

Brainstorming as a Support Tool for Industry 4.0 Advances in the PIM

Dawesley da Costa Mota¹, Fabiana Rocha Pinto²

¹Department of Engineering, Centro Universitário FAMETRO, Brazil

²Doctorate in tropical agronomy, Centro Universitário FAMETRO, Brazil

Received: 03 May 2021;

Received in revised form:

30 May 2021;

Accepted: 13 Jun 2021;

Available online: 19 Jun 2021

©2021 The Author(s). Published by AI
Publication. This is an open access article
under the CC BY license
(<https://creativecommons.org/licenses/by/4.0/>).

Keywords— Industry 4.0; Quality tools;
Brainstorming.

Abstract— This paper discusses Brainstorming as a tool to support Industry 4.0 advances in PIM and how this tool can match the needs of Industry 4.0. Considering the current time and assuming that brainstorming is a quality tool responsible for the emergence of new ideas, demanded by the market, it is worth considering that the ideation process is crucial to match the needs of Industry 4.0, which more than ever is expanding worldwide. With all this search for improvement companies seek better tools and management support techniques to develop projects with higher quality, productivity and brevity thus becoming a more competitive industry. For this, the concept of brainstorming will be exposed, its use and application of the tool in the process of project idealization implemented in a guided way, contribute to the control of processes and provide gains in the operational sector of the quality system adopted. The methodology used consists of field research in the very industry where the researcher works, observing and collecting relevant data regarding the use of the tool in the work environment. The main objective is to understand how Brainstorming influences Quality 4.0 in the development of the so-called 4th Industrial revolution, where the evolution of information technology and its introduction in production processes are modifying traditional industries, taking them to different levels of quality and development and thus maximizing its use in the PIM. The results indicate that the tool is very useful for development and problem solving.

I. INTRODUCTION

With the advent of the new industrial revolution, quality is translated into an intelligent process for the modernization and improvement of industries, therefore, in face of this new reality, quality tools enable the understanding on productivity and efficiency in Industry 4.0. Brainstorming is a tool commonly used in the industry and it is necessary to reflect on its role in this new context.

This new paradigm drives and optimizes advances in the production process. Thus, the use of brainstorming, as a quality tool, is a strategic point to meet the needs of the customer and the market, since it seeks to stimulate and

present, as a team, possible solutions or ideas, in addition to organizing them.

Brainstorming Applicability in Industry 4.0

The quality tools are reconfigured to meet the new challenges in the quality management process arising from the Industrial Revolution itself. We are in the fourth Industrial Revolution, which is characterized by automation and connectivity, generating a significant advance in the relationship between man and machine.

Quality today is more present and active, as it is not limited only to the product or service. The term quality nowadays applies to several segments of life, such as:

quality of life, quality of air, quality of ethical standards, etc.

According to [1] there is a vision that quality is necessary for the strategic positioning of the company in the market, where there are more conscious and demanding consumers. In this way we live more than ever in the quality era. Currently, quality represents the search for satisfaction not only of the customer, but of all the publics of a company and also of its organizational excellence.

According to [2], the increasing complexity of the organizational activities brought as consequence the increase of the difficulty degree to solve problems. Nowadays, problems require a multidisciplinary intervention for their solution, since only one person, no matter how much skills and knowledge he possesses, will not be able to solve complex organizational problems, generating the need for teamwork.

Within this vision, quality tools provide an increase in the skills and competencies of the team, introducing new techniques and methods for problem identification and resolution.

[3] says that quality tools are all the process employed in obtaining improvements and positive results, thus allowing a better exploitation of its products in the competitive market.

[4] describes that the quality tools are divided into basic ones, with instruments to help the professional in the analysis of the problems and complementary ones, which serve as support to the use of the first ones.

Among the tools used in the quality and project management system, the following can be cited: the Cause and Effect Diagram, Pareto Diagram, Scatter Diagram, Histogram, 5W2H, Brainstorming, Flowchart, and Control Chart.

The quality tool targeted by this research is brainstorming, due to its method for generating group ideas in a short period of time and the contribution of all members in order to obtain innovative and creative solutions to the problem.

Brainstorming

Created in 1938 by the Englishman Alex Osborn, brainstorming is a tool for generating group ideas in a short period of time, also known as "brainstorming". The objective of this tool is to potentiate the individual's creativity, putting it at the service of his objectives.

