

TOWARDS DIGITAL INNOVATION, THROUGH AN ANALYSIS OF CRITERIA FOR THE IMPLEMENTATION OF INDUSTRY 4.0. SYSTEMATIC SORTING

TOWARDS DIGITAL INNOVATION, THROUGH AN ANALYSIS OF CRITERIA FOR THE IMPLEMENTATION OF INDUSTRY 4.0. SYSTEMATIC ARRANGEMENT

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Abstract - Industry 4.0 ensures the change in manufacturing processes, where the digitization of both economic and production sectors are the main part of it. It is necessary that there is a direct interaction in each stage of the manufacturing process, related to the machines, which places the organizations that implement Industry 4.0 strategies with improvements in their processes and innovating in their business units. The identification of those factors that are determinant in the implementation of Industry 4.0 strategies, will allow facilitating the transition in process innovation with positive and efficient effects. In this way, the present work is focused on making a proposal, which contains all the parts that make up the planning of the research project; which aims to analyze the factors and strategies that allow a successful implementation of Industry 4.0.

Keywords: Industry 4.0, factors, digitalization, implementation.

Abstract - Industry 4.0 ensures change in manufacturing processes, where the digitization of both the economic and production sectors are the main part of it. There needs to be direct interaction at every stage of the manufacturing process, related to machines, which places organizations implementing Industry 4.0 strategies with process improvements and innovating their business.

units. The identification of those factors that are determinant in the implementation of Industry 4.0 strategies will facilitate the transition to process innovation with positive and efficient effects. Thus, this paper focuses on a proposal, which contains all the parts that will make up the planning of the research project; which aims to analyses the factors and strategies that enable a successful implementation of Industry 4.0.

Key words: Industry 4.0, factors, digitization, implementation.

INTRODUCTION

The concept of Industry 4.0 has become a trend that has come to improve the way are done, both in the day to day and in labor aspects. Intelligent devices, the emergence artificial intelligence, information clouds, the internet of things, among other relevant concepts, have generated major changes in companies and in the way people do things.

The results show that facilitating and hindering drivers play an influential title in companies' decision making to adopt Industry 4.0. The main motivating factors identified are expected benefits, market opportunities, job problem, customer requirements, competition, and image of

quality. In addition, resources, skills and support are identified as facilitating factors.

Lack of the right people, lack of funding, lack of knowledge, technical challenges, operator training and the change of mentality of operators to accept new digital technologies are identified as hindering factors.

Background

There are several ways to organize the parts that make up a research project, but it will always be in an orderly fashion and respond to certain criteria. A research project should contain the object of study, limitations, objectives, justification, an outline, frame of reference, hypothesis, methodology, timetable and sources. [1]

Since 2011, the term Industry 4.0 has been integrated into the industrial sector, especially the implementation of information and communication technologies. This term was coined as a philosophy that offers companies the opportunity to differentiate their products by increasing the efficiency of their procedures, routines and systems. It also mentions that Industry 4.0 is not only from a technological perspective, but also includes human resources and the management of the organizational culture of each company, with the possibility of being flexible. [2] In Mexico the boom was until 2018, with the entry of a new government and the opening of investment in the manufacturing sector; companies managed to introduce this concept of industry 4.0 as a main axis in the economic development of the country. [3]

An example of the introduction of Industry 4.0 in Mexico is in the automotive and textile industries, where the construction and consolidation of smart factories has begun. [4] These changes in the use of technology and online commerce have boomed in recent years. All this development goes in hand with the fact that industries not only in Mexico but also in Latin America are adopting this Industry 4.0 philosophy. [5]

There is no clear definition of the term Industry 4.0, but the concept has acquired an impressive boom in global industry. The aspects of interconnectedness/connectivity, human factor, internet of things, interoperability, production planning, as influential factors in the basic principles of implementation. [6]

Industry 4.0 has introduced impressive changes in companies and organizations operating in a globalized world. This has forced changes in communication, new ways of information processing, and, in , to perform an analysis of the

requirements and capabilities in a new way of life.[7] following is a of the The list requirements and capabilities of a new way of life.

The 2030 global trends document emphasizes:

- Information and Communication Technology
- Technologies relevant to the security vital resources.
- New health technologies.
- New technologies from manufacturing and automation.

