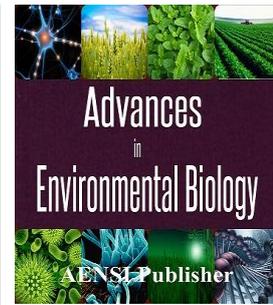




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Analyzing Balanced Scorecard with System Dynamics

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ABSTRACT

The Balanced Scorecard (BSC) as a common way of performance measurement let the managers to convert strategic goals of company to the series of performance measurement criterions. It means that successful organizations are not only dependent on financial measures but they also measure their performance from three aspects; customer, internal process, learning and growth. The Balanced Scorecard focuses attention of management on just a few measures and bridges different functional areas but it has also received some criticism as follow: BSCs focus on unidirectional causality, are unable to distinguish delays between actions and their impact on performance, have a dearth of validation capabilities, integrate insufficiently strategy with operational measures and suffer from internal biases. We propose a system dynamics approach to develop a BSC in order to overcome these limitations. We present a case study from the company of generating medical equipment where this approach is applied. The results suggest that developing a BSC with system dynamics is a promising approach to supplement existing BSC frameworks.

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INTRODUCTION

Performance management, and in particular the version of it known as balanced scorecard (BSC), has become a topic of considerable interest in both the business world and in academia [7]. The term and concept of the BSC originates from the field of Management Accounting, where control on the basis of purely financial criteria was found to be inadequate [7]. To this end, traditional planning and control system exclusively based on financial indicators are insufficient to communicate to shareholders and other stakeholders the value creation process the management wants to foster through the designed strategy [11]. As a matter of fact, if not accompanied by other indicators, financial measures do not provide an accurate picture of the companies direction and, so, can lead the management to seek short-term goals rather than long-term growth.

For instance, managers may be reluctant to invest in intangible assets in order to avoid reductions of current financial results [13]. In the long term, however, such a policy may imply lower efficiency and effectiveness, as well as customers and other stakeholder's dissatisfaction. In addition, the Balanced Scorecard minimizes the distance between different fields [1].

Despite or perhaps in response to its popularity. The BSC concept is not without criticism. In this paper we will argue that these criticisms can again be traced back to an often implicit systems perspective on organizations. Broadly speaking, these criticisms can be seen as the other side of the coin for the before-mentioned advantages of the BSC. Yes, from a systemic perspective one may expect that only a few process indicators can point at the key leverage points of the system [3].

In this paper we discuss five shortcomings to the currently common way of developing and using BSC. We also present a BSC development approach to overcome these weaknesses, one that is based upon system dynamics modeling.

The reminder of this paper is structured as follows. The upcoming section contains a brief literature overview of the main contribution of the BSC and the shortcomings noted to current theory and practice. Then we discuss how system dynamics modeling could overcome these shortcomings. Section 4 describes the case setting and section 5 the structure of the simulation model that was developed by VENSIM software. We then

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present in section 6 the findings from our model analysis and finally we propose research limitation and our main conclusion in section 7.

Advantages and limitations of current bsc theory:

The Business Scorecard is a performance measurement system introduced by Kaplan and Norton [7]. According to these authors, a BSC addresses shortcoming of traditional performance measurement system that relied only on financial measures. To overcome this, Kaplan and Norton [7] introduced three additional measurement categories that cover non-financial aspects. The result is a scorecard that translates the strategy of a business unit into objectives and measures in four different areas:

1. The financial perspective: this aspect includes criterion of profitability like operational profit , Return On Invested Capital , sales growth, cash flow growth or Economic Value Added;
2. The customer perspective: how the company wishes to be viewed by its customer;
3. The internal process perspective: this aspect explains the required proceedings for efficient operating in organization and it is focus on internal process of organization;
4. The organizational learning and growth perspective: this aspect answer the question that if the organization can continue its improvement or not?

It may seems that the word "balanced" in this approach means creating an equipoise in measures that are relating to the 4 perspective of BSC, but indeed as Kaplan and Norton said the majority of Balanced scorecards measures in organizations relay on financial measures (35%) yet, so the word " balanced" here creates the equipoise between:

- Financial and non-financial measures;
- Internal and external shareholders;
- Short-term and long-term goals;
- Dependent and independent indicators

Advantage1:

The first advantage of BSC is that focuses management attention on just a few numbers of performance indicators. Creating only three or four strategic measures for each perspective of balanced scorecard can help the organization following performance indicators which are necessary for selected strategy, this let the management to concentrate on long-term goals rather than short-terms. [1].

