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Procedia - Social and Behavioral Sciences 75 (2013) 272 – 281

Procedia
Social and Behavioral Sciences

2nd International Conference on Leadership, Technology and Innovation Management

Optimization of automotive glass production through business process reengineering approach

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Abstract

In today's ever-changing world, the only thing that doesn't change is 'change' itself. In a world increasingly driven by the three Cs: Customer, Competition and Change, companies are on the lookout for new solutions for their business problems. To increase product yields and to ensure consistent product quality, key issues of industrial fermentations, process optimization and scale up are aimed at maintaining optimum and homogenous reaction conditions minimizing costs. The aim of our paper is to propose a methodological approach based on Business Process Reengineering in order to optimize the re-engineering production processes improving the management costs and considering the determination of process areas, the general layout, the selection and organization of the production equipment, the definition of the times of the realization process and the measure of the "ability" of the process.

Keywords: BPR, Industrial Plant, Optimization, Customer Satisfaction.

1. Introduction

Nowadays, especially after the recent financial downturn, companies are looking for much more efficient and creative business processes. They need to place better solutions in the market in a less time with less cost. To do so is to risk being well behind the curve when the economy does recover, and losing precious ground to competitors who found creative ways to keep their innovation initiatives moving

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doi:10.1016/j.sbspro.2013.04.031

during the darkest days of the downturn. To increase product yields and to ensure consistent product quality, key issues of industrial fermentations, process optimization and scale up are aimed at maintaining optimum and homogenous reaction conditions minimizing costs. For each individual product, process and facility, suitable strategies have to be elaborated by a comprehensive and detailed process characterization, identification of the most relevant process parameters influencing product yield and quality and their establishment as scale up parameters to be kept constant as far as possible (Schmidt, 2005). One of the most popular and well-documented change intervention has been business process reengineering (BPR). Successful business process improvement hinges upon top management support, customer satisfaction, cross-functional teamwork, and a systematic means of solving problems (Hammer and J. Champy, 1993; De Felice and Petrillo, 2010 a). On the other hand successful business innovations that drive growth and new business are guided by the following five principles:

1. Vision to create new products, business models or processes that make a difference and create new markets.
2. Systematic processes and rigor that stimulate creativity and learning to execute on the vision;
3. Focus on clear and present customer needs, the market facts, and the intangible;
4. Growth-oriented leadership with passionate team that is decisive, inclusive, focused, takes risks, and has market expertise;
5. Reward and recognition system for teams that take measured risks and experiment.

The aim of the project is the reengineering the automotive glass production line because: Obsolescence of existing machinery and equipment; Variations in the quantities produced.

The main subjects of this research include:

1. Adopt appropriate theory to serve as the execution tool of BPR and, concurrently, consider short- and long-term business developments.
2. Establish a model able to analyze clearly business knowledge asset and management demands for business operation processes.
3. Discuss and verify the feasibility the model by applying it to an actual construction firm case in order to promote the concept in future research directions and practical applications.

The paper is organized as follows: section 2 surveys the existing literature about BPR. Section 3 will describe the proposed methodology together with an application example based on a real case study. Finally in the last section 4, conclusions and research guidelines for future work will be summarized.

2. Literature Review

Companies are continually seeking new management interventions to improve their operations (Hipkin and De Cock, 2000; De Felice and Petrillo 2010 b). Business Process Reengineering has been the most influential management movement of the 1990s, and like the quality movement of the 1980s, it has put management attention squarely on processes and operations (Loch, 1998). The popular conception of BPR was crystallized by Michael Hammer and James Champy in their 1993 best-seller Reengineering the Corporation, the most influential reengineering book. In particular, they advocate a reintegration of industrial work, reversing the trend toward specialization and division of labor that has been with us since the early Industrial Revolution. On the other hand, Hammer and Champy advocate dramatic change, as opposed to an incremental or evolutionary approach, in implementing new process designs and associated organizational structures. Indeed, many managers' primary association with the term 'reengineering' is the bold approach to change management advocated by Hammer and Champy. To evaluate principles of process design, one needs to understand the causal relationship between design choice and bottom-line performance. For this kind of cause-and-effect reasoning, one first needs a vocabulary to describe business processes, including generic names for the elements that make up a process (Hammer, 1996).

