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Technological Adaptation Model; an integrated application process to the productive chain in MyPyMES

Modelo de Adaptación Tecnológica; un proceso de aplicación integrada a la cadena productiva en MyPyMES

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Abstract

The purpose of this work is to develop a new analysis proposal an integrate the tools in the management of productive technological evolution projects in the industrial area, through a technological and procedural assurance plan for change management, focused on the creation of value and innovation, in order to face the challenges of globalized competition, respond to a productive logic with characteristics of the so-called smart factory and thus close the technological gap. Among the significant tasks, the review and analysis of the means of integration was developed, to associate them with the existing knowledge generated in the interaction, with practical purposes in decision-making activities, for the construction of strategies, and daring actions to face challenges, that promote the change to contemporary technologies, rapid methodologies, for the design and management of engineering and industrial automation projects, in order to generate competitive advantage in MyPyMES. The results allowed the construction of a Technological Adaptation Model that supports MyPyMES.

Industrial Evolution, Technologial Adaptation, Industrial Project

Resumen

El propósito del presente trabajo es desarrollar una nueva propuesta de análisis e integrar las herramientas en la dirección de proyectos de evolución tecnológica productiva en el tema industrial, a través de un plan de aseguramiento tecnológico y procedimental para la gestión de cambio, enfocado hacia la creación de valor e innovación, con la finalidad de hacer frente a los desafíos de la competencia globalizada, responder a una lógica productiva con características de la denominada fábrica inteligente y así cerrar la brecha tecnológica. Entre las tareas significativas se desarrolló la revisión y análisis de los medios de integración, para asociarlos con los conocimientos existentes en el entorno y considerar aquellos conocimientos generados en la interacción, con fines prácticos en las actividades de toma de decisiones, para la construcción de estrategias y acciones atrevidas para enfrentar retos, que impulsen el cambio a tecnologías contemporáneas, metodologías rápidas, para el diseño y gestión de proyectos de ingeniería y automatización industrial, en pro de generar ventaja competitiva en MyPyMES. Los resultados permitieron la construcción de un Modelo de Adaptación Tecnológica que apoye a las MyPyMES.

Evolución Industrial, Adaptación Tecnológica, Proyectos Industriales

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Introduction

In Mexico, the Mexican industry has not been studied in depth, so it is interesting to start from internal processes of information and knowledge; associate it with the existing knowledge in the environment and consider the knowledge generated in the interaction, the concept refers to the processes, practices and decision-making activities for the construction of strategies and bold actions in relation to risks, which drive change, in favour of innovation, in order to generate competitive advantage (Lumpkin and Dess, 1996; George and Marino, 2011).

MSMEs in hostile environments have consistently and creatively developed new processes, products or services, increasing their competitiveness, enabling them to compete in international circuits. However, in most studies it has been observed that small firms have strong difficulties in generating sustained profitability, increasing or developing commercial opportunities and transforming them into sales (Andreeva and Ritala, 2016; Teece, 2016; Guesala et al., 2018).

Mexico is attractive for foreign investment because of its labour force, its geographical location and its commitment to the formation of technological capabilities through foreign trade and the entry of foreign capital (Solleiro-Rebolledo and Castañón-Ibarrra, 2014); it currently has a favourable outlook in terms of innovation according to the Global Competitiveness Index 2018 of the World Economic Forum, ranking 50th out of 140 countries in terms of innovative capacity to generate new goods and services.

There is still much to be done in terms of linking technology companies in projects with universities, consultancies, suppliers and other specialist bodies for the development or integration of industrial solutions with technological applications.

Thus, an improvement in the organisation's performance can be explained through the company's ability to constantly renew itself by identifying and exploiting new opportunities in response to customer demands and continuous improvement.

In the context of organisational growth, entrepreneurship is identified among the capabilities of greatest interest, given that it is a factor that leads to the development of innovation capabilities and the achievement of sustainable competitive advantages (Porter and Kramer, 2011; Barney, Ketchen and Wright, 2011; Marvek, Davis and Sproul, 2016).

The aim of this paper is to integrate the tools in the management of productive technological evolution projects in the industrial sector, through a technological and procedural assurance plan for change management, focused on value creation and innovation. The importance of this research is based on the fact that, to the author's knowledge, there are no instruments in Spanish that evaluate the features and interactions, which has aroused concern through the literature and because of its transcendence in the economic development of the country; with the purpose of achieving the correct adjustment between the environment and the capacities that organisations must adopt to promote efficient practices in the daily production of any product, by means of automated manufacturing cells, given the inexistence of human-machine and machine-machine communication processes which allow an intelligence capable of significantly improving the entire production line of any product in such a way that it drives business innovation, through the generation of competitive advantages in MySMEs. The second section of the paper presents the conceptual framework, as well as a review of the literature and empirical studies related to technological and procedural assurance for change management, with a focus on value creation and innovation. The third section describes the methodology employed, while the analysis and results are presented in the fourth section, and finally conclusions, limitations and implications for future research are presented and discussed.