According to [5] the technique is divided into three parts: Finding the facts; Generating the ideas or ideation process; Finding the solution. From finding the facts in solving a problem there are two subparts: Problem Definition and Preparation.

This tool can be used by anyone in the organization and at any stage of the problem-solving process, but it should be conducted by a single person to maintain order during the process, as in the identification and selection of issues to be addressed.

The objective of this method is to focus the attention to the most important aspect of the problem, developing the reasoning for the visualization of the problem, solutions and improvements in different and amplified angles. According to [6] in a problem-solving process this tool serves as a "lubricant", since the causes of problems are difficult to identify and the direction to follow or options for solving the problem are not apparent.

Because it is associated with creativity, brainstorming is widely used as an auxiliary tool in the development of other tools, for example, it can be used to develop the PDCA cycle planning.

Brainstorming in Industry 4.0

The brainstorming is used today as a tool to solve the problems developed in the advancement of Industry 4.0, widely used in Design Thinking (DT), popularized by [7], which is the approach to problem solving that uses the sensitivity of designers and their methods to identify the needs of users and transform them into business opportunities.

Brainstorming ties in with this tool assisting in the development of innovative and radical solutions allowing industry to excel in the industry 4.0 market.

Design Thinking has three pillars: Inspiration, Ideation and Implementation. Inspiration or also known as immersion, can be divided into two stages: Preliminary and In-Depth. The first aims at the reframing and the initial understanding of the problem, while the second aims at the identification of opportunities and needs that will guide the generation of solutions in the next phase of the project, and the ideation [8].

For [7], ideation is the process in which ideas and concepts are generated and prototyped with the aim of generating innovations on the problems identified in the Inspiration stage.

After the solutions are well defined and inspired in the user needs (focus of the whole analysis), the solution implementation is taken to the market. [7] still cites that, in the implementation stage, one must plan the method that will achieve the expected future reality, which implies the creation of business model prototypes to evaluate the impacts on the organization's activities. It is imperative, at this point, that the organization: identifies the reasons to drive the solution's success; prioritizes the activities of the sectors that commit to deliver the related strategies; defines the strategic, operational and economic relationships; and defines the venture's economic impact.

With the ability to solve complex problems, brainstorming, is applied in one of the three (3) pillars of Design Thinking, ideation process. During the Ideation process the best ideas are submitted to an evaluation by the team itself. Those approved take shape with the rapid elaboration of prototypes, spending only the time, investment and efforts necessary to generate information that will be useful for the progress of the idea [9].

The transformations associated to the concept of Industry 4.0 present potential to increase the flexibility, speed, productivity and quality of the production processes [10]. Its impacts, however, will go far beyond: they will affect the economy, businesses, governments, people and work. Industry 4.0 is the product of a profusion of technologies applied to the production environment, what [11] calls "megatrends". Among them, Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Services (IoS), autonomous vehicles, 3D printers, advanced robots, artificial intelligence, Big Data, nanomaterials and nanosensors [10], [11], [12] stand out. It is in this context that brainstorming emerges as an empowering tool for the development and improvement of Industry 4.0, bringing better ideas and improving the projects developed in this revolution.

The objectives of the study are: to understand through theoretical survey about the quality tools, directing the look to the brainstorming and how it accompanies the development of Industry 4.0; and expose the impacts of brainstorming in the industry.

II. MATERIAL AND METHODS

The applicability of brainstorming in the industry enhances its adaptability capacity, regardless of the context. Data was collected in the Industrial Pole of Manaus through data made available arising from a survey by means of questionnaires in Google Forms, in order to understand and collaborate with the existing practices.

The investigation, of paramount importance for scientific development, leads the researcher to delve into the problem at issue, leading him to seek solutions and/or results that answer positively or not the questions raised in the research [13].

According to the need raised for the development of the project, it is necessary a scientific approach to the efficiency and use of brainstorming as a working tool to aid the development of Industry 4.0 in the PIM.

To this end, it will be used as a method of data collection the field research and the theoretical basis on the subject within the area of the established theme.

Nature of the Investigation and the Method

The following research will be of qualitative nature, due to the fact that this methodology provides a better view and understanding of the context of the problem in order to use the ideas and narratives of the companies investigated, thus observing the motivation of the use of the brainstorming tool or the reasons for not using it.