Today's information and communication technologies not only emphasize the social networking of the Internet, but it has become a platform for communication between machines and products, offering a complete solution that surpasses the potential possibilities of the traditional manufacturing industry. [8]

The principles for the implementation of Industry 4.0 include the following aspects: interconnection, connectivity, technical assistance, the human factor, intelligence, awareness, interoperability, information transparency, technology, organization, production planning. [9]

The application of industry practices as a whole 10] 11] Moreover, the correct applications of these emerging concepts promote cost reduction, due to good design and operational efficiency of processes, reducing nonconformities and defect rates, as well as ensuring on-time completion and delivery of the product. [12]

Project impact

The planning stage of any research project is one of the most important phases, since it is where the work method, the steps to be followed, the materials to be used and the expected results are determined

When focusing on Industry 4.0 it is necessary to mention that, given the existing global competition in organizations, the technologies and strategies of Industry 4.0 can be a driving factor for increasing their competitiveness, since by introducing changes they impact their processes. This study is expected to have the following impact and/or benefits:

- To have relevant and first-hand information on the critical elements in the implementation of Industry 4.0 in organizations in the region (Cd. Juarez - El Paso, Texas).
- Propose a predictive model that will help explain the relationships between the elements identified in this study and the successful use of Industry 4.0 technologies and strategies.

- Identification of training needs for professionals and teachers to conceptualize the adoption of Industry 4.0, which will allow designing strategies focused on an effective implementation.

DEVELOPMENT

Once the objectives and impact of the project have been defined, it is very important to determine the methodology, materials and method to be applied. These concepts, which are already defined for the project, are shown below and are based on authors who are specialists in the digitization of the industry.

Methodology

The methodology to be followed will be quantitative, since several tools will be used, ranging from data collection, statistical analysis to test assumptions and discussion of the results. [13] The path of the research will be through a study of analysis of variables and factors; being carried out in a transversal-causal way in a local context, on industry 4.0; to then describe the cause-effect relationships in a neutral way. [14] The methodological approach suggests that the variables should be studied in their natural state, in the objective scenarios independently. [15]

Materials

In the revision phase of the state of the art, articles and publications identified will be analyzed using the database of the virtual library of the Universidad Autónoma de Ciudad Juárez (UACJ), which has 30 databases. For the collection of information, a previously designed and validated questionnaire-type measurement instrument (hereinafter MI) is necessary. In the statistical data analysis stage, it is essential to use a desktop and/or laptop computer of medium gamma or high gamma; with sufficient characteristics such as processor speed and storage capacity, for the use of software packages such as: Minitab®, SPSS® and Amos®.

Method

The method proposed in this work consists of four stages:

Stage 1. Design of the MI, validation by expert judgment and confirmation of the internal reliability of the MI through statistical analysis.

Stage 2. Initial exploratory statistical analysis for the identification of outliers by means of the Mahalanobis Distance; determination of sample size and data fit (KMO- Kaiser Meyer Olkin, and Bartlett's test of sphericity).

Stage 3. Statistical analysis of the hypothetical model under the five-step approach or Structural Equation Modeling (SEM) process. These are:

- Model specification
- Model identification
- Model estimation
- Model test
- Modification of the model

Stage 4. Conclusions, recommendations and future lines of research.

DISCUSSION AND ANALYSIS OF RESULTS

It is crucial to systematically plan and order the steps of the Industry 4.0 implementation project in Ciudad Juárez to ensure its success and maximize its benefits. Careful planning allows identifying and mitigating potential risks, optimizing the use of resources, and setting clear and achievable goals. It also helps coordinate the activities of multiple stakeholders and maintain focus on long-term strategic objectives.

This ensures efficient and effective project execution, minimizing delays and maximizing return on investment. In summary, systematic planning is essential to guide the process of transformation to Industry 4.0 in a structured and successful way.

In carrying out this sorting, it was found that due to its qualitative design and limited sample size, the findings of this study should be complemented with quantitative studies to improve the generalization of the proposed model.

Knowledge of the Industry 4.0 decision components will help manufacturers in their decision whether or not to invest in its implementation, as they can be applied to balance advantages and disadvantages, understand the benefits, identify the skills and support needed, and what challenges to expect. For policy makers, our findings identify important aspects of the ecosystem that need improvement and how manufacturers can be motivated to adopt Industry 4.0.

