of an employee, the increasing of the innovation degree in the enterprise generally, the improvement of the product quality, work climate, the meetings number of the committee, customers loyalty, the profit by employee.*...

For the particular case of the formation modeled in Figure 3, we must take into account the *influence of environmental factors* on consumer behavior such as *culture, reference groups, social class or family*. Therefore, it is necessary to define indicators allowing to isolate the influence of these external elements.

The process model, related to the evaluation, fixes periods of gathering information order to proceed with of evaluations and simulations leading to predict the results tendency. These last information will allow to make decisions leading to the success of the training program. Through to the indicators, the process model associated with the evaluation will allow to react in real time to avoid any situation leading to the failure of training (non-realization of the objectives). For that purpose, it is just enough to compare the initial values, the collected values and the expectations of the enterprise.

The first and second stages of A2MO are important because they insure a best management of the training program and the basis for the success of the stages 3 and 4.

3.3 Stage 3: Monitoring

This stage of A2MO consists in controlling the progress of the processes. A control based on precise indicators and relevant in order to have dashboards allowing making quickly the good decisions. The dashboard of the training has to cover two big dimensions: the efficiency and the efficacy. The training process said to be efficient if it gives the maximum of results by consuming the minimum of resources and said to be effective if it gives the expected results.

The dashboard of the efficiency of the training will be composed of indicators of consumption of resources and of activities output allowing measuring the efficiency of each of the three stages of the process, as well as the general efficiency of the training project. The following indicators allow building the dashboard of the efficiency of a training program: time dedicated to the identification and to the needs analysis (combined time of the employee, his superior and the training manager), perceived usefulness of the training/time dedicated, the gap enters what the employee masters and what he has to master, the adequate level of training to reduce or cancel the gap (beginner, intermediate, advanced), mode of training (*external, intern, coaching, e-learning, tutoring, etc.*), time to design and the elaboration of the program, etc. These indicators can be analyzed by sex, seniority, social status, type of training, or operational unity (*service, department, store, etc.*). The dashboard of the effectiveness focuses either on the effectiveness of a training, or on the global effectiveness of the training system. Its structure includes the model of training evaluation and contains more indicators than the efficiency dashboard.

This stage allows us to calculate the tangible and intangible training benefits (without additional costs) by using indicators values.

3.4 Stage 4: Optimization

In this stage of A2MO, we use machine learning algorithms (example, logistic regression, neural networks or support vector machines) to *classify training activities* according to defined criteria (example, financial yield) and to *do simulations* to increase the efficiency and efficacy of training activities. To do that, we realize a pretreatment on the indicator values to have a data set for a supervised learning algorithm, unsupervised or semi-supervised. The stages of monitoring and optimization constitute our module of business intelligence because they allow: improving personal efficiency, speeding up the process of decision making, increasing organizational control, encouraging exploration and discovery on the part of the decision maker, speeding up problem solving in an organization, facilitating interpersonal communication, promoting learning or training, generating new evidence in support of a decision, creating a competitive advantage over competition, revealing new approaches to thinking about the problem space, and helping automate managerial processes.

When the training evaluation process is completed, the enterprise training programs will be clas-

sified in two categories: profitable and unprofitable. Hence, we will have a dataset D_n that can be used in training of a machine learning algorithm.

$$D_n = \{Z_1, Z_2, \ldots, Z_n\}$$
$$\forall i \in \{1,2,\ldots,n\}, Z_i = (x^{(i)}, y^{(i)}) \text{ with } x^{(i)} \in \mathbb{R}^d \text{ and } y^{(i)} \in \{0,1\}$$

Each Z_i is associated to a particular training program in the enterprise. The $x^{(i)}$ are the indicators (see 3.1 and 3.2) related to the training. Hence, we can have indicators which take numerical values (for example,*number of committee meeting*) and others that take categorical values (for example, *climate at work*). $y^{(i)}$ represents the training class (*profitable or unprofitable*), profitable corresponds to 1 and its opposite corresponds to 0. **n** is the number of completed training program and **d** is the number of indicators.

It is obvious that to use this data set with a machine learning algorithm, it is necessary to make a pretreatment to *standardize* or *normalize* the inputs $x^{(i)}$.

In our approach, the purpose of the classification is to be able to predict the achievement or none achievement of the training objectives by observing only the indicators behavior. Furthermore, we must be able to determine the indicators which have more weight in the realization of training objectives. That's why we may use a parametric machine learning algorithm like logistic regression, neural networks or the support vector machines.

The optimization consists of a simulation allowing guiding the training process towards objectives achievement. To do this we may use semi-supervised learning.

4 CONCLUSIONS

The advantages obtained through our approach can be seen from two angles. In the domain of business process management, we add a new category of business process and extend BPMS by adding the validation pre-execution (through ETREOSys).

Concerning the evaluation of enterprise training, we propose a complete approach of training project management facilitating decision-making and the calculation of the tangible and intangible profits.

With regard to the existing training evaluation models, we propose A2MO method. This approach consists in *Analyzing* the need, process *Modelling*, *Monitoring* the project progress and guaranteeing the expectation of the objectives, *Optimizing* the global and personal yield by a series of simulation. We add a particular level of diagnostic (classification and optimization) allowing to understand the dysfunctions related to the attainment or not attainment of training objectives. Our approach ensures the training activities alignment with business needs and allows the ROI calculation without additional investment.

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