RECENT J. (2021), 65:145-150
https://doi.org/10.31926/RECENT.2021.65.145

Research on the Concept of Antifragility in Project Management Applied in Industry 4.0

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Abstract
This study summarizes the analysis of how the concept of fragility could be applied in the industrial environment through project management, as well as the emphasis on the methods of adaptation of an organization in response to changes in environmental conditions, so that it can absorb the shock and sometimes even to progress in conditions of uncertainty. For the industrial field, the application of specific antifragility concepts in project management can generate a greater capacity for adaptability to changes in external environmental factors and thus a much more stable growth over time - especially in the light of Industry 4.0 challenges. In this regard, this paper makes several proposals and interpretations of these decision-making mechanisms. The natural conclusion leads us to the fact that the concept of antifragility can be extended, both theoretically and practically, in the field of industrial management.

Keywords
project management, antifragility concept, decision substantiation, systems adaptability, management of the industrial projects

1. Introduction

In the field of industrial management due to delayed reactions of decision makers and failure to adapt in time to changes in external environmental conditions - expressed by various events and / or factors, more or less known - the failure rate of projects is quite high. Although the organization of the activity is rigorously carried out, and the planning involves the application of principles within predetermined limits of performance, due to the influence of unforeseen factors, the final effects sometimes highlight deviations from the initial project variant.

Because industrial projects are meant as resources involved (material, technological, human, financial, time resource) it is more important than in any other field the need to reduce the effects of risk and uncertainty generated by the unforeseen. The competitive advantage is increasingly difficult to maintain taking into account that the market, with all its components, is evolving with high dynamics.

Under these conditions, decision-makers can apply a limited range of established strategic models and principles, most of which are based on event forecasting and risk analysis. Approaching the future in project management also involves identifying new models and principles, which are not only based on prediction, but which, once confirmed, could have significant value. Thus, according to [1-3], the concept of antifragility is presented as an aid in identifying and formulating strategies.

2. Project Management - Concept Presentation

In order to correctly identify the concept of project management, we start from the presentation of the classic definitions - of the respective management of the project - and later will be treated within the concept.

According to established and diverse definitions in the literature - "management involves achieving the goals of the organization through effective and efficient management as a result of planning, organizing, coordinating and controlling the organization's resources" [4], and - "a project is a temporary effort to achieve a unique product, service or result" [5].

In summary, the project can be defined as a management of resources over a certain period of time, which aims to achieve precise objectives.

According to the British literature, "the project is a temporary effort to create a unique product or service, which leads to a beneficial change or added value" [6], and its features are identified in the British standard BS PD 6079 [7] - excerpt: „Uniqueness - to be characterized by non-repetitiveness; to bring an innovation from a managerial point of view; involve elements of risk and uncertainty; to have imposed results; to have a determined quality; imposed resources".

Project management allows the concrete highlighting of specific activities in carrying out a project, with the identification of specific techniques and resources used optimally to achieve clearly defined objectives, depending on the constraints imposed (time, cost, quality, etc.) in terms of efficiency - so as it is defined in the literature.

Research and development projects, in general, and with applicability in industry in particular, are characterized by the fact that they do not have a built theoretical basis and no significant practical experience, involving in solving new concepts, technologies and principles (in the testing phase sometimes) with a high degree of unpredictability, which frequently generates the adaptation to the conditions of the competitive environment, therefore the change of objectives.

Within the industrial management, of the production management in the manufacturing industry, it can be emphasized that the transformation of the semi-finished product into a finished part is done by removing the processing addition. In general, under well-defined conditions of industrial production, this can be expressed by the relation:

$$P_f = F_{opt}(R_m, R_t, R_u, R_f, t) \quad (1)$$

where P_f - finished part; F_{opt} - optimization function; R_m - material resource; R_t - technological resource; R_u - human resource; R_f - financial resource; t - time resource, and the optimization function can take the most convenient mathematical form for the decision maker.

According to the new management principles, in the current competitive conditions, the standards of success in a project are structured according to five criteria, Table 1.

3. Industry 4.0 - Presentation of the Concept

The phrase "Industry 4.0 - 4th Industrial Revolution" was introduced to the public [10] in 2015 by Klaus Schwab (Executive Chairman of the World Economic Forum). The term is found in the research conducted at the request of the German government by the project teams that have been collaborating in identifying a strategy to increase competitiveness in the industrial field. The strategy aimed to generate added value in industrial areas considered underexploited: nanotechnologies, nanomaterials, artificial intelligence, the Internet of Things (IoT), additive technologies, etc., especially through digitization.

