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Integrating TRIZ in project management processes: an ARIZ contribution

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Abstract

Organizations are living in a constant change environment; their business and finance aims are very demanding. Project management faces up to a lot of problems and challenges. Project management community needs appropriate and efficient management practices.

Generation of innovative ideas and solutions can give considerable contribution to project success; can bring efficacy and efficiency to organizations and markets. Without innovation, many organizations and its projects can be doomed to failure. The generation of ideas and systematical innovation is crucial to the project competitiveness.

TRIZ methodology can contribute to the definition of the best project structure. TRIZ analytical tools can be very useful to problem solving in project management.

TRIZ has been developed with special emphasis on product problems and product improvement. However, TRIZ is also used for process problem solving, so it can be useful for all project management issues and activities.

This paper attends to applicability of TRIZ and its analytical tools (namely ARIZ) in project management processes. A new approach was proposed. Its main achieved results and expected impacts are exemplified on a case study.

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Keywords: Project Management, TRIZ, ARIZ, Problem Solving

1. Introduction

In a society where increased competition, market maturity and nature conservation are key factors for business success, many companies aim to improve the efficiency of creating new products and services. To achieve these objectives, organizations have developed and continue to develop many operating procedures for describing and

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optimizing internal processes. The improvement of these processes can be obtained where there is an effective Project Management.

Project management aims to ensure, throughout the life of a project, its efficiency and effectiveness. The ultimate goal of customer satisfaction consists of several categories or groups of processes that interact with each other, designated by project management processes groups [1], which are: Initiation, Planning, Executing, Monitoring and Controlling, and Closing.

The issue of process management is a recurring theme over the past decades, for which they were studied and applied methodologies, which highlight the TRIZ, as an accurate methodology, based on pre- defined patterns, in order to support the resolution of specific problems, which have been mainly applied in product development.

This research is based on previously conducted studies on the application of TRIZ, it is intended to expand its applicability to project management processes. It begins with the introduction of core concepts, like process definitions, TRIZ, ARIZ, and Project Management Processes. It continues with a description and analysis of the applicability of the proposed approach, and it ends with the presentation of the main results and the discussion of their main impacts.

2. Emergence of TRIZ in Project Management Process

According to ISO 9000 [2], a process can be defined as a "set of activities" interrelated and interacting, which transform inputs into outputs (see Fig. 1). This set of activities can be carried out by one or several functional areas of an organization, interrelated among themselves and with one or more inputs and an output clearly defined. From these activities, depends individually or as a whole, the measurable results (quantities, deadlines, execution times) that represent (or should represent), added value to customers or the organization.

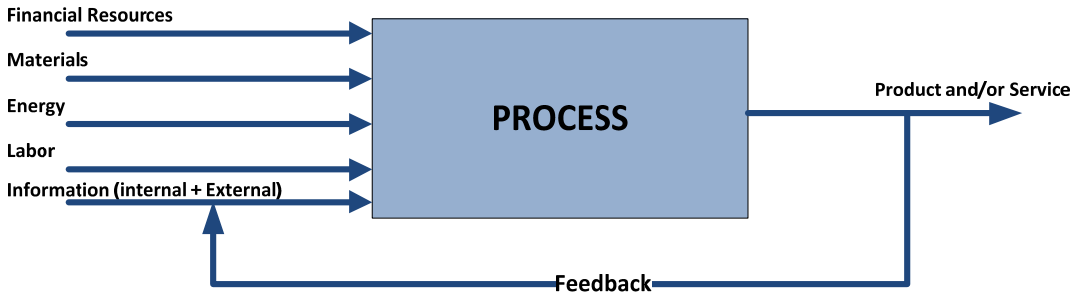

Fig.1. Schematic representation of a process

So, a process is a set of interrelated activities which have as their ultimate goal, obtaining a product, service, or a predetermined result. This interrelations defines a specific ordering of work activities across time and space, with a beginning and an end, clearly identified, that is, a framework for action [3] using several resources to generate the results set in order to support defined results or objectives [4]. When this transformation occurs, it should add value and create an outcome that is more useful and effective way [5]. This usually involves more than one function of the organization and its implementation has significant impact on other functions of the same.

Depending on the complexity of a process, it can be divided into sub-processes, which will be distributed in the various activities that compose them, and a more detailed level, tasks. The level of detail to consider is the most suitable for the analysis to be achieved. According to this concept, processes can be hierarchical, from the Macro Process until the task be divided into sub-processes and macro processes grouped. However, not all processes have the same relevance for the organization, either as to the results generated, and either for the resources involved.

According to ISO 9000 [2], the processes approach, means that, first an activities set selection must be developed, whenever one input and one output are identified; and after this selection, it should verify that this isolated set of activities, brings added value throughout the management process.

