Opportunities for process reengineering in Bulgarian bread production (a case study)

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Abstract. The aim of this paper is to outline the importance of business process reengineering and to prove that it could have great effects on the manufacturing industry. Sustainability becomes an important factor in production and the issue of energy efficiency is examined in the paper. The research is conducted in a bread producing factory. After reengineering, the company achieves better performance, cost minimization, increase in production and a significant energy efficiency improvement.

Keywords: Reengineering, Process, Energy Efficiency, CO2 emissions

1. Introduction
Companies need to be adaptable to change so that they are able to offer quality goods and services. The organizations that do not change according to environment will disappear from the markets [1-2]. In response to the competitive pressure, customer demands and ever-changing regulatory conditions, many companies are fundamentally rethinking the way they do business [3-5]. One of the most popular management tools for organizational change is the so called ‘business process reengineering’ (BPR).

BPR aims a successful market realization of newly-developed products, reduction of production costs and efficiency increase [6]. Hammer and Champy defined it as “the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed” [7]. According to T. Davenport BPR “encompasses the envisioning of new work strategies, the actual processes design activity, and the implementation of the change in all its complex technological, human, and organizational dimensions”[8]. Talwar emphasized on rethinking and reconstructing the organizational structure, workflow and value chain [9]. BPR is the redesign of business processes and the associated systems and organizational structure to achieve a dramatic improvement in business performance [10], [3]. Despite the variety of definitions and the differences between them, all authors agree on the importance of BPR.

BPR could be implemented everywhere, including manufacturing companies [11]. Manufacturing industry is one of the greatest energy consumers and carbon emitters globally [11]. That is why energy efficiency is vital for the company. According to the Global Energy Institute, industrial energy use is forecast to jump 26% by 2050. Energy-related carbon dioxide emissions decline except for the
The increasing price of energy and the current trend of sustainability have exerted new pressure on manufacturing enterprises that have to reduce energy consumption for both cost saving and environmental friendliness, as well as Life-Cycle Inventories initiatives [13-14]. Manufacturing companies have to find the balance between competition and environmentally friendly production. The environmental awareness leads the EU member states agreeing on the principle of “20/20/20 by 2020”, i.e. a 20% reduction in greenhouse gases, a 20% share of renewable energies and a 20% increase in energy efficiency by the year 2020 as compared to 1990 indicators [15]. According to the International Energy Agency (IEA), it is vital that a reduction by two-thirds in the energy intensity of the global economy is achieved by 2050. This could be accomplished only by strict energy efficiency measures [16]. The prices of energy are continuously growing as a consequence of the increased demand for energy combined with a restricted supply in the market. This together with the dynamics in price setting generates uncertainties for organization schemes with respect to accurately calculated energy costs [17]. Energy savings are expected to be achievable from increasing both the energy efficiency of production [18] and the logistic processes, as well as innovative energy monitoring and management approaches [19], leading industries to a way of producing “more with less” [20].

This paper aims at outlining the opportunities of BPR. It shows that when used to redesign a process, BPR can give outstanding results. The research is conducted in a factory producing bread. What the management of the company aims at is not only cost minimization and increased production but most importantly – energy efficiency improvement. The main goal of the management of the organization is to improve the energy performance of the factory, i.e. to reach measurable results of energy efficiency, energy use and energy consumption.

2. Methodology

Appropriate instruments must be used so that the process of production is successfully reengineered. A lot of different methodologies related to BPR have been identified in the specialized literature. A consolidated one is presented here which according to the author reflects the most important aspects in a concise and clear way. The methodology consists of five phases [21].

The first step is the preparation for reengineering. Here it is vital for the managers to be sure that BPR is necessary and of great significance for the company.

The second step includes mapping and analysis of the existing process. This phase aims at identifying any obstacles that could occur through the whole progress.

The third activity is related to the design of the future process. The main objective here is the creation of alternatives to the current situation which must meet the company's goals.

What follows is the implementation of the reengineered process. This phase is the most difficult one as the efforts for reengineering meet opposition and resistance.

The last phase includes continuous improvement of the reengineered process. The focus here is on monitoring the progress of action as well as the outcome.