Advantage2:

The second advantage of the BSC is that it serves as a bridge between different fields. Both financial and non-financial measures are included in the scorecard.

Also researchers from different management fields have examined the concept. The management accountancy aspect of the BSC has been considered by, for example Newing [12] and Norreklit [13]. From a strategic perspective, the BSC has been described by for example Mooraj, *et al.* [10], Hudson *et al.* [6] and Kaplan and Norton [8]. Also in operations management field the BSC is well-known [11,2,5]. This successful use of the Balanced Scorecard by researchers and managers from different fields indicates that it is possible to combine performance measures related to different aspects of a company into only one scorecard.

Limitations:

1. Unidirectional causality too simplistic.
2. Does not separate cause and effect in a time.
3. No mechanism for validation.
4. Insufficient links between strategy and operations.
5. Too internally focused.

System dynamics as a method to overcome bsc limitations:

In this article, we advocate the use of system dynamics as a method to overcome the limitation of current BSC. In particular, we suggest a two-stage process of system dynamics (SD) model building for BSC development:

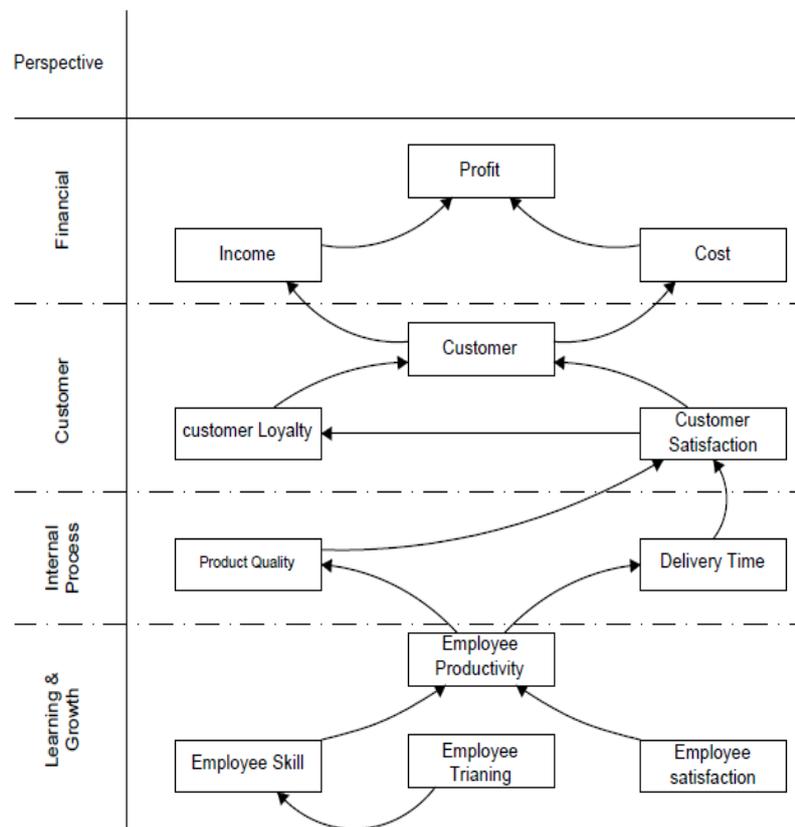
Stage1: elicit mental models from management of perceived interrelationships using causal loop diagrams (CLDs).

Satage2: translate causal loop diagrams into a quantified simulation model using key company data. (Akkermans and Oorschot).

Systemthinking requires some changing in system operation. It means that when there is system perspective, we see all the evidence as a whole unit system which is in relationship with other systems. [4]

Table 1: BSC limitations and System dynamics solution.

BSC limitations	System dynamics solution
Unidirectional causality	Creating feedback loops.
Does not separate cause and effect in a time.	considering delays and accumulation
No mechanism for validation.	Creating quantified simulation model that can be more rigorously tested and validated.
insufficient links between strategy and operations	Linking strategy with operations and use organization policy in model.
Too internally focused	Broadening system boundaries with challenging the clouds.