Using the TRIZ methodology, the choice of activities set the probability of success can be huge. As Jamali & Hashmi [6] argue that the transfer of ideas between individuals and principles, management processes, enables a series of unpredictable interactions. These interactions can lead to unpredictable obtaining various contradictions and as a consequence, the 'chaos'. The failure to systematize similar problems and their solutions, can lead to contradictory processes in which TRIZ, can be used to avoid these processes contradictions.

Despite the TRIZ methodology to be directly targeted at the area of Science and Engineering and the principles of TRIZ Invention be directed to the same area, can we create principles of TRIZ Invention, directed to another area, namely in Project Management?

In this research, we intend to apply the TRIZ methodology in the context of the processes involved in Project Management.

3. Proposed Approach

There is a research line that is searching to extend TRIZ to different areas of engineering including non-technical areas. For instance, Yang [7] makes an analysis of 36 Chinese war strategies and TRIZ principles ending recommending 36 strategic principles to be considered for contradictions elimination. Also, Retseptor [8] shows how the 40 TRIZ principles can be used in Project Management that will be considered in this approach.

Table 1, next presented, shows how some of these principles are applicable to both Engineering and Project Management, already proposed by Retseptor [8], including the identification of the main project management process groups in which each principle may have the most potential applicability.

Table 1. TRIZ principles applied to Project Management Processes

PRINCIPLES	APPLIED TO ENGINEERING	APPLIED TO PROJECT MANAGEMENT	PROCESS GROUP
5. Merging	Join or merge Identical or similar objects assemble identical or similar parts, in order to perform operations in parallel	Create a network of alliances to achieve unit among all project stakeholders. Perform collective approaches to problem or opportunities in meetings	Initiating
	Link operations in sequential or parallel, in view of the surrounding temporal	Use of PERT and GANT charts	Planning
6. Universality	Make a system or object perform multiple functions, eliminating the need for additional parts	Facilitate the diversification of skills in a matrix structure	Planning
	Use of standard methods	Forms usage for product of processes specification	All
8. Anti-weight (Balance)	To compensate for the weight (a negative trend) of and object or system associate other object or system that provides a positive trend	Ensure support from Top Management. Deliver reports to management prior to implementation of new initiatives	All
9. Preliminary anti-action (Neutralizing)	If need to perform an action with both effects: beneficial and harmful, the action should be replaced by one that neutralizes the harmful effects	Use of PERT. Eliminate the need for crisis management	Planning, Monitoring and Controlling

The analysis was performed to the engineering parameters and selected those who would adapt more easily to the emotional / functional component. Using ARIZ (see Fig. 2), a contradictions table of the selected parameters was created (see Table 2).

The ARIZ is the Russian acronym for Algorithm of Inventive Problem Solving leading to the problem inventive solution. It is a systematic method that can integrate all of the TRIZ heuristics. This algorithm defines the ideal final result and identifies the contradictions [9].

The most important steps of this algorithm are: 1) formulation of the problem statement, 2) formulation of the contradictions, 3) conflict analysis, 4) Application of methods for contradictions elimination and if a solution can't be found 5) verify problem statement and reformulated and then start again using the new statement (as can be seen in Fig. 2).

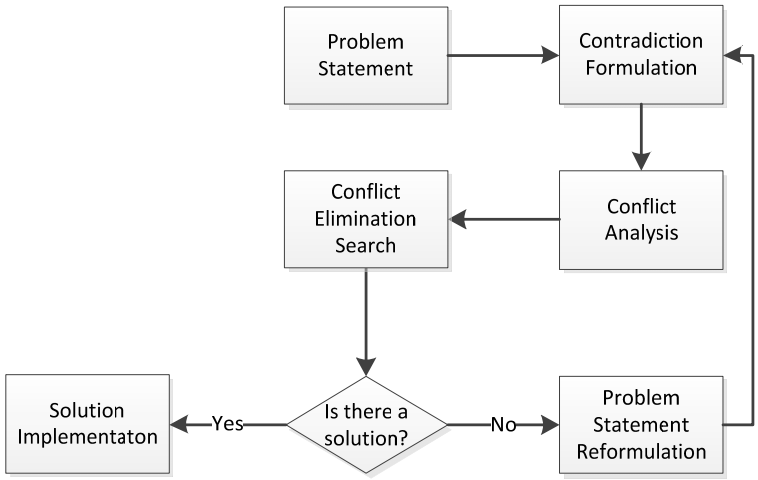

Fig. 2. A Simplified ARIZ flowchart

Having in mind the TRIZ principles referenced in Table 1 and based on the article reviews and individual knowledge of project management process from project management practitioners in a brainstorming session [10] eight main parameters were identified, namely:

1. Psychological pressure
2. Emotional stability
3. Information loss
4. Time Waste
5. Reliability
6. Harmful factors acting on the process
7. Adaptability
8. Productivity

Applying the ARIZ method to this selected principles it is expected that TRIZ approach can empower the problem resolution in project management process as presented and discussed in next section.