According to many in the BPR field reengineering should focus on processes and not be limited to thinking about the organizations. After all the organization is only as effective as its processes (Hunt, 1996). So, what is a process? “A business process is a series of steps designed to produce a product or a service. It includes all the activities that deliver particular results for a given customer(external or internal).” Processes are currently invisible and unnamed because people think about the individual departments more often than the process with which all of them are involved. So companies that are currently used to talking in terms of departments such as marketing and manufacturing must switch to giving names to the processes that they do such that they express the beginning and end states. These names should imply all the work that gets done between the start and finish. For example, order fulfillment can be called order to payment process.

For almost a decade now there has been considerable discussion in the literature on Business Process Reengineering (BPR) and today there still remains considerable confusion, particularly amongst managers, as to exactly what constitutes BPR and how it is different from other change initiatives such as Total Quality Management (O’Neill and Sohal, 1999). Several authors have provided their own interpretation of the changes being applied to organizations, for example Davenport and Short (1990) have described BPR as the analysis and design of work flows and processes within and between organizations. Other authors such as Talwar (1993) have focused on the rethinking, restructuring and streamlining of the business structure, processes, methods of working, man management systems and external relationships through which value is created and delivered. Petrozzo and Stepper (1994) on the other hand, believe that BPR involves the concurrent redesign of processes, organizations, and their supporting information systems to achieve radical improvement in time, cost, quality, and customers’ regard for the company’s products and services. While Lowenthal (1994) describes the fundamental rethinking and redesign of operating processes and organizational structure, the focus is on the organization’s core competencies, to achieve dramatic improvements in organizational performance, as BPR’s essential components. TQM is “an approach to improving the competitiveness, effectiveness and flexibility of a whole organization. It is essentially a way of planning, organizing and understanding each activity, and depends on each individual at each level” (Oakland, 1993). TQM involves placing the customer as the focal point of operations. Its aim is to continuously improve process performance in order to satisfy customer requirements (Bennis, 1992). It involves the bottom-down communication and deployment of objectives, and the bottom-up implementation of continuous improvement activities. At the centre of TQM is the concept of the management of processes, and the existence of internal suppliers and customers within organizations. Organizations which have adopted TQM are likely to have developed an understanding of the processes which are operated, and attempt to make the customer the target of improvement activities (Oakland, 1993). BPR also emphasises focus on the process. However, authors such as Klein (1993) suggest that BPR is much more radical than TQM, while others, notably Davenport (1993); Harrison and Pratt (1992) suggest that TQM and BPR can and should form an integrated strategic management system within organizations. BPR is not intended to preserve the status quo, but to fundamentally and radically change what is done; it is dynamic.

3. Methodology

Based on the BPR theory, this research developed a model, which fuses on project management and concepts and practices (Figure 1) (McElory, 2003) after a careful review of general BPR models in the literature (Papavassiliou and Mentzas, 2003; Ozcelik, 2010). The model encompasses five main processes, including process representation, process evaluation, process analysis, process redesign, and process validation (De Felice et al., 2005).

1. **Process representation:** This research thoroughly reviewed and analyzed processes already selected. The elements of process reengineering, e.g., activity roles and items, related knowledge, and relationships with other processes, were progressively assessed and depicted in the context of construction firm management systems. The main purpose of process representation is to model relevant process information so that follow-up work, i.e. process evaluation, may be executed.
2. **Process evaluation:** The reengineering activity aimed to achieve regeneration in light of unreasonable/inefficient process problems, and, thereby, accrue the greatest benefit. Consequently, process performance must be assessed and diagnosed before changing. The crux that obstructs the operation process should be identified in order to serve as the basis of process redesign. The purpose of process operation lies in linking into a company's actual business functions, and, thereby, helping to maintain or enhance company operations.
3. **Process analysis:** In this stage, analytical work was divided into two parts, i.e., "analysis for gap of performance" and "analysis for gap of service". The result was identification of a process redesign policy necessary to solve process problems.
4. **Process redesign:** This stage focused on the problems and defects found during process evaluation and analysis as well as to revise or reconstruct processes in order to make them fit process objective requirements. The result both reduce the difficulty of constructing the process model during the procedure representation stage and generates reengineering experience that is available as feedback input for future tasks.
5. **Process validation:** Performance of the process before and after reengineering should be further inspected and validated to help ensure the effectiveness of the redesigned process. Should the execution performance of redesigned process not improve significantly on the original, the process should cycle back to the process redesign step.