**Fig. 1:** Strategic plan of organization.*Study subject, utabtajhizmehregan company:*

The scope of the company's activities according to the number 6 article of the statute is comprised of designing, manufacturing and producing medical machines and equipments and doing all sorts of commercial and financial exchanges including purchase, sale, import and export regarding the subject of the company in recent years, the organization has encountered with several changes. At first, it encountered with some changes in senior managers, then with high customer demands; therefore it intended to increase the work force and finally encountered with stability and then decline of demands. It's obvious that meanwhile the organization involved in some problems, therefore, we are willing to help solving these problems by improving the organization performance.

Model structure:

Nowadays, the discussion of recognition and modeling the organizational processes is prevalent in many of the large and small scale organizations. The discussions about management and modeling the organizational processes can be presumed as an important factor in organizations' success in business. In spite of the fact that there's no premade instruction for modeling, all of the successful modelings follow a regular process which consists of the following activities:

1. Defining the problem
2. Arranging the dynamic hypothesis (or theory) about the roots of the problem
3. Arranging the simulation model for testing the dynamic hypothesis
4. Model testing
5. Designing and evaluating the policies for improvement. [9]

"Generally, visualizing the sequence of business activities and related information are called Modeling."

The steps of dynamic balanced – scorecard is as follows:

1. Full understanding of the organization in which, the dynamic balanced – scorecard is going to be performed.
2. Translating the strategy of the organization into operational objectives. Recognizing the four dimensions of balanced – scorecard and drawing the plan of organization’s strategy and then specifying performance indices according to the designated goals.
3. Drawing the convoluted causal diagram based on the cause and effect relationship between indices.
4. Setting the quantity model (stock and flow diagram) using Vensim software based on the four dimensions of balanced – scorecard, defining each element and determining the quantitative relationship between them.
5. Evaluating and modifying the model of system dynamics using the methods of system dynamics.
6. Simulating and analyzing the model and then comparing the results with real system; continuous modification of the model to reach the complete conformation with real situation.
7. Redesigning the relationship between model factors and using the results of the model to change the current position of the model.

Designing the model of dynamic balanced – scorecard:

Recognizing the problem and defining the problem (choosing the limit):

The balanced – scorecard just represents a complete image of the organization, but it’s static. The purpose of this article is that the system dynamics is used as a tool for increasing the effectiveness of the balanced – scorecard. System dynamics lets us to observe the dynamics of system behavior, using mathematical model of elements and their relationship in the system. Now, let see the strategic plan of the organization:

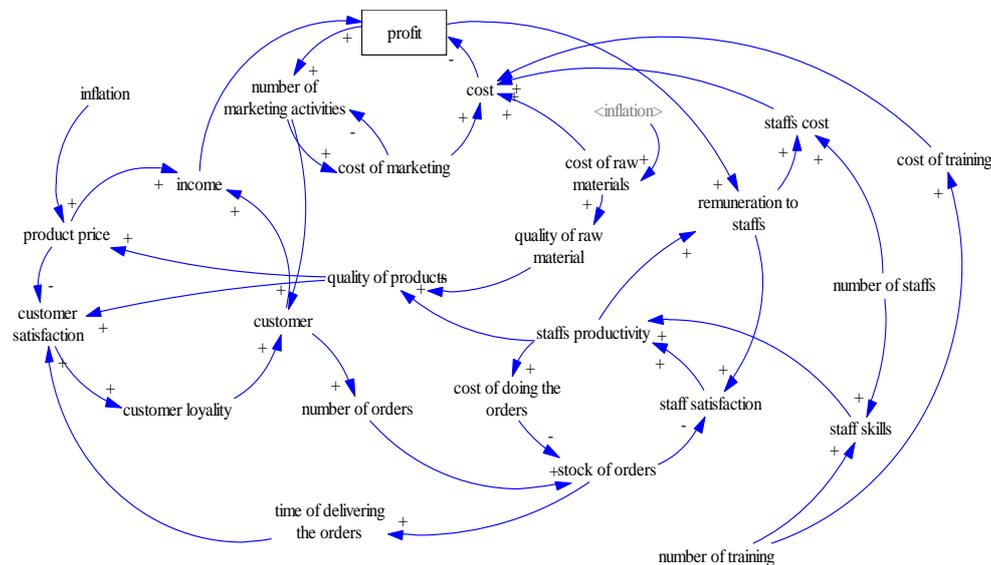


Fig. 2: The cause and effect diagram of strategic plan of the organization.