Theoretical framework

In recent decades, studies have tended to reveal the impulses that allow resources to be transformed creatively, maintaining the quality of the products developed and produced, while complying with Good Applicable Practices; given that the operating principles of each automation approach differ, as they include standards and operating regulations, linked to different models, contexts or different times.

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These requirements are imposed on industrial processes for the purposes of performance, quality and flexibility, making it necessary to use new technologies for control and monitoring. PLC's are born with the purpose of offering solutions and greater safety in automated equipment; as they have software for their programming, they facilitate the Human-Machine Interface (HMI).

The Human-Machine Interface HMI (Human Machine Interface), depending on the producing company, offers different versions of software, customised tools for the design of interfaces at a basic level of work environment, capturing field signals through PLCs using standardised communication means and protocols by means of industrial network links.

The purpose of the automation of production processes is to facilitate the operator's task; for the purposes of monitoring and follow-up, as well as for the establishment of criteria for adjustments and/or changes within the process (Barzaga-Martell et al., 2016).

Analogue instrumentation (pressure gauges and thermometers) has become only indicative, giving its place of importance to transmitters, such as pressure and temperature indicators, which by means of a Programmable Logic Controller (PLC), these devices obtain data and execute actions that through a technological architecture focused on the analysis of signals and systems are based on mathematical control models. Its task is to respond to stimuli captured by sensors by sending signals to actuators such as valves, pistons, motors, with regard to this technology applies the principle of open and closed loop control systems, the most used is the closed loop in order to generate a feedback of information to develop stable control process perform automatic control of the process.

Of the different supervision systems that exist, the most widely used are called SCADA (Supervisory Control and Data Acquisition), which is a set of supervision and control software applications, specially designed to allow access to plant or process data through digital communication with the instruments and actuators in interaction with the operator (high-level graphic interface) together with data acquisition.

At the next stage of the pyramid are the Manufacturing Execution System MES (Manufacturing Execution Systems), computer programmes used mainly to obtain information from the different stages of the production process from the supply chain, document the transformation of raw materials into finished products, so that they serve to analyse and evaluate the internal needs of a plant.

Finally, Enterprise Resource Planning ERP (Enterprise Resource Planning Systems) tools are resource management systems necessary to carry out business tasks, which integrate and manage a large amount of information associated with the production and distribution of the product as a commodity with which decisions are made at the executive level, which affect the previous levels of the automation pyramid and whose repercussions are noticeable throughout the plant.

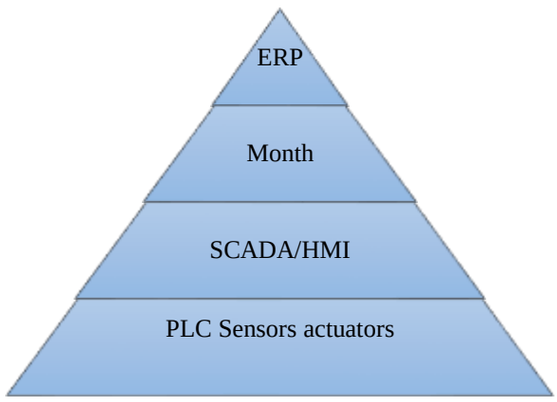

Figure 1 Model of the automation pyramid according to ISA-95 standard

Many are the antecedents that are identified in the literature as ideas and determining factors to include analysis technologies and improvements in production processes, such as HMI/SCADA, achieve a large amount of information about the processes, although with poor analytical processing for the intelligent use of information in executive decision making and/or their interactions for the generation of better production processes, better products or services and better forms of organisation.

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Methodology

The research refers to the development of an analysis methodology to improve business transformation processes through technological evolution, acquiring or adapting existing equipment, which can be automated to improve the performance of the production plant and the capacity for innovation in MSMEs, therefore, the design used is experimental, quantitative, cross-sectional and correlational (Hernández, Fernández and Baptista, 2010).

The scope of the research is exploratory in nature, as it approaches the problem of relatively unknown studies and in turn suggests verifiable statements in order to generate knowledge that will contribute to research on the subject.

Being considered as an evolutionary adaptation in terms of field elements in the production hardware, significant modifications are made in the machines and plant equipment, this generation of devices contemplate, forms and designs similar to those of Industry 3.0, but with control data communication functions with greater quantity or robustness at the time of transit of information, which streamlines the operation for the user, such as connection technology and fast communication IO-Link or through the OPC UA standard.