In details as depicted in Figure 1, the implementation process has five main steps-process selection, process mapping, process improvement, process verification, and process implementation:

- **STEP 1 - Process Selection:** The first step is to select critical business processes based on its potential to add value to businesses. After process selection, the processes can then be mapped.
- **STEP 2 - Process Mapping**: The goal of process mapping is to understand the current process or set of processes and associated problems. Project limitations and the process mission are also established at this stage. Process mapping is the most important stage as it provides a full view of the process in its entirety, both upstream and downstream along the process path.
- **STEP 3 - Process Improvement:** After the team maps the process, improvement can begin. A process can be corrected, simplified or reengineered.
- **STEP 4 - Process Verification:** Once the team generates alternative process flows, verification of the choices can begin. The team determines the impact of each alternative on the company as a whole. The team has made its own decisions and has assumed ownership of the project.
- **STEP 5 - Process Implementation:** The final step is to implement the new process.

The steps involving the following aspects: Analysis of Production Process; Definition of a new layout design; Planning and design process; Optimization of production process; Analysis of results.

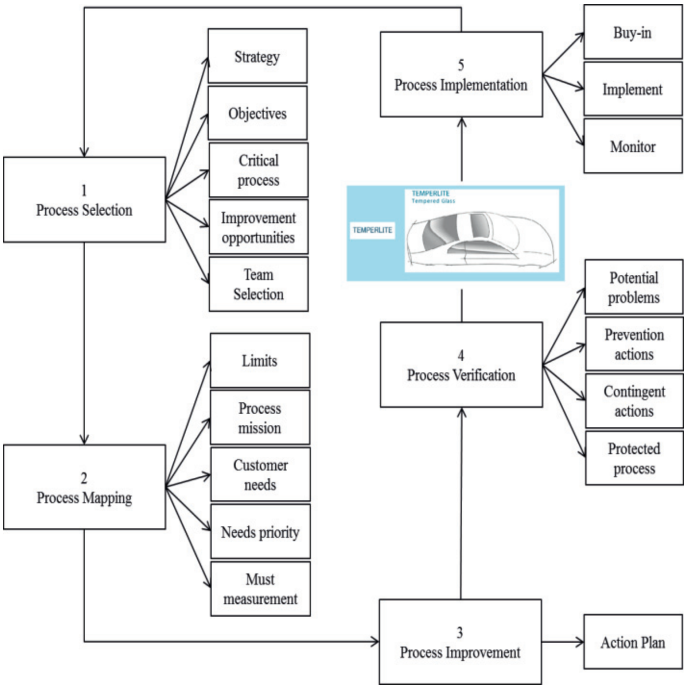

Fig. 1. Methodological approach

STEP 1 - Process Selection. We will apply our study to a real case study that involve tempered glass production for automotive sector (see Figure 2).