4. Expected results

This section presents and discusses the expected results hope to gain from the application of TRIZ in Project Management. Having in mind the TRIZ principles and considering the principles set out in Table 1 and applying the ARIZ method to them, identified contradictions were discussed resulting in the contradiction matrix exposed in Table 2. Through the contradictions highlighted in dark, in Table 2, the discussion of the feasibility and expected results of applying the TRIZ methodology to Project Management is next presented.

Table 2 – Project management contradiction table

PARAMETER	1.	2.	3.	4.	5.	6.	7.	8.
1. Psychological pressure		-	+	B	-	+	-	-
2. Emotional stability	-		-	-	+	-	+	+
3. Information loss	+	-		+	-	+	-	-
4 Time waste	B	-	+		-	+	-	-
5. Reliability	-	+	-	-		-	+	+
6. Harmful factors	+	-	+	+	-		-	-
7. Adaptability	-	+	-	-	+	-		-
8. Productivity	-	+	-	-	+	-	-	

- : Harmful iteration; + : Useful iteration; B : Both (harmful and useful) iteration

The process ideality can be calculated as follows:

$$\text{Ideality} = \text{Number of Useful Functions} / \text{Number of Harmful Functions} \qquad \text{(Eq. 1)}$$

So, in this case, the ideality is: $I = 22 / 32 \approx 0{,}6875$.

In case of the contradiction between Emotional Stability (2.) and Information Loss (3.), the principle to be applied to solve the problem would be the number 8 (Balance). The resolution of this contradiction has an impact on all processes of project management, to ensure support of top management and delivery of reports to management prior to implementation of new initiatives.

In case of the contradiction between Information Loss (3.) and Adaptability (7.), the principle to be applied to solve the problem would be the number 6 (Universality). The resolution of this contradiction has impact on development planning by diversification of skills in a matrix structure. It has also implications in all processes of project management in the use of standard specifications.

In case of the contradiction between Time Waste (4.) and Reliability (5.), principles to be applied to remedy the situation would be the number 5 (Combination) and 9 (Neutralizing). The resolution of this contradiction has impact on the process of Initiation, by creating a network of alliances to achieve unity among all stakeholders and / or conduct collective approaches to problems or opportunities in project meetings. It also has implications in the process of Planning and Monitoring and Control in the use of PERT and GANTT charts, promoting for example collaborative scheduling and crisis management reduction or elimination.

In case of the contradiction between Reliability (5.) and Harmful Factors Acting on the Process (6.), principles to be applied to remedy the situation would also be the number 5 (Combination) and 9 (Neutralizing). The resolution of this contradiction has impact on the process of Initiation. It is important to create a network of alliances to achieve unity among all stakeholders and / or conduct collective approaches to problems or opportunities in meetings. It also has implications in the process of Planning, Monitoring and Control, in the use of PERT and GANTT charts and in the crisis management reduction or elimination.

In case of the contradiction between Harmful Factors Acting on the Process (6.) and Emotional Stability (2.), principles to be applied to remedy the situation would also be the number 5 (Combination) and 9 (Neutralizing). The resolution of this contradiction has impact on the process of Initiation, by performing an action to create a network of alliances to achieve unity among all stakeholders and / or conduct collective approaches to problems or opportunities in meetings. It also has implications in the process of Planning, Monitoring and Control, in the use of PERT and GANTT charts and the elimination of crisis management.

There are cases in which no contradiction was identified, and therefore, according to ARIZ, would not be treated. One such case would be the Information Loss vs. Time Waste. This can be harmful in Project Management. So in the near future, it should be necessary to consider solutions to the full adaptability of TRIZ methodology in Project Management.

5. Implementation Test

The AJC company runs its activity, since 1953, based on manufacturing medical and hospital material, being the main activity the conception, manufacture and assemblage of washer disinfectors of bed-pan and stainless steel utensils, vertical and horizontal steam sterilizers and steam generators. They also manufacture a broad line of stainless steel utensils. The company offers a complete and qualified service of maintenance and technical assistance to medical and hospital equipment's, in order to ensure their normal and permanent functioning, but also to warranty their efficiency, reliability and durability.

The sterilization services implement in hospitals new philosophy which encompasses the traceability of equipment to use in the sterilization station, sterilized material, sterilization processes and handling operations with sterilized material and with material to be sterilized. The new sterilization philosophy leads to improvement of sterilizer capacity and sterilizer features. Actually hospitals need centralized management software for all sterilization equipment (including washing and disinfection machines, sterilizers, medical sealers), as well as materials to be sterilized (surgical, orthopedic, textile and another utensils) and the sequence of operations (separation of material, washing and disinfecting, sorting and packing, sealing, sterilization, distribution and collection of material to be sterilized in the hospital).