It is widely acknowledged that the main feature of Industry 4.0 is adaptability. At this stage of industrial development, the aim is to implement intelligent production systems, interconnected with IoT (Internet of things), Cloud technology and BigData systems. In other words, Industry 4.0 is realized through the ability to collect information, to structure, analyze and transmit information in order to make decisions characterized by efficiency under the circumstances of dissipating decision-making control.

During this period, companies that are adapting to Industry 4.0 are investing heavily in human resources and smart technologies, considering any element of a production line as a primary source of information. The direct consequence is the conceptual change in the approach of the production process, passing from restraining in stocks (stored stock) to customization of production (stock demand).

In the case of project management structural changes also occur. Thus, the traditional management implied the identification of the actions specific to the activities of planning, organization, management and control. The project manager, being the decision-maker, had to consider all aspects from the identification and allocation of resources to the control and management of risk.

The specific activities of Industry 4.0, being characterized by adaptability, impose the same type of change also on the project management. The usual transformations identified are related to the adaptation to the following characteristics: production flexibility, implementation of new manufacturing technologies, digitization, production automation, virtual reality, Internet of Things (IoT), collection - analysis - real-time data processing.

Table 1. The model for a successful project, divided into five criteria [8, 9]

No.	New success criteria	Remarks	Old criteria for success
1	Project efficiency	Keeping to the limit of time	Keeping to the limit of time
		Framing in costs	Framing in costs
		Framing in other predefined types of efficiency	Framing in other predefined types of efficiency
		Yield, functionality / performance	
2	Impact on the team	Team satisfaction	
		Team morale	
		Impact on team skills (Skills)	
		Increasing the value of team members	
		Staff retention in the team	
		Zero cases of burnout in the team	
3	Impact on the customer	Compliance with the required functionality	
		Compliance with technical specifications	
		Satisfying the needs of customers	
		Solving a customer's problem	
		The customer uses the product	
		Customers' satisfaction	
4	Business success	Sales success	
		Profit	
		Creating of a large market share	
		Cash - Flow	
5	Preparing for the future	New organizational capabilities	
		Development of new technologies	
		Creating a new market	
		Creating a new product line	

The largest share is represented by dynamism and flexibility in production, which is the main difference compared to traditional management systems. Change requires the adaptation of decision makers, but also the development of new skills.

Reducing analysis and information processing times is possible by connecting all elements of production systems (technological resource permanently interconnected with human resource) to data transmission (IT) systems. Only at this time, this results in the importance of human resources specialized in new systems and processes, production or management.

4. Antifragility and Project Management from the Perspective of Industry 4.0

The transition to the Fourth Industrial Revolution - Industry 4.0 will generate new management concepts, new production structures, but also new professions. The impact on project management and production processes will not be limited only to technology issues, but also to information flow and organizational structure [11].

Industry 4.0 will be characterized by the implementation of change - high adaptability in project management. The decision-makers, under the given conditions, will have to revolutionize their way of working and reconfigure their whole range of skills in the conditions of an increased autonomy.

A very important advantage, when moving to Industry 4.0, is the high dynamic and flexible nature of production. The generous possibility of setting up a dynamic production, which can change at any stage of the project, is a strong point, but it can also be a great challenge, because the decision-maker will have to take responsibility more, faster, with results, more efficient.

In support of decision makers come artificial intelligence, through elements of virtual reality, complemented by the automation of all managerial processes that do not involve analytical thinking or

design ability. This will significantly shorten the working time on a project, but at the same time it is a major source of conflict by eliminating human resources from the process of design, execution, implementation, control. Sometimes, the emphasis put on creativity comes as a consequence of the dynamization of the market under the pressure of competitive factors, which implicitly implies the dynamization of production.

Knowing the fact that in Industry 4.0 all the elements specific to industrial systems will be interconnected, the assets and personal information of the organization must be protected in real time, so cyber security will become a security element for decision makers.

Analyzing the brief information presented, it can be concluded that probably the greatest challenge on the project management side will be the ability of decision makers to adapt in real time, to work and take advantage of new manufacturing technologies and the full advantage of prediction and suggestion algorithms provided by Big Data, Cloud Computing and IoT. This ability to adapt, this type of mobility of the decision-maker, could be expressed by: antifragility applied in project management.

The concept of antifragility was developed by Nassim Nicholas Taleb and set out in detail in his book "Antifragile", which is the fourth book in "Uncertain" [1], a philosophical and practical essay on uncertainty, published in five volumes. The concept is based on the fact that in an increasingly complex world, the focus should be not only on prediction, but especially on adaptation and flexibility.

Antifragility differs from robustness through the fact that robust systems do not degrade or adapt when subjected to stress. Antifragility also differs from agility by the fact that agile systems only change their behavior until they return to their original level. On the other hand, systems that have antifragility characteristics are improving as a result of shocks.