Technological integrations of IT solutions for smart grids, by means of new generation servers connected to cloud computing, once unified, allow the analysis of variables to be developed by means of KPIs or production indicators and therefore in classic control systems the feedback of information is limited compared to an Industry 4.0 system, which can generate a system of intelligent alerts.

Among the agile project methodologies, FEED or FEL (Front-End Engineering Design - Front ENd Loading) engineering is considered, consisting of defining the basic parameters of the process, determining the arrangement and sizing of equipment and ideal models, designing and specifying the system in constitution in this case of hardware, for production and processing of industrial control and sales channel software, in order to establish the specification to performance in an ideal industrial environment.

It is proposed to apply a standardisation level of operability and generation of value, by means of the integration of devices and software programmes that a system of this nature must have, among which are considered MES systems, ERP, HMI/SCADA, PLC, Field Elements or sensors, Augmented Reality systems, robotic autonomy, cyber security, vertical and horizontal integration communication, big data information processing, Internet of things as well as simulation, whose functions and interfaces are already duly installed in the devices or platforms currently marketed as conventional line products which respect the components of the ISA95 standard (Salinas, 2017).

Results

In the case of MSMEs, due to their specific characteristics, it is considered appropriate to consider interdisciplinary communication networks, favouring cooperation and diversity, to address the planning process, as well as to visualise the information necessary for execution; elements such as problems, execution time, budgets, areas involved, risks, products obtained, etc., focused on the creation of value and innovation.

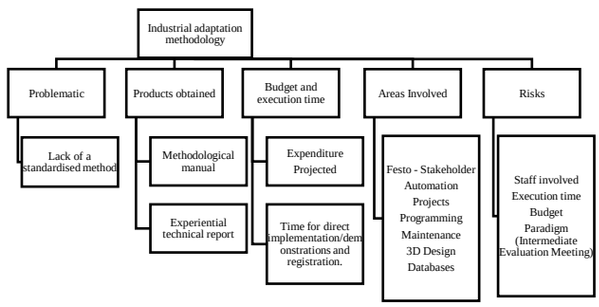

Figure 2 Proposed Model Adaptation Plan

The formulation of an engineering project, as well as its direction and development, generate the adaptation and quality factor to achieve the desired objective, through the use of agile methodologies for the creation and management of projects.

The help of a business model for innovative management, generates a solid base to frame the scope of an integration with a high impact media expectation, which also represents a considerable economic cost by attending to a high number of integrated technological media.

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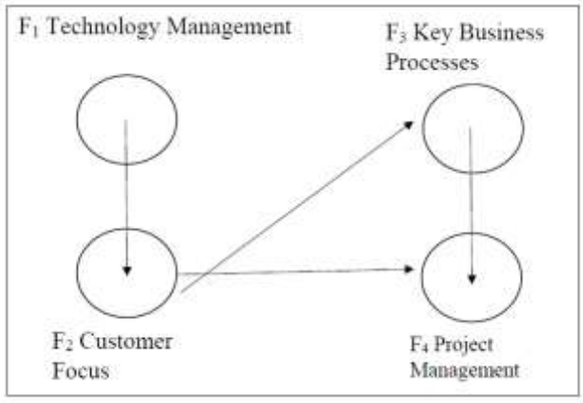

Figure 3 Graphical distribution of the Innovative Management Model of a Mexican Research and Development Technology Centre
(Martínez Ruiz, 2019)

Through modular visualisation, Technology Management takes on a highly representative place by contemplating determining factors from technological planning, implementation, assimilation processes, acquisition and development of technology, by considering process automation as a value proposition and key differentiator in a company that develops integral technical solutions.

Figure 4 Technological Adaptation Model

Faced with the challenge of developing a technological adaptation protocol, engineering principles are fundamental in the efficient and relevant diagnosis and design of the solution, from digitised design to the machining of parts, through collegial work between the members of the interdisciplinary team.

Conclusions

The study demonstrates the importance in the work of the project leader, in the initial diagnosis, the plan or design for the migration of a modern automated production system to a contemporary high-tech one, selection of parameters for implementation, as it is a high level of complexity, due to the multiplicity of variables encountered, thus, in the dynamics of innovation, organisation, technologies, sector dynamics and the response of society are interwoven (Rip, 2012).

For future work, it would be interesting to develop improvements to the system using an agile methodology such as Kamba or Scrum, fine-tuning to a linear life cycle, supported by artificial intelligence.

As Martínez Ruiz refers, in the 4th. Industrial Revolution there is a point of Disruption and Aporia, whose impact fissures the modernity of the productive nature and from the educational perspective, the generation of technical competence standards, typical of methodological management.

The present study is not free of limitations; the complete coverage of all the articles could not have been achieved, given the search procedure chosen. Therefore, there may have been papers left out that were aimed at migration or technological adaptation where a different language was used. Consequently, factors derived from the analysis need to be treated with caution.

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