Dynamics hypothesis:

Starting point of the causal circle is education of personnel. Education leads to learn knowledge and new skills and improves the skill level of personnel. By increasing educational terms the skills improve more and more, and the skill level decreases when the employee leaves the office. In other words, to maintain knowledge in a fixed level needs constant education. Development of personnel’s skills leads to their productivity. Productivity of personnel in doing and completing orders and decreasing the stock of orders has a prominent effect and finally decreasing the stock of orders leads to personnel satisfaction. Raw material with a cost – creating nature has a positive effect in the quality of product. It means, by spending more money for raw material, the quality of raw material increases and high quality of raw material increases the quality of products. Improvement of product’s quality, in one hand leads to more satisfaction of customers and hence increases the number of customers, and on the other hand leads to high price of the product. But it finally leads to more income and profit. More profit leads to spending more capital for purchasing high quality raw material. In addition, cost – creating marketing activities lead to increase the number of customers. Increase in customers numbers leads to more income and profit. More profit also increases the number of marketing programs. Remuneration as a cost – creating factor, affects the productivity of personnel. Productivity of personnel leads to creation of high quality products and high quality leads to customer satisfaction and loyalty. Satisfied and loyal customers, by their positive suggestions to others about your business, lead to attracting more customers

and having more income and finally lead to more profitability. As the amount of income and profit increases, the more remuneration is presented to the personnel. The number of orders increases, regarding the increase in the numbers of customers in the system. Increase in the number of customers lead to stock of orders and heavy workload leads to dissatisfaction of personnel and reduction of their productivity. Reduction of personnel's productivity, by affecting the quality of products, may have a negative effect on customers' satisfaction and loyalty and this low satisfaction and loyalty, in turn, leads to reduction of customers.