The extant manufactured sterilizers were analyzed concerning its adaptation to the new tendencies of sterilization. TRIZ methodology was used to identify contradictions and eventual problematic situations and to eliminate the contradictions and to solve the problems. ARIZ flowchart was applied (see Fig.2).

Several contradictions were identified. It became clear that new sterilizers to be introduced on the market will have to undergo significant changes.

Beyond another features, the sterilizer must undergo changes at the level of pressure vessel where the sterilization of materials is performed.

The pressure vessel is constituted by the chamber, jacket, doors and other components welded to the pressure vessel.

The dimensions of the sterilization chamber were modified. Former dimensions were: 70 centimeters of wide, 70 centimeters in height, 150 centimeters of depth with 735 liters of capacity. The new dimensions are: 70 centimeters in wide, 112 centimeters tall, 110 centimeters of depth with 862 liters of capacity.

The sterilizer door performance was questioned too. The two doors working vertically were replaced by two doors working horizontally.

The guide system for the door movement was changed too. Now the doors are sliding.

They detected a problem with difficult access to some mechanical and electrical components. The problem was solved by modification of the component layout. The new sterilizers will have modular approach of the component layout; some mechanical and electrical components were transferred to the lateral side of the sterilizer. Therefore, the maintenance operations will be easier.

They carried out the study of component layout (including electric framework, power framework, vacuum pump, water pump, condensate pan, valves, filters, etc.) to make assembly, maintenance intervention or replacement of the components easier.

As a result of all these changes, the structure that supports the sterilizer and its components was reformed and redesigned too.

The sterilizer loading system was undergone with important changes. The former loading system had an outside loading car that guided to the baskets load platform where the material to be sterilizes was placed into the chamber. Later, a similar outside loading car was allowed to withdraw the load platform, baskets and utensils of the chamber in the clean area after sterilization (see Fig. 3a).

The loading system of the new sterilizer will be consists of a load car placed inside the chamber with the material to sterilize. There is a second outside loading car that transports the loading car from the sterilizer to the transportation board and vice-versa. The transportation board allows transport the sterilized material to outside and the material to be sterilized to the sterilization station (see Fig. 3b).

Fig. 3. (a) former loading system; (b) new loading system

The figure 4 shows two Sterilizers:

- Sterilizer with sliding door vertically – before the application of TRIZ methodology (see Fig. 4a).
- Sterilizer with sliding door horizontally – after the application of TRIZ methodology (see Fig. 4b).

Fig. 4. (a) former sterilizer AMARO 5000 with the door vertically; (b) new sterilizer AMARO 5000 with the sliding door horizontally

This project aims to achieve significant improvements in the quality of the sterilization process, simplifying the maintenance of the equipment, the traceability of the processes and equipment, the quality of work of the operators of sterilization station, making easier the sterilizer manufacture and assembly processes, the improvement and introduction of a new concept of charging system of the sterilizer. The developments described will allow company to submit an innovative concept that will be introduced in hospitals of medium and large dimensions.

The AJC Company began to apply the project management methodology. The project management is been applied to make the company more competitive, to support the management of change, to implement strategies that ensure continuous innovation, flexibility and agility. The applying of project management will be extended to more and more professionals, to all functional areas in the company activities.

For the study the multifunctional project team war formed oriented towards customer satisfaction accomplishing the project according to specifications, deadlines and budget restrictions.

The project was analyzed, a financial evaluation was carried out, the critical factors of success were identified and its management strategies were outlined. All project activities were organized, planed and controlled with focus on results and taking into account the business environment, human factors, uncertainty and risk.

The project management methodology was implemented also to support conflict management. The company is now giving first steps following implementation of project portfolio management.

6. Final Comments and Main Conclusions

The constant need for change, results in a current trend in business, which consists of the increasingly frequent use of projects to achieve its objectives. There is therefore a great need to obtain a powerful project management highly efficient. One of the factors that contribute most to the success of a project is the generation of ideas and innovation. The lack of these factors may in many cases lead to the failure of a project. In a world with increasingly borderless communication and information, innovation is crucial to maintain market competitiveness. The TRIZ methodology, with its strong theme of innovation, can contribute to accelerating the resolution of problems that may cause risks to the projects.

The ARIZ flowchart would be very useful for schematization of project tasks, structural analysis, identification and formalization of contradictions and problematical situations and its solving.

The methodology is far from being defined for the Project Management, so it is important to develop or adapt new integrated methods to harmful cases where there are no contradictions.

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