This study lays the theoretical foundation for an alternative approach to conceptualizing the adoption of Industry 4.0 beyond the concept known as Unified Theory of Acceptance and Use of Technology (UTAUT). The integration of positive and negative factors enriches the understanding of the decision making factors for the adoption and implementation of Industry 4.0.

An influx in the use and subsequent abundance of data can be attributed to the advancement of Industry 4.0 and has called for companies to review their systems. Nowadays, the handling and processing of information has increased considerably, which has led to the adoption of terms such as *big data* or *IoT*.

This has led to a greater need than ever for companies to collect, store, process, control and manage their information so that, in doing so, they can better use and manage it.

Companies make use of historical data contained in clouds or virtual storage servers, so that autonomous systems can manage and configure and diagnose based on these historical data, the use of such systems promotes productivity in companies, reducing energy consumption and the quality of their products or services. When we talk about connectivity we refer to the key part that allows the link between devices, systems and people, that which allows them to have communication and be exchanging information. Adopting technologies in companies refers to the means of communication and technological tools for the transfer and storage of data and information.

These channels that favor the adaptation to the culture of the use of technologies is a fundamental key to the monitoring of processes when talking about production, to the optimization of efficiency and, in the long term, to the reduction of costs.

In Industry 4.0, the customer has become one of the main protagonists, since their participation, preferences and experiences are fundamental to increase competitiveness in the industry. Companies have to respond effectively not only to customers' needs but also to their expectations. That is why any transformation in the industry begins with the interaction of companies with their customers, either through personalization, experience, active participation and co-creation of value, these being the strategies that Industry 4.0 requires for its implementation in a company.

As long as the company applies technological tools or intelligent systems such as algorithms, artificial intelligence, etc. in all these strategies, the necessary reciprocity for digital transformation will be achieved. Now is the time for organizations to introduce changes for Industry 4.0. However, if you are going to initiate the changes, you will need a well thought out plan and a team invested in the upgrade.

For which a questionnaire could be designed on the following topics in form of the following questions:

1. Should a company try to implement Industry 4.0 principles?
2. If a company does not apply Industry 4.0 principles, which of the factors represents the main reason?
3. What factors motivate a company to implement Industry 4.0?
4. Do companies have any strategy for Industry 4.0?

The activities proposed to carry out the project are presented in Table 1, where the period of completion is also mentioned.

Table 1. Programming of activities.

No.	Activity	Period of performance
1	Literature review: Industry 4.0, critical success factors in Industry 4.0, Quality 4.0, Industry 4.0 predictive models for the identification of critical factors and their possible relationships with the successful implementation technologies and strategies. Industry 4.0.	January-March 2024
2	Elaboration of theoretical framework. Design and/or validation of the measurement instrument by means of pilot runs and statistical analysis.	April-June 2024
3	Application of the measurement to the target population, validation of the hypothetical structural model and obtaining results. preliminary.	July-September 2024
4	Analysis of results, adequacy of the proposed predictive model, elaboration of conclusions and recommendations, future studies and proposals for action.	October - December 2024

CONCLUSIONS

The systematic ordering in the identification of factors for the implementation of Industry 4.0, is essential for several reasons, it allows a comprehensive and structured assessment of the key factors influencing the adoption of this digital transformation in the industrial sector.

This type of project facilitates the identification of the relationships between different factors, for example, in projects focused on Industry 4.0, in which digital and physical technologies converge, where industrial processes are designed and operated.

The interconnection of cybernetic systems, artificial intelligence, internet of things and data analysis, open a panorama of unprecedented opportunities to increase efficiency, productivity and competitiveness in the region.

The implementation of Industry 4.0 requires more than simply adopting new technologies, it is to understand and address a series of interrelated factors ranging from technological infrastructure to human resource training. This is why collaboration between private sector companies, educational institutions and government is of great importance to implement Industry 4.0.

In conclusion, the implementation of Industry 4.0 in Ciudad Juárez represents a unique opportunity to boost industrial growth, innovation and sustainable development; however, it is necessary to jointly address most of the factors that influence this process, from technological, socioeconomic and cultural factors.

Based on this research work, we will proceed to the design and validation of the measurement instrument by means of pilot runs and statistical analysis.

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