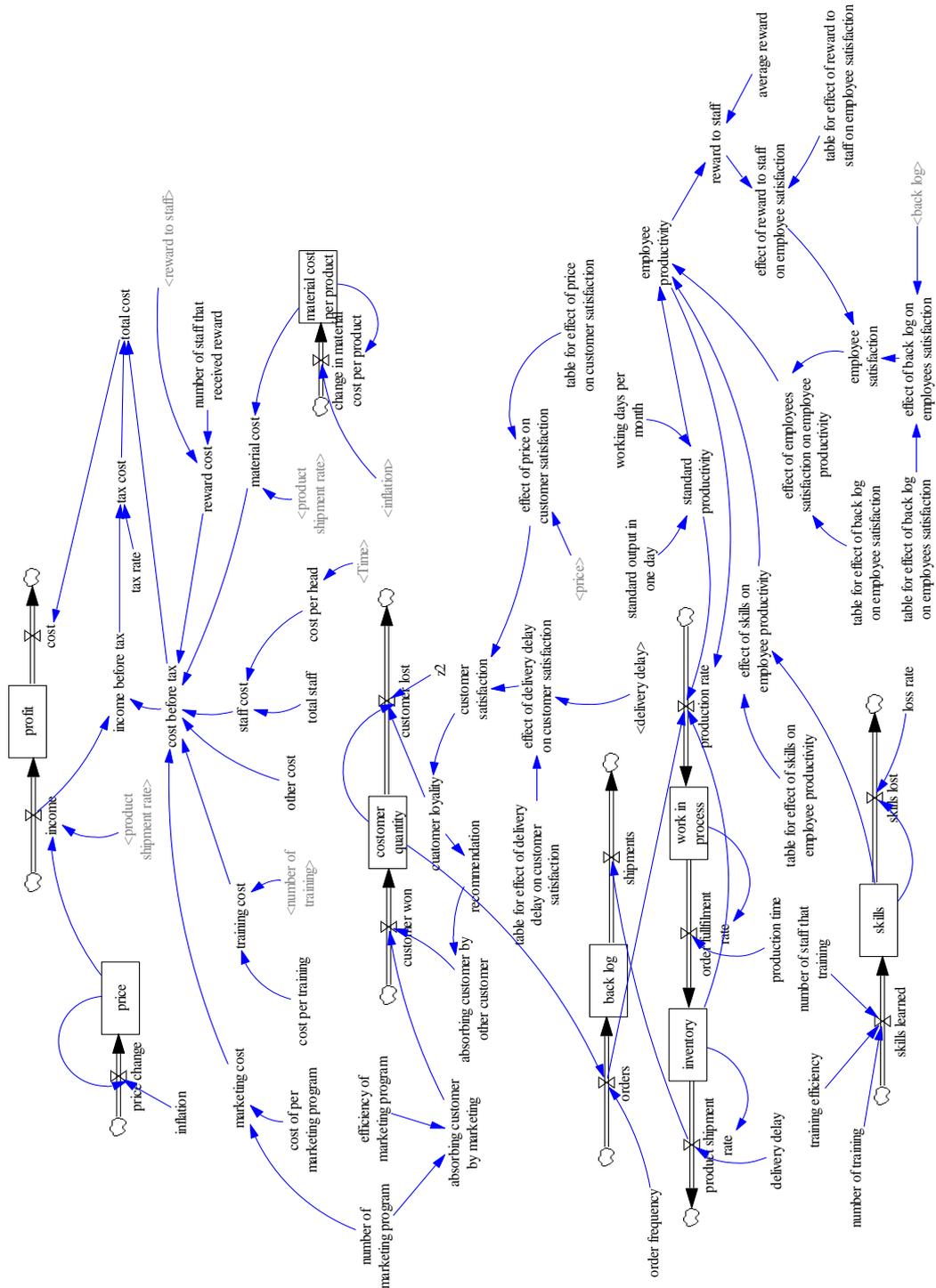


Fig. 3: Simulation model of dynamic balanced – scorecard.

Cause and Effect Diagram:

The cause and effect diagram of strategic plan of the organization is as follow:

As the figure presents, the atop cause and effect relationship happens between the important key variants of the organization, and several times the come and go relationship happens between the variants in aspects of the strategy plan and each of them affects the increase and decrease of the other dynamically and as cause and effect relationships. Actually, these effects occur with a proper delay in accordance with dynamic systems' concepts and this issue is being considered in design and quantitative calculations of next part and in the simulation software, by available functions.

Performing the simulation model of dynamic balanced – scorecard:

As you consider, the simulated model is performed after being designed in VENSIM software and results and the procedure for predicting the variants is shown in the figure.

Results of the model:

After investigating the strategy, objectives and activities of the company, we found out that the training and learning activities of the organization have greater impact on income, profit and finally satisfaction and productivity of personnel, comparing to other parameters such as granting remuneration to the personnel. A the present, the subject of staff training is under discussion in the aforesaid company, but the present quantity of educational activities are not enough for increasing productivity of the personnel and quality of products and also continuing to live in the competitive situation and gaining more percentage from the market share. We're willing to find out by changing these numbers of training, how the other variants such as satisfaction and productivity of personnel and finally income and profit will be. In the diagrams of the following figure you can see the effect of increasing training activities from 3 programs per month to 5 and finally 10 educational programs per month.

