



Proposal of an information system for the supply chain for an electric vehicle

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Abstract: In this paper we propose the elements to design an information system that allows the automation of the management of the supply chain for the manufacturing system of an electric vehicle. The design of this control system begins with the stage of defining the production order that will meet demand requirements, forecasts or characteristics of the operation of the company. Once this amount is defined, the numerical value of that volume is entered in the software designed for this function. The electronic system must have previously integrated the input elements defined in the logistics model of provisioning used in this work. Finally, a proposal is made to establish an updated and pertinent information system that offers better alternatives for communication among the workers of the plant, and provides the vehicle to share information about the manufacturing process.

Keywords: supply chain; information system; logistic model.

I. Introduction

In recent years, information systems have been one of the main areas of study in the area of business organization (Trasobares, 2003). The increasing globalization, the process of internationalization of the company, the increase of the competition in the markets of goods and services, the rapidity in the development of the information technologies, the increase of the uncertainty in the environment and the reduction of the cycles of life of the products originate that the information becomes a key element for the management, as well as for the survival and growth of the business organization.

At present, the supply chain has become the basis of business development, for which different technologies have been implemented to improve its management (Correa & Gómez, 2009). The integration of these Information Technologies (IT) in the manufacturing sector favors the levels of competitiveness in this type of organizations (Radu et al., 2005, Correa & Gómez, 2009, Velarde et al., 2011, Aguilera et al., 2015). The supply chain as a concept emerges to provide solutions to the problem of the multiplication of efforts and the response capacity of companies (Larsen et al., 2007), for which the management of the supply chain has generated a lot of interest in the recent years (Mendoza et al., 2014).

In the work of Aguilera et al., (2015) the importance of the introduction of IT in the supply and production systems is highlighted, which aims to make more efficient the operational activities and the flow of material resources in the Business. In correspondence with this, it is important to highlight that the use of IT in production processes as well as in the management of the supply chain, must guarantee the supply and compliance of the agreements that are carried out with suppliers, considering how The first option is to share information related to the supply of material resources (Goncalves et al., 2010).

In Javier (2012), the notion of supply chain management is related to the globalization of production and the inclination for manufacturers to stock supplies around the world, which requires the efficient management of regulation of the global flows of inputs or outputs (Mendoza et al., 2014). The management of inventories of finished product, product in process and raw materials, is one of the most complex logistical aspects in the industry of production and distribution of goods, in the inventories these can represent around 25% of the current assets of a company (Gutiérrez & Villegas, 2007). The technologies that support supply chains have been one of the key tools in the decision-making process of companies.

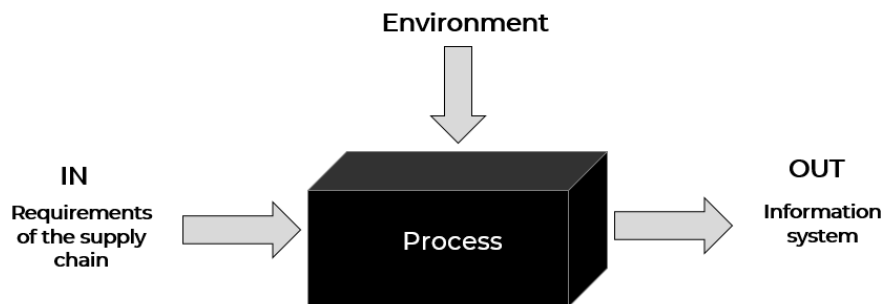
Among the most used traceability and automation technologies are: bar codes, optimal character readers, electronic data interchange (EDI) and radio frequency data identification (RFID) (Mendoza et al., 2014). In Silva et al., (2017)

the existence of standardized logistic models that respond to the needs of organizations is considered. The most widely used models are the SCOR model (Supply Chain Operations Reference Model) which increases performance levels by integrating indicators and information and communication technologies in their development (Cano *et al.*, 2015) and the CPFR model (Collaborative Planning Forecasting and Replenishment) that the information in a CPFR model for the input logistics or supply chain, should come from the projection of the demand that impacts on the provisioning scheme that is implemented (Escoto *et al.*, 2007). The objective of this paper is to design the elements of the information system for the automation of the supply chain management for the manufacturing system of an electric vehicle.