Qualitative research is appropriate for this research, because according to [14] it is seen that it is directed to interpret its object of study, has a subjective, evaluative character, where the researcher is the one who analyzes the concepts and results, bringing to the research a particular view on various factors that influence the result itself.

Considering that the industrial development happens to better serve society, the environment and the industry itself, it is necessary a deeper understanding about the tools used to develop and enhance the Industry 4.0 at the PIM, especially raising the question about the use of the brainstorming tool, as one of the possibilities of developing Industry 4.0, expanding the understanding about the possible reasons that led the PIM to introduce or not such a tool in the process of ideation and improvements in the PIM itself.

Field of Observation and Subject of the investigation

Established in the city of Manaus, the economic model entitled the Manaus Free Trade Zone was created in 1967, through Decree-Law 288. Still in the government of President Juscelino Kubistchek in 1957, Law No. 3,173 created the Manaus Free Trade Zone, which actually only became effective 10 years later [15].

When it was implemented, the main objective of the Free Trade Zone was to foster the economic development of the region. Besides, it focused on the integration between the Northern States and had the intention of promoting the occupation of this space. This is because the North region is the least populated in Brazil [15].

With approximately 600 industrialists, divided into: Two-wheeled pole, Electro-electronic pole, Mechanical pole, Watchmaking pole, Metallurgical pole, Chemical pole, Plastic pole and Miscellaneous pole. Due to the vast number of factories installed in the PIM, the research field approached will be only three (3) or four (4) factories, this choice is due to the fact of the approach of the researcher with the team responsible for applying the improvements required by the 4th Industrial Revolution.

Data Collection and Information Processing Mechanisms

As an initial activity for the identification of the use and application of brainstorming, the researcher will make a participant observation of the use of the brainstorming tool in the environment in which a plastics pole factory works.

This instrument of data collection will be applied by the simple fact that as a technique used in research, it should be emphasized that its objectives go far beyond the detailed description of the components of a situation, allowing the identification of the meaning, the orientation and the dynamics of each moment [14].

Among according to [14], in the approach by "Participant Observation" it should be emphasized that its objectives go far beyond the mere description of the components of a situation, allowing the identification of the meaning, the orientation and the dynamics of each moment. In view of the intersubjectivity present at each moment, observation in situation allows and facilitates the apprehension of the real, once essential aspects are gathered in the field.

First, it was observed during meetings and team comments how the brainstorming tool is understood and used by the same, then the researcher problematized the observations and generated seven (7) guiding questions that led him to generate the data to better understand the use of the tool as a tool to manage projects.

III. RESULTS AND DISCUSSIONS

The ascendancy of brainstorming as a tool in the PIM is visible and proven by the results collected by this research. The responses obtained were observed from the project follow up meetings.

The team observed uses brainstorming and is composed of individuals from various areas, thus making it a multidisciplinary team.

When questioned about which tools are used by each team, they exposed: Pareto diagram, kanban, Brainstorming, 5W2H, Ishikawa diagram, PDCA, Business Model Canvas (BMC), designer thinking, project portfolio, flowchart, control chart, GUT matrix, FMEA and Quality Function Deployment QFD. It is worth mentioning that the members who did not include brainstorming, pointed out only the tools that help brainstorming.

The use of brainstorming in the aid of the projects is guided by each member, having as a result: a. To help in the agility in developing the project; b. In the macro view of the risk analysis (this answer appeared five times); c. In the elaboration of more complete scopes; d. In the decrease of expenses in the development of the project; e. In the raising of ideas to solve the problems found in the MVP (Minimum Viable Product); f. In the development of the pre-project. Assist in the development of the pre-project; f. Assists in solving complex problems (this answer appeared three times); g. In quality control and project management; h. Assists in GUT matrix through problem solving; i.

Assists in PDCA; j. Assists in decision making for the development and choice of projects.

In the questioning made about the use of brainstorming as a main tool and/or as an auxiliary tool, we obtained the following answers: no participant uses it only as a main tool; five participants answered that they use it only as an auxiliary tool to other tools, such as, for instance, PDCA, FMEA, designer thinking and GUT matrix and 3 other participants assumed that they use it both as a main tool and as an auxiliary tool, helping in the PDCA and designer thinking tools.