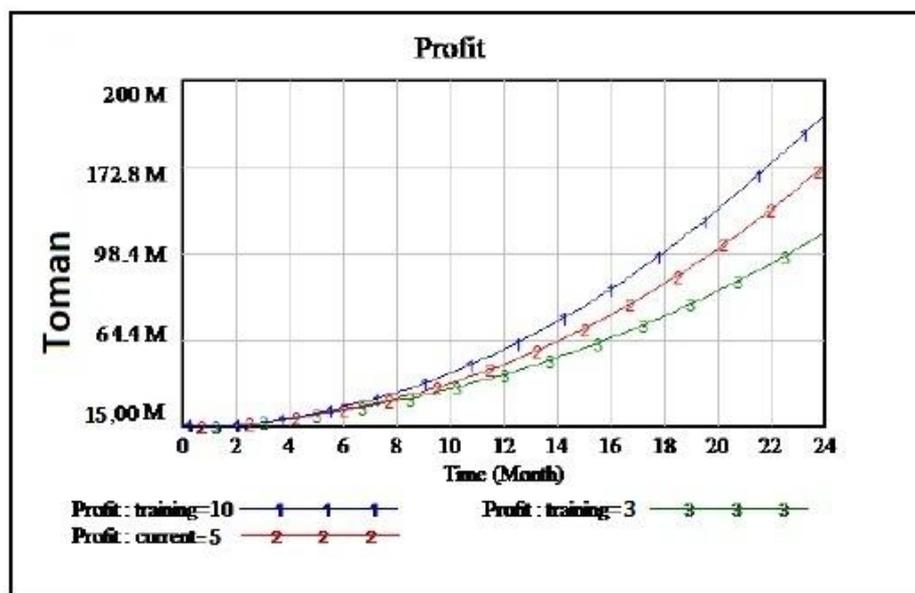


Fig. 4: The effect of increasing training activities from 3 programs per month to 5 and finally 10 educational programs per month.

Results:

The Balanced Scorecard is the best way of performance measurement in organizations that considers both financial and non-financial measures and makes equipoise between both internal and external shareholders and also between Short-term and long-term goals; BSC presents a full and complete image of the system but this image is static. In addition this measurement system suffers from internal biases. So we can broaden our mental model by system thinking and dynamics system and see the organization as a whole dynamic unit with casual loops in it.

Such measurement system is not only appropriate for generative companies but it is also good for companies that offer specific services where a customer plays the key role of making profit.

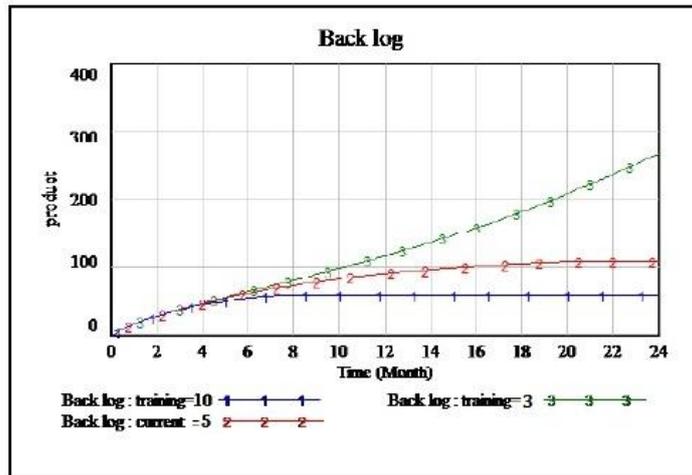


Fig. 5: The effect of increasing training activities from 3 programs per month to 5 and finally 10 educational programs per month.

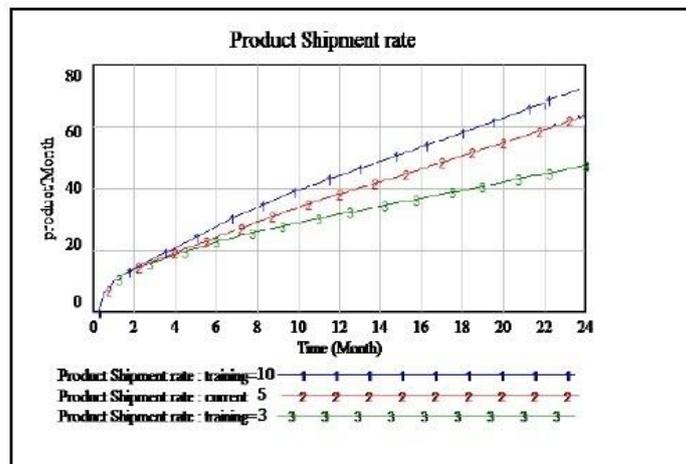


Fig. 6: The effect of increasing training activities from 3 programs per month to 5 and finally 10 educational programs per month.