In the Table 2 the stages of adaptation of the systems to unforeseen events with high impact are presented.

Table 2. Possible effects of unforeseen events on systems

Level of adaptation	Attitude of the system	System action	The effect of the unforeseen event	The system after the action of the unforeseen event
Fragility	avoid stressors	rejects the stress factor	complete shutdown of the system	system off
Anti-agility		resists change	system degradation	degraded system
Robustness	neutral	manages the stress factor	continuing the normal functioning, largely unaffected by stress	the system remains in the initial stage
Agility	waiting for stressors	adapts to the stress factor	system adaptation	adapted system
Antifragility		it develops based on the stress factor	system improvement	improved system

A very important aspect to note is that antifragility can be maintained only up to a certain threshold, above which fragility is reached. Any variation below this threshold is absorbed and converted into additional value.

The elements that characterize antifragility are summarized as follows:

- optionality - is the ability to solve a problem in several ways, using different elements. Optionality can be also represented by flexibility and mobility.
- investment resources - these must exist and / or be procured in order to be used in a timely manner. In order to survive an unforeseen event, investments should be possible.
- the strategy of "Seneca's dumbbell" – shall be summarised to being both super-conservative and super-aggressive in approaching strategies. In the literature, the weightlifting strategy is also similar to the floor (minimum and safe point) and the ceiling (maximum point, but risky) of a room, intervals between which we must always position ourselves. We can't make the "floor" "ceiling" by always adopting very aggressive strategies, but we can't make the "ceiling" "floor" by always being

at the bottom of the market. We can extrapolate this strategy to at least two elements of the industry: production and investment.

- the introduction of small doses of "random" - when we subject an element of a system to a stress factor and it does not fail, the next step is to try to test the system itself. In Industry 4.0 this can be done very easily through simulation and virtualization.
- reducing unnecessary intervention - this element of antifragility is all about to reducing the phenomenon of iatrogeny. Iatrogeny occurs when intentional intervention in a system causes more harm than good. Iatrogeny usually occurs with excessive intervention.
- taking responsibility and results - this concept translates as: ensuring that the one who makes the decisions or does the work has something concrete to lose or gain from the result.

5. Applicability of Antifragility in Project Management in Industry 4.0

Although there are promising steps towards the development and implementation of principles and concepts, the industrial structure of most countries is not developed enough to support a direct migration from Industry 3.0 to Industry 4.0. Specifically, it is proposed a gradual transition to type 4.0 industrialization through flexibility and mobilization, in managerial, technical and logistical measures, using elements that belong to antifragility.

The antifragility of a company is related to the antifragility of the elements that make it up. Organizing departments in such a way that they are highly flexible and adaptable demonstrates their antifragility. This can be done through decentralization and horizontal integration.

Optionality can be represented by holocracy - that is, by decentralization and interconnection (holon, from the Greek language - "an independent and fully functional unit, which is at the same time part of a larger entity", in other words individual autonomous element and in the same time part of the whole). Decentralized systems have a much greater ability to adapt at random, because they can conceive their own rules so that they can be applied to a specific, detailed, not broad, spectrum, as in the case of centralized systems.

The Seneca Dumbbell Strategy can be extrapolated at least in two elements of the industry: production and investment. On the investment side, the applicability of the method is based on two pillars: continuous incremental innovation (small, continuous, but secure development increments) and revolutionary innovation (large, high-risk, high-gain development increments). As regarding the production flexibility, the proposed strategy is based on the introduction of small doses of "random", which can be applied through virtualization and process simulation or even enterprise simulation. In those processes, minor system disruptions are introduced in order to highlight vulnerabilities. Specifically, this thing is difficult to do in the absence of specialized staff, considering the complexity of the real systems.

Reducing unnecessary intervention is strictly related to iatrogeny. Reducing unnecessary human intervention is done by automation and by making decisions based on the data provided by the system (software and / or intelligent technology, data collection, analysis and structuring, etc.), and not strictly on intuition.

Taking responsibility is greatly facilitated by decentralization. Decision-making autonomy increases the degree of responsibility, creativity and, as a consequence, the general productivity of the employee. The employee's freedom to apply his skills, to experiment and to achieve his own development, raises the degree of staff stability, so it is a real strong point of this element of antifragility.

6. Conclusions

The environment in which project managers work is dynamic, constantly changing. Adaptability is a key point without which they cannot keep up with the changes of the environment in which they operate.

The research undertaken aims to present the concept of antifragility and the possibility to be applied in project management from the perspective of Industry 4.0, which is characterized by a permanently high dynamic. Although the concept of antifragility is very versatile, little is known about its application in management or industry. For this reason, further research is proposed on this topic.

The development of management models in Industry 4.0 based on the concept of antifragility can be an interesting topic to address in the future.

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