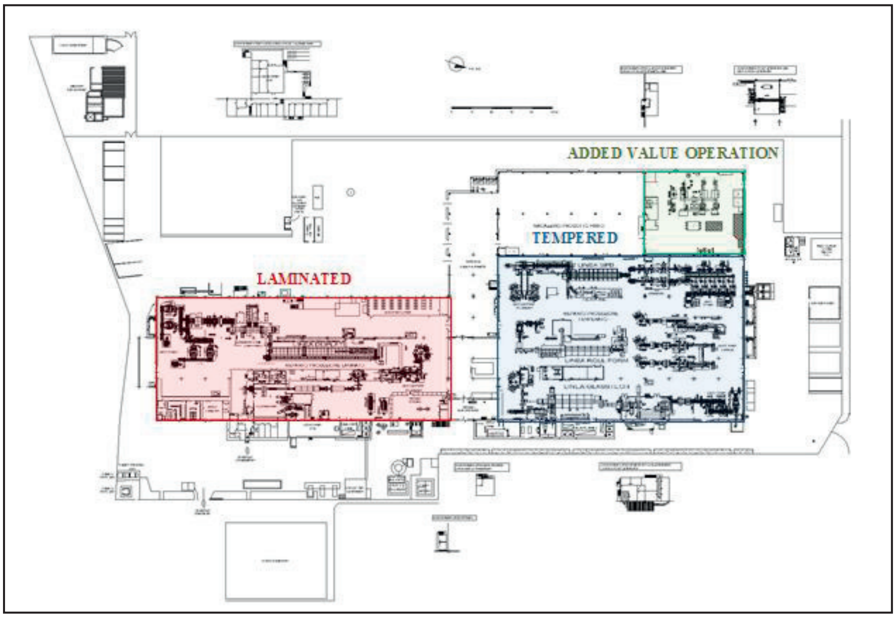

Fig. 2. Global Lay-out

Figure 3 shows the layout of the specific production.

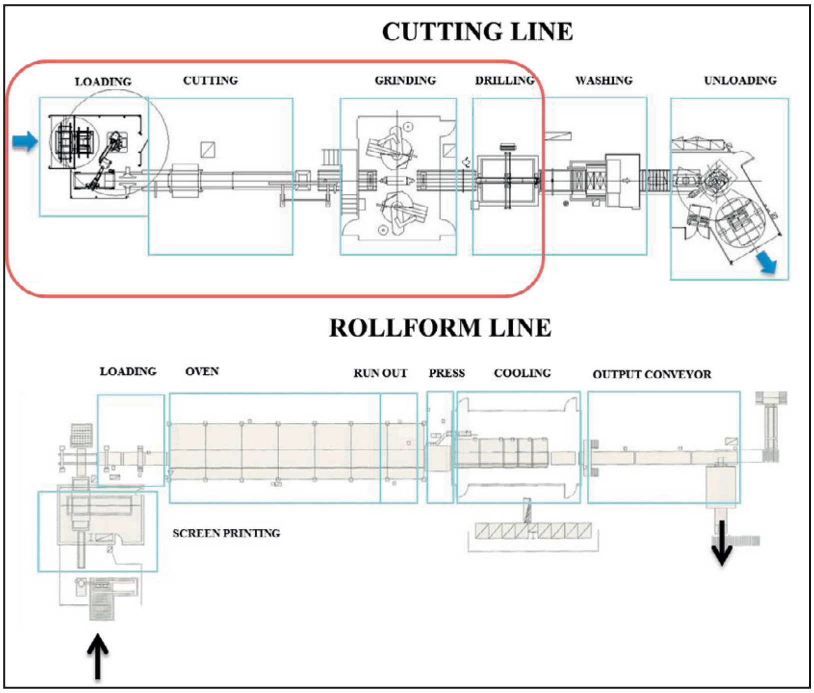

Fig. 3. Lay-out of our production line "as is"

STEP 2 - Process Mapping. The motivations behind the study of the layout are: 1) Obsolescence of existing machinery and equipment; 2) High production costs; 3) Need to increase the production volume of the side windows. It is necessary to replace machines because they are not able to satisfy quality levels required by customers because the presence of defects on the glass products such as chipped edges, polished edges and scratches. The rejection rate is higher at 2.9% including 1.1% for chipped edges, polished edges to 0.5% and 1.3 for scratches.

STEP 3 - Process Improvement: Here below are shown the main layout alternatives analyzed (figure 4 and figure 5). To choice the optimal layout we used the analysis of factors method which provides: a) To do a list all the most important factors (i = 1, 2, ..., m); b) To judge each lay-out alternative (j = 1, 2, ..., m) with reference to the same factor using a numeric values. In our case we used the following value: 5 "very good solution", 4 "satisfactory" 3 "indifferent", 2 "not satisfactory" and finali 1 "inadequate"; c) Assign weight to each factor p, d) Add up the points Pj (weight) calculating the score (we indicated with g_{ij} the judgment):

$$P_j = \sum_{i=1}^{m} p_j \cdot g_{ij} \qquad \text{j=1, 2, …, n number of alternatives} \qquad (1)$$