3. Implementation and Results

The research is conducted in a factory producing bread and confectionery products. It is medium-sized enterprise which was established in 1982. “Bread and Confectionery Company” Ltd. produces 38 types of bread and 40 types of bread products. At the moment the factory has two main bread lines, one special bread line and a pastry line. The lines have a capacity of 1200 pieces/hour (Line 1) and 2400 pieces/hour (Line 2). The weight of the produced bread is 700 g. The four bread lines, together with the silos, represent the main electricity consumers of the company. The management of the factory is constantly trying to adopt innovation and uses different strategies in order to improve the processes and increase profit. The company is certified according to the international standards ISO 22000:2005, ISO 9001:2008, ISO 14001:2004, BS OHSAS 18001:2007 and there is a plan for implementation of an energy management system and a certification according to ISO 50001. This proves that the management of the factory values not only quality but also safety work conditions.
Following the steps in the methodology presented above, we start with considering the need for reengineering. The company plans to increase production, as the current capacity does not correspond to the market demand. That is why in order to improve the energy efficiency of the existing process of production and to reduce production costs, the company plans to implement the following measure (later mentioned as Measure 1): Purchase of a bread line with a capacity of 2400 pcs/hour.

The second phase of the reengineering methodology includes analysis of the situation as it is at the moment. For the needs of its activity, the company buys two types of energy carriers - electricity and diesel fuel. The main energy carrier in “Bread and Confectionery Company” Ltd. is electricity. It is used by all facilities involved in the production and the provision of indoor climate.

The consumption of diesel fuel is complementary - only for refueling vehicles for the transport of goods and materials and for providing administrative needs. The two largest consumers are the tunnel furnaces of Line 1 and Line 2 with installed capacity of 630 kW and 770 kW. The furnaces are equipped with a modern control system and consume 450 kW and 400 kW in normal operation.

Electricity consumption for the last three years (2017-2019) is presented in Table 1. It could be summarized that the consumption was relatively stable. The average over the three years is 4 265 124.67 kWh/year, with deviation within ±2%. Diesel deviations are observed within ± 17% compared to the average of 839 441.23 kWh/year.

The third phase of the methodology is related to the design of the future processes. As it was mentioned above, the management of the company has decided to replace the old main bread line with a capacity of 1200 pieces/hour with a new one with a capacity of 2400 pieces/hour. New machinery need to be purchased and put into operation in view of the expansion of the capacity of the bread production plant. For that aim the enterprise makes a survey of the market for similar equipment from different manufacturers and suppliers and collects information about the technical data and price. The new line requires a change in the equipment and technological scheme of the silo. The technological scheme of the bread line will not change compared to the old one, presented in Fig. 1.

What follows next is of great importance for the company – calculation of the energy savings and comparison of the results before and after reengineering - Table 2. 2019 is taken for a representative year. First, work hours per day and daily consumption are calculated for each facility of the old bread line. The calculations for the new bread line are made according to the same algorithm but for a capacity of 48000 breads per day.

Figure 1. Technological scheme of the bread line.
Table 1. Annual energy consumption

| ENERGENT NAME | 2017 t | 2017 kWh | 2017 lv. | 2018 t | 2018 kWh | 2018 lv. | 2019 t | 2019 kWh | 2019 lv. |
|---------------|--------|----------|----------|--------|----------|----------|--------|----------|----------|
| Diesel fuel   | 59.89  | 698739   | 142253.81| 84.87  | 990140   | 193535.63| 71.10  | 829445   | 136451.44|
| Electrical energy | 4168395 | 540429.39 | 4351721 | 501106.66 | 4275258 | 524575.59 |
| TOTAL:        | 4867134 | 682683.20 | 5341861 | 694642.29 | 5104703 | 661027.03 |