The changes perceived by participants regarding the use of brainstorming were commented in meetings, presenting the following information as: a. Cost reduction (six answers appear); b. Agility in the creation process; c. Better team harmony (two answers appear); d. More complete and complex projects; e. More comprehensive scopes; f. Higher rate of project approval at the board; g. Decreased problems found in products (three answers appear); h. More competitive products on the market; i. Quicker problem solving; j. Decrease of risks arising from new projects (appeared twice); k. Decreased problems caused by the products; l. Organization of the manufacturing process.

Therefore, brainstorming is a tool that presents itself in different contexts of the industry. In obtaining the collaboration of eight participants from two different teams and regardless of which one they belong to, it is clear that the tool is of added value for the results expected in Industry 4.0.

It is understood that even if the tool is used in an auxiliary way by the members, it achieves unquestionable positive results, defended by [16] such as: reduction of costs, risks, problems and agility in their resolution. Due to the composition of a multidisciplinary team, which enhances the brainstorming tool itself, it is perceived by it that there is a greater competitiveness of products when launched on the market.

IV. CONCLUSION

It is clear that the needs of Industry 4.0 have given rise to quality enhancing tools. The complex and dynamic structure of the industry, as well as the context in which it operates, allows us to reflect on a new take on this new methodology.

Brainstorming itself, values interdisciplinarity, the exchange of ideas, group dynamics, the search for relevant and quick solutions, corroborating with the industry itself, the society and the being that composes it.

REFERENCES

- [1] DANIEL, É. A.; MUBARCK, F. G. Levantamento Bibliográfico do Uso das Ferramentas da Qualidade. *Gestão e Conhecimento*, 1-43. 2014.
- [2] LUCINDA, M. A. Qualidade: Fundamentos e práticas para cursos de graduação. Rio de Janeiro: Bradsport, 2010.
- [3] GODOY, A. L. de. Ferramentas da Qualidade. 2009.
- [4] LINSB. F. E. Ferramentas básicas da qualidade. *Ciência Da Informação*, 22.Edição v. 22 n. 2 (1993).
- [5] COLETTI, J.; BONDUELLE, G. M.; IWAKIRI, S. Avaliação de Defeitos no Processo de Fabricação de Lamelas para Pisos de Madeira com uso de Ferramentas de Controle de Qualidade. *Acta Amaz*, Manaus, v. 40, n. 1ª, p. 135-140, 2010.
- [6] SEBRAE. Manual de ferramentas da qualidade, 2005.
- [7] BROWN, T. Change by design: how design thinking transforms organizations and inspires innovation. New York: HarperCollins, 2009.
- [8] VIANNA, M.; VIANA, Y.; ADLER, K. I.; LUCENA, B.; RUSSO, B. Design thinking: inovação em negócios. Rio de Janeiro: MJV Press, 2012. 162p.
- [9] BONINI, L.; SBRAGIA, R. modelo de design thinking como indutor da inovação nas empresas: um estudo empírico. – São Paulo: Revista de Gestão e Projetos, 2011.
- [10] BOSTON CONSULTING GROUP. Industry 4.0: The future of productivity and growth in manufacturing industries. BCG Perspectives, 2015
- [11] SCHWAB, K. The Fourth Industrial Revolution. Genebra: World Economic Forum, 2016.
- [12] CONFEDERAÇÃO NACIONAL DA INDÚSTRIA. Desafios para a Indústria 4.0 no Brasil. Brasília, 2016.
- [13] GERHARDT, T.E.; SILVEIRA, D.T.; Métodos de Pesquisa. Porto Alegre: UFRGS, 2009.
- [14] SPRADLEY, J. P. Participant Observation. Orlando-Florida. HarcourtBraceJovanovichCollegePublishers, 1980
- [15] HOLLAND, M.; GURGEL, A.; CERQUEIRA, C.; SERIGATTI, F.; GELCER, D.; ANDRADE, J.M.A.; ALBURQUERQUE, P.; PIERI, R. Zona Franca de Manaus: Impactos, Efetividade e Oportunidades. Escola de Economia de São Paulo: FGV, 2018.
- [16] KOHN, N. H.; PAULUS, P. B.; CHOI, Y. Building on the ideas of others: An examination of the idea combination process. *Journal of Experimental Social Psychology*, v. 47, p. 554–561, 2011.