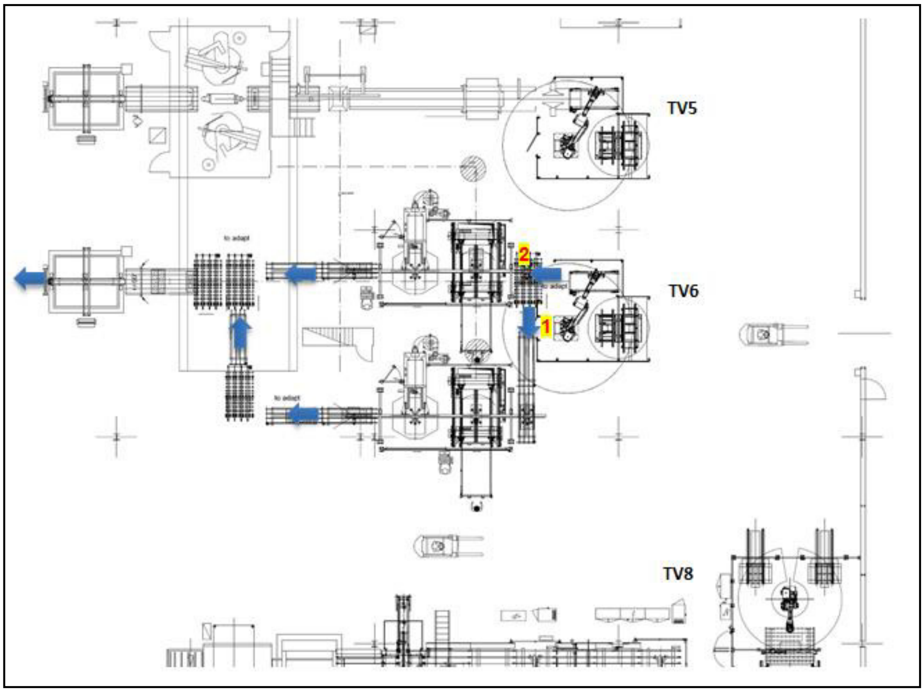

Fig. 4. New lay-out - solution A

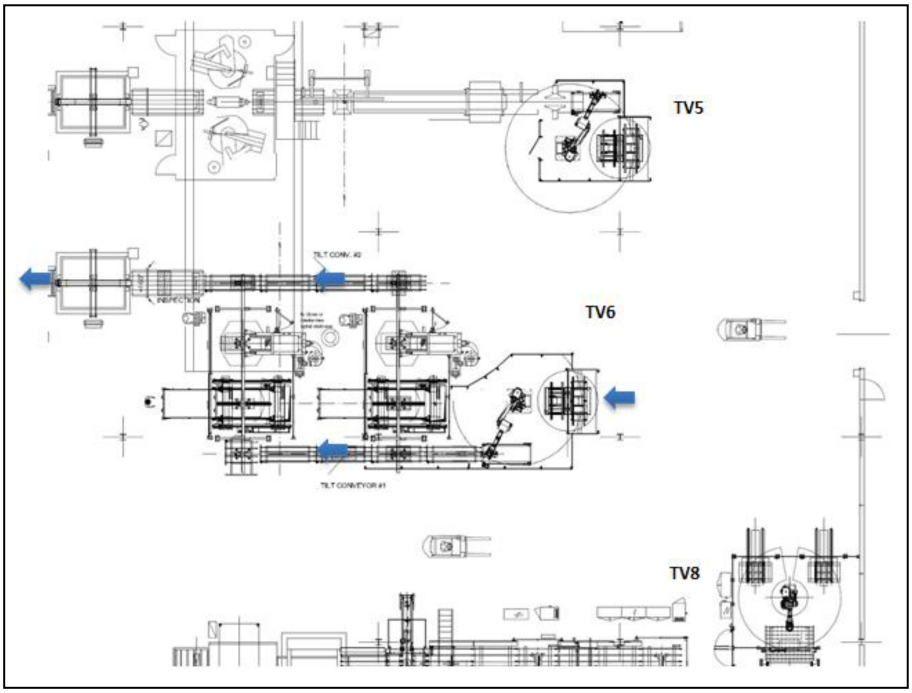

Fig. 5. New lay-out - solution B

STEP 4 - Process Verification: in Table 1 are shown the parameter considered in the choice of new plant. The best layout, is the solution B with a total score of 103 equal to 76%.