Table 2. Energy savings before and after Measure 1

| Measure № | BEFORE MEASURE 1 | AFTER MEASURE 1 | ENERGY SAVINGS | ENERGY SAVINGS FOR A PRODUCT UNIT | ENERGY SAVING RATIO | SAVED CO2 EMISSIONS |
|------------|------------------|-----------------|----------------|----------------------------------|---------------------|---------------------|
|            | ENERGY CONSUMPTION REQUIRED FOR MEASURE 1 | PRODUCTION | SPECIFIC CONSUMPTION | ENERGY CONSUMPTION REQUIRED FOR MEASURE 1 | PRODUCTION | SPECIFIC CONSUMPTION | ENERGY SAVINGS | ENERGY SAVINGS FOR A PRODUCT UNIT | ENERGY SAVING RATIO | SAVED CO2 EMISSIONS |
|            | Ein/Nin | E_{in}/Nin x N_{exp} | E_{exp} | N_{exp} | E_{exp}/N_{exp} x E_{exp} | kWh/y | kg/y | kWh/y | kg/kg | kWh/y | kg/kg | % | t/year |
| 1          | 3523672 | 6081600 | 0.58 | 7047344 | 3563030 | 12163200 | 0.29 | 3484313 | 0.29 | 49.4 | 2853.65 |

Table 2 presents the production converted to kilograms as its number is multiplied by the weight of one bread – 0.700 kg. Then, the energy saving ratio (ESR) for Measure 1 is calculated using the formula:

$$ESR = \frac{(Ein\div Nin \times Nexp - Ein\div Nin \times Nexp)}{Ein\div Nin} \times 100 \text{ (1)}$$

ESR – Energy Saving Ratio;
Ein – Energy consumption before the implementation of Measure 1 (3523672 kWh/year);
Eexp – Energy consumption after the implementation of Measure 1 (3563030 kWh/year);
Nin – Manufactured products before the implementation of Measure 1 (6081600 kg/year);
Nexp – Manufactured products after the implementation of Measure 1 (12163200 kg/year);
Ein/Nin – Specific consumption before the implementation of Measure 1 (0.58 kWh/kg);
Eexp/Nexp - Specific consumption after the implementation of Measure 1 (0.29 kWh/kg).
The financial benefits from Measure 1 are presented in Table 3 where the energy savings could be examined. The payback period is calculated using the formula:

\[ PB = \frac{I_0}{B} \] (2)

- \( PB \) – payback period
- \( I_0 \) – Investment
- \( B \) – savings/year

Then follows a calculation of carbon emissions reductions. After implementation of Measure 1, the annual energy savings equal 3484.313 MWh/year. This means a reduction in CO2 emissions of 2853.65 t/year (at an emission factor for electricity of 0.819 t/MWh). The calculations are presented in Table 4.

Last but not least, is presented the information about the planned energy savings for the factory after the implementation of Measure 1:

- Annual energy consumption: 5 104 702.81 kWh/year.
- Corrected annual energy consumption for the year accepted as representative: 8 628 374.61 kWh/year.
- Annual energy savings from the recommended package of measures: 3 484 313.35 kWh/year.
- Planned energy savings after the implementation of Measure 1: 40.38%. They are calculated by dividing the amount of annual energy savings by the amount of corrected annual energy consumption, then the amount is multiplied by 100.

The last two phases – implementation in the factory and monitoring the progress of action will happen after the management examine the research in detail and approve the suggested steps. The results from the reengineered process are outstanding not only for the profit of the company but also for the environment.

| Table 3. Financial benefits form Measure 1 |
|------------------------------------------|
| Savings | Investments | Payback period | Life |
| lv./year | lv. | year | year |
| 427526.42 | 1 203 352.00 | 2.81 | 10 |

| Table 4. CO2 emissions before and after Measure 1 |
|-----------------------------------------------|
| Indicator | Energy carrier | Ecological equivalent gCO2/kWh | Energy consumption kWh/year | CO2 emissions t/year |
| CO2 emissions before Measure 1 | Electro energy | 819 | 7047343.60 | 5771.77 |
| CO2 emissions after Measure 1 | Electro energy | 819 | 30563030.25 | 2918.12 |
| Reduced CO2 emissions after Measure 1 | Electro energy | 819 | 3484313.35 | 2853.65 |
| CO2 after Measure 1 | | | | 49.4% |
4. Conclusion
The reengineering model that was discussed in the paper shows the importance of BPR as the results are outstanding: better performance, cost minimization, increase in production and most significantly – considerable energy efficiency improvement. The latter must become a priority for industrial companies not only because of increase of energy costs and political demands but mainly because of the positive impact they could make on environment.

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