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Implementation of an Intelligent Model Based on Big Data and Decision Making Using Fuzzy Logic Type-2 for the Car Assembly Industry in an Industrial Estate in Northern Mexico

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Abstract. In our days, we are living the epitome of Industry 4.0, where each component is intelligent and suitable for Smart Manufacturing users, which is why the specific use of Big Data is proposed to determine the continuous improvement of the competitiveness of a car assembling industry. The Boston Consulting Group [1] has identified nine pillars of I4.0, which are: (i) Big Data and Analytics, (ii) Autonomous Robots, (iii) Simulation, (iv) Vertical and Horizontal Integration of Systems, (v) Industrial Internet of Things (IoT for its acronym in English), (vi) Cybersecurity, (vii) Cloud or Cloud, (viii) Additive Manufacturing including 3D printing, and (ix) Augmented Reality. These pillars can all be implemented in factories or take some depending on the case you want to improve. In Industry 4.0, the Industrial IoT is a fundamental component and its penetration in the market is growing. Car manufacturers such as General Motors or Ford expect that by 2020 there will be 50 billion (trillion in English) of connected devices and Ericsson Inc. estimates 18 billion. These estimated quantities of connected devices will be due to the increase in technological development, development in telecommunications and adoption of digital devices, and this will invariably lead to the increase in the generation of data and digital transactions, which leads to the mandatory increase in regulations, for security, privacy and informed consent in the integration of these diverse entities that will be connected and interacting among themselves and with the users. Finally, the use of Fuzzy Logic type 2 is proposed to adapt the correct decision making and achieve the reduction of uncertainty in the car assembly industry in the Northeast of Mexico.

Keywords: Smart manufacturing, industrial IOT, big data applied to the automotive industry, fuzzy logic type 2 for decision makings.

1 Introduction

Today technology is an important part of everyday life, from the way we communicate, to the different types of technologies that allow us to carry out many types of processes in different industries. On the other hand the Mexican industry, particularly the automotive industry is not exempt from these technological advances, which are part of industry 4.0 (I4.0) has an endless number of technologies that make it compete in the market, but in turn these technologies are not being effective enough to meet the demands of today's world, therefore this chapter will show a literature review of the concepts that will be the basis for the proposal of a new intelligent model that is able to combine cutting-edge technologies, in order to optimize processes and resources within the automotive industry in northern Mexico.

2 Literature Review

This section shows the main concepts to this article and how they have been generating and evolving along the history, this section gives us an idea of what exists with respect to the technologies mentioned as Industry 4.0, Big Data, Fuzzy Logic Type-2.

2.1 Industry 4.0

Industry 4.0 (I4.0) is the latest standard for data and computation oriented advanced manufacturing [2], The term "Industry 4.0" originated from a project initiated by High-tech strategy of the German government to promote the computerization of manufacturing. Industry 4.0 is considered as the next phase in the digitization of the manufacturing sector, and it is driven by four disruptions: the astonishing rise in data, computational power, and connectivity, especially new low-power wide-area networks [3].

The I4.0 was named because in along the history it was the fourth industrial revolution, the first one (I1.0) refers to the first revolution which occurred in the 1800s, where the most important change was mechanical manufacturing, then in the 1900s take place the second revolution which have as main chance the assembly line and it means an increase in mass production, before the I4.0 occurs the third revolution, this happened around the 1970 when the industry introduce the use of robots get better in the production, all this information was taken from the next table 1.

As it mentions before the I4.0 is based on nine pillars this was written by [1] and they are:

I Big Data and Analytics.
II. Autonomous Robots.
III. Simulation.
IV. Horizontal and Vertical System Integration.
V. The Industrial Internet of Things.
VI. Cybersecurity.
VII. The Cloud.

Table 1. Technology evolution from Industry 1.0 to Industry 4.0. [2].

Time Technology	Evolution Transition	Defining
1800s	Industry 1.0	Mechanical Manufacturing
1900s	Industry 2.0	Assembly Line (mass production)
1970s Manufacturing	Industry 3.0	Robotic Manufacturing (Flexible Manufacturing)
2010	Industry 3.5	Cyber Physical Systems
2012 Foward	Industry 4.0	Virtual Manufacturing

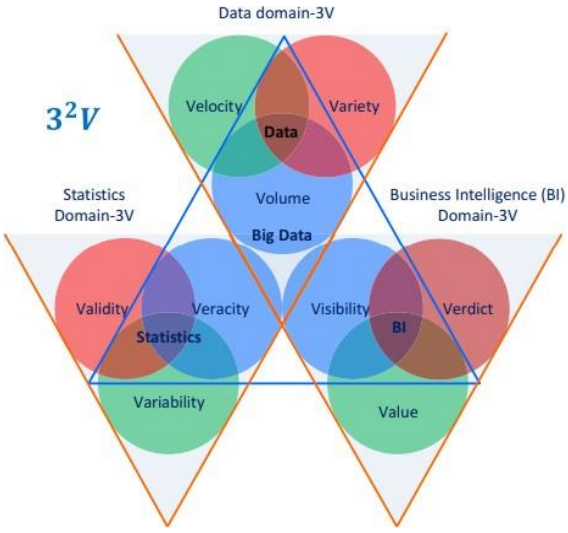

Fig. 1. 3v's Model for Big Data.

VIII. Additive Manufacturing.

IX. Augmented Reality.

2.2 Big Data

One of the most important part of I4.0 is the Big Data and Analytics, normally is associated with the result of the use of internet, sensors, management systems, but big data isn't about a big group of data, is a model named "Model of 3v's", Volume, Velocity, Variety [4]. Then this model was increase with a new "Vs", variability [5] for the "Model 4v's",the next suggest for the "Model 5v's" was value, and along the time this model has been increasing to the las model named "3v2 Model" and is mentioned by Wu et al. [6], and he show us the Venn Diagram.

Some of the autors like Zhang, Zhan, Yu [7] talk about the use of Big Data in the industry of car, He proposes that the use of big data helps determine the characteristics that a user searches for in a car, in addition to predicting how sales will be in the coming months. Otherwise, Kambatla, Kollias, Kumar Grama [8] talks about the future to big data, he gives us an idea of what the use of big data implies, from the type of hardware that is needed to apply this technology, be it the use of memory, the hierarchy of memory that this implies, to the types of network and systems distributed that allow the application of big data for companies.

On the other hand, Philip-Chen and Zhang [9] mention that in order to be competent the use of big data is a big part for innovation, competition and production for any company, and that the use of big data should include the use of cloud computing. , quantum computation and biological computation, besides that the development of tools is an important part of the use of these technologies. Making decisions in a company is one of the big problems for them, the use of data science techniques base on big data allows making decision at massive scale depends from the big data technologies, storage and engineering that the company has.

2.3 Fuzzy Logic

Fuzzy logic has obtained attention of researchers for last couple of decades. It has opened new horizons both in the academia and the industry site, although, conventional fuzzy systems (FSs) or so called type-1 FSs is capable of handling input uncertainties, it is not adequate to handle all types of uncertainties associated with knowledge-based systems [10], the type-2 provide additional design degrees of freedom fuzzy logic systems, which can be very useful when such systems are used in situations where lots of uncertainties are present, The resulting type-2 fuzzy logic systems (T2 FLS) have the potential to provide better performance than a type-1 (T1) FLS [11]. A type-2 fuzzy set is characterized by a fuzzy membership function, i.e., the membership value (or membership grade) for each element of this set is a fuzzy set in [0,1], unlike a type-1 fuzzy set where the membership grade is a crisp number in [0,1] [12]. Membership functions of type-1 fuzzy sets are two-dimensional, whereas membership functions of type-2 fuzzy sets are three-dimensional. It is the new third-dimension of type-2 fuzzy sets that provides additional degrees of freedom that make it possible to directly model uncertainties [11] (Fig. 2).