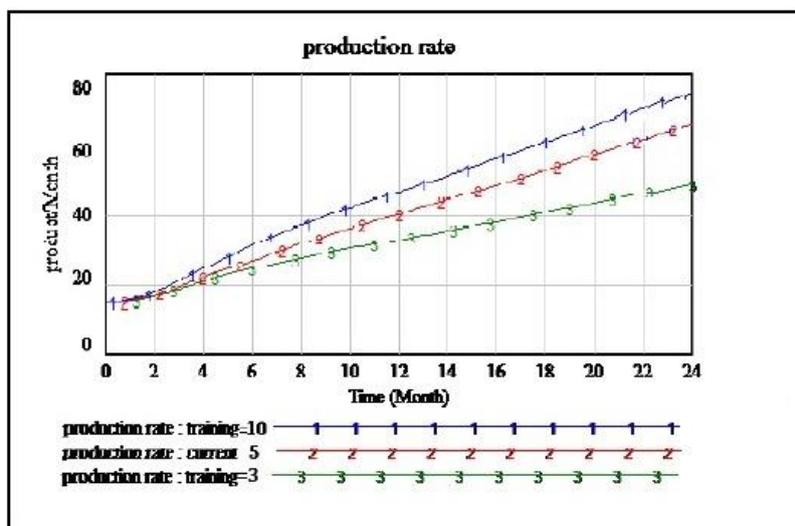


Fig. 7: The effect of increasing training activities from 3 programs per month to 5 and finally 10 educational programs per month.

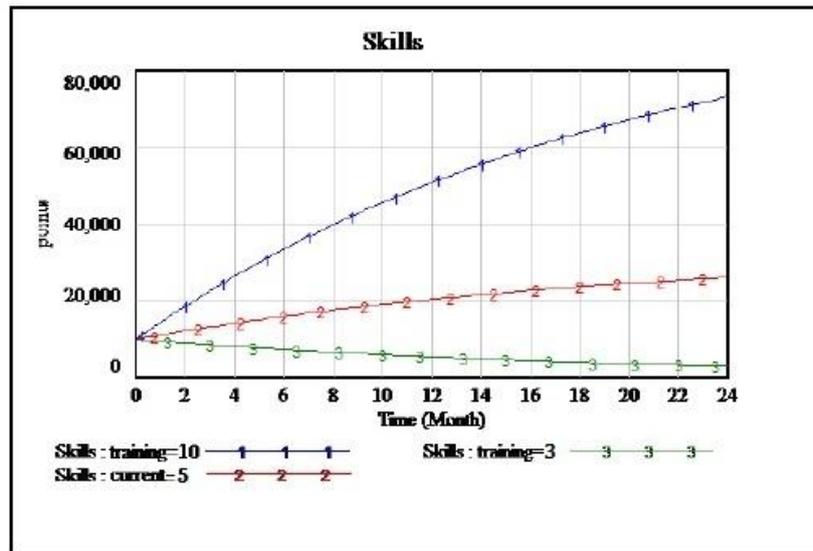


Fig. 8: The effect of increasing training activities from 3 programs per month to 5 and finally 10 educational programs per month.

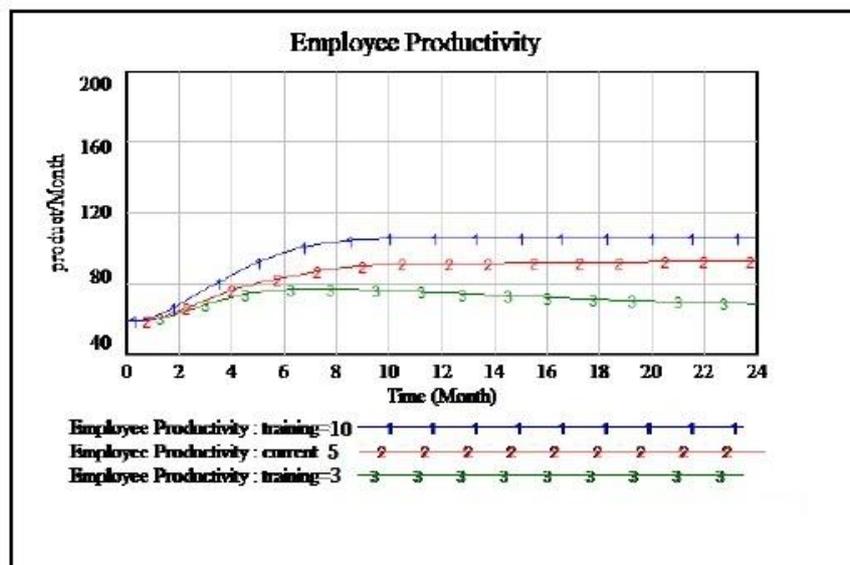


Fig. 9: The effect of increasing training activities from 3 programs per month to 5 and finally 10 educational programs per month.

As the figure shows, when the staff training increase; the skills and productivity of staffs, production rate, and income and finally the profit of organization will be increase.

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