Table 1. Lay out - solutions

	Weight (P)	**Solution A**		**Solution B**	
Criteria		Rating	Score	Rating	Score
New Re-engineering	5	2	10	4	20
Flexibility	5	2	10	2	10
Efficiency	5	3	15	5	25
Good use of space	5	3	15	4	20
Area occupied (m^2)	4	3	12	4	16
Space for visitors	3	4	12	4	12
Value Benefit Complete			**74**		**103**
Value Benefit (Percentage)			**55%**		**76%**

To select the layout for the new plant we also considered the path that the glass waste must follow from cutting machines, after being crushed into hoppers, to arrive on the existing tape. We designed the new flows of materials in order to avoid possible interference, ensure work areas needed to staff (Figure 6).

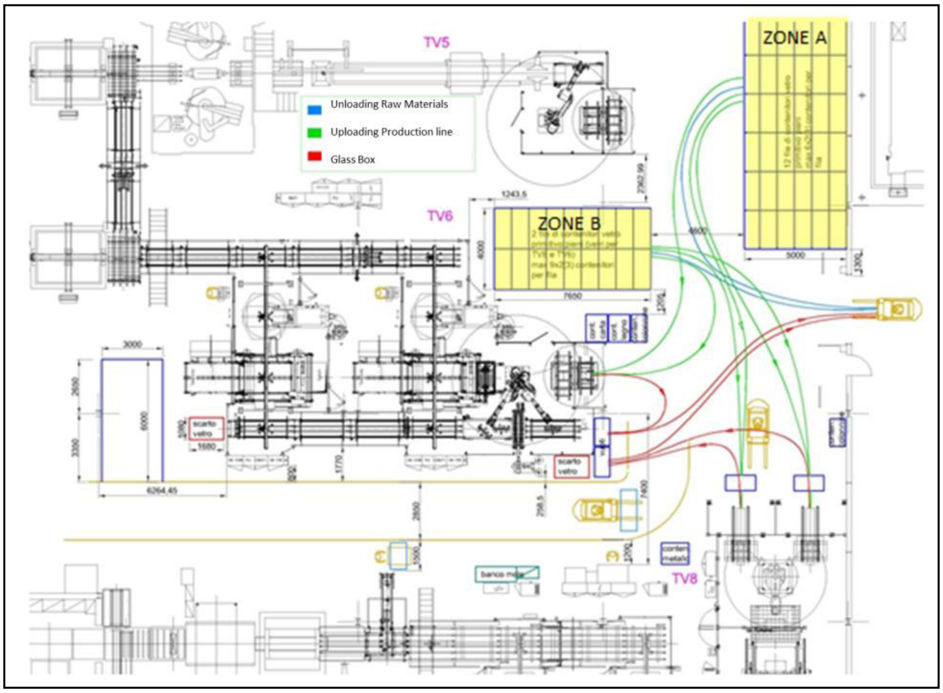

Fig. 6. Material flow

STEP 5 - Process Implementation. In figure 7 are shown work phases characterizing the construction of new plant.

Fig. 7. Work phases for the new plant

The total cost of installation of the cutting line includes several items summarized in the table 2.

Table 2. New plant installation costs

Description	Unit Cost [k€]	Total Cost [k€]
Transport	8	8
New Conveyors	15	15
Disposal of old plant	20	20
Masonry	20	20
Mechanical Installation	40	40
Electrical Installation	37	37
Piping	25	25
Software	10	10
Robot	15	15
TOTAL		**190 k€**

4. Conclusion

The aim of the paper has been to develop a methodology and technical approach for the design and the realization of a production line. A key factor in achieving the goal of the project consists in a reduction of production times. The benefits of installing the new cut line are: 1) Increased production capacity from 155 pieces/h to 240 parts/h; 2) Improvement of production process; 3) Waste reduction from 2.9% to 1.4%; 4) Reduction of production costs. Table 3 shows the saving obtained by the reduction of waste, for the quality, for the tooling and the maintenance with a total saving of € 281,000 / year.

Table 3. Saving costs

Description	Before	After	Saving	Cost	Total saving
Waste	2,9%	1,4%	-1,5%	4.414 k€	66 k€
Quality	493 k€	332 k€	33%		161 k€
Tooling	47 k€	21 k€	55%		26 k€
Maintenance	38 k€	10 k€	74%		28 k€
				TOTAL	**281 k€/year**

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