3 Discussion

The automobile assembly industry today has multiple options for the assembly, from different models of cars, different types between these models, even the color of these is an important factor for decisions within companies. On the other hand, currently companies use different mathematical models as a solution for decision making, which, although useful and functional, only present between 60% and 65% of success in them, showing a little less than half of failure within the decisions for the company. Case, a car is assembling in 7 stages and this passes through 4 work stations, only the assembly

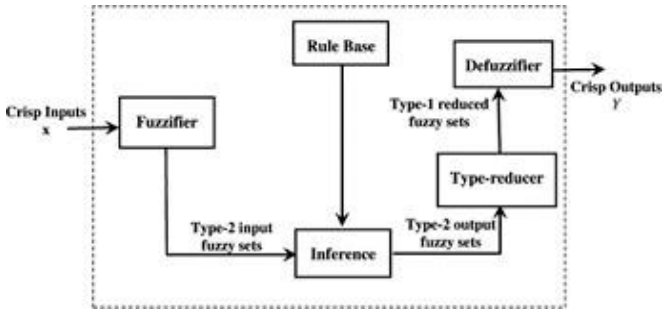

Fig. 2. Show us the diagram of a fuzzy logic controller.

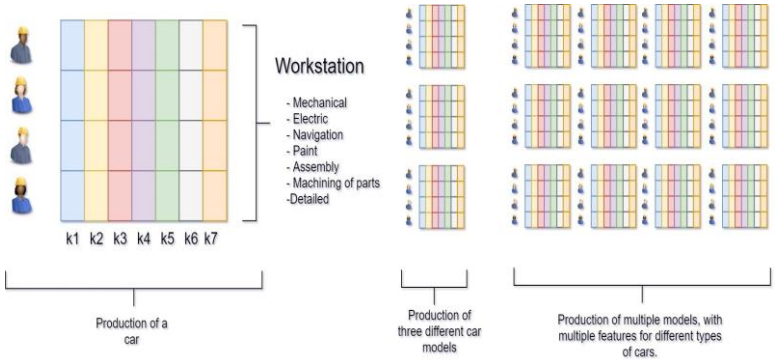

Fig. 3. A multiple production of cars with multiple variables produce multiple critical points within the company.

of this car has as result 28 critical points, now if 3 different models are made at the same time, and what happens if 4 cars are made of each model, the number of variables and critical points of the process grow significantly (Figure 3), so the mathematical and stochastic models are not being practical enough for this type of companies, representing 40% of losses or inefficiencies in the production of final products.

4 Proposal

The proposal to help the way to optimize resources in the supply chain of a company is the realization of an intelligent model based on Big Data, which will be the technology responsible for generating the best options to optimize the use of materials in the warehouse of a car assembly industry in north-eastern Mexico (Figure 4), as well as a great help in making decisions for the company. Once the analysis through Big Data and the best options generated are available, Fuzzy Logic Type 2 technology will be integrated to determine the best way to use the company's resources or the best decision for the company.

The combination of these cutting-edge technologies would represent an improvement for many of the warehouses within the assembly industry within Mexico,

Fig. 4. Use of big data for sorting and generation of options.

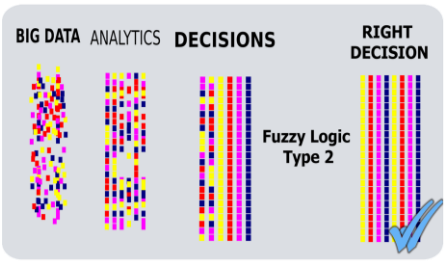

Fig. 5. Integration of Fuzzy Logic Type-2 for the choice of the best option.

even this model can be adaptable to other industries and government agencies or any business that has a warehouse and involves decision making in it, since the goal of this intelligent model is to increase by up to 85% the optimization of resources and the effectiveness of decisions made by the company.

5 Conclusion

There are many scientific articles that allow to continue with the research and development of the intelligent model, it is worth mentioning that, although there are articles related to Big Data, other Fuzzy Logic Type-2, but there is not much about the combination of both technologies, so it is thought that the development of hybrid intelligent model can be a great revolution in the management of decisions and warehouses within the industry.

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