II. Methodology

For the design of the proposal of the information system, the starting point is the assurance of the correct flow and functioning of the supply chain which is constituted as the set of operations oriented to the acquisition of the necessary materials for the activity of the company, as well as its storage, waiting for the production process to start; For this, the theory of systems is used as a support tool for the design of the information system. (Fig. 1). Using a specific type of modeling is usually a difficult problem due to its inherently subjective nature, the proposed model must enable natural communication with the end user to ensure an accurate and consistent capture of their preferences (Yeganeh *et al.*, 2014 Sun & Teng, 2012).

Figure1: General Systems Theory as a support tool for the design of the information system.



For the development of the information system, the emphasis must be placed on the results, in order to effectively take advantage of the investment in information technologies it is necessary to model, and ideally to reach the automation of the analysis with systems based on rules of experts. This fact, as stated in Espinosa & Salinas (2015), is irrelevant for development because it frees the design of people, in its beginning, since it forces participants to think about what is missing as relevant information and not in a new way of working, which can complicate them, even knowing that this aspect should be defined in advance.

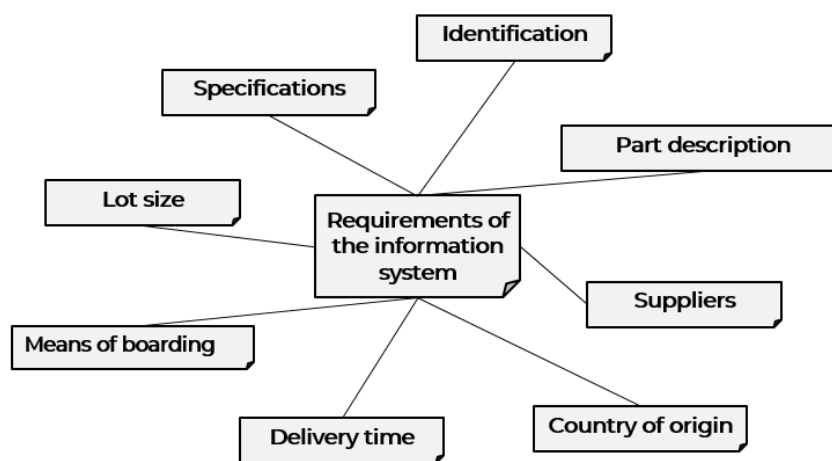
The design of this control system begins with the stage of defining the production order (number of vehicles to produce) that will meet demand requirements, forecasts or characteristics of the operation of the company. Once this amount is defined, the numerical value of that volume is entered in the software designed for this function. The electronic system must have previously integrated the input elements defined in the logistic supply model (Silva *et al.*, 2017) which are (Fig 2):

- Identification: Unique identification of the part, piece or sub-assembly according to its level in the assembly tree and explosion of the product.
- Short description of the part: It must be oriented towards a descriptive definition of few characteristics that helps to identify it and to articulate the respective technical sheet.
- Approved Suppliers: They are established in order of priority, they include the List of Approved Suppliers (AVL) must be previously integrated based on the optimal evaluation system of the company and must consider prices, quality of service, delivery times, capacity of answer among other factors to determine its priority.
- Country of origin: For information purposes to identify the transport chain, modes used, legal requirements, additional costs, customs time (if required) and / or special considerations in the product according to its origin.
- Delivery time: This element of considering the supply chain in its entirety and not partially. The delivery time must be the one that passes from the placing of the purchase order until the arrival of the material to the reception area of the corresponding warehouse of the company. If there are not exact times for legal, customs or intermediate warehousing processes, the pessimistic time of this activity must be considered to integrate the total delivery time.
- Means of shipment: Consider the transport chain in its entirety. If a multimodal operator is used, the same step as the rest of the agreements should be considered.
- Lot size: Refers to the minimum order quantity, it can be a single piece of a unit or a minimum size that the supplier defined in the subsection of this list allows that part number.

- **Specifications:** Refers to the PDF document that includes the technical characteristics of each part. It must include dimensions, tolerances, colors, special features, textures, materials, inspection methods, 3D or inspection 4.0 references, evaluation methods for entry inspection, necessary entry documents, part number with the factory supplier (if applies), type of inventory characterization (ABC), if it is feasible to use it in cross dock, rejection procedure, among others.

With all the aforementioned elements, the design of the electronics system run is carried out, which considers previous stocks in storage and defines the estimated time (according to previously loaded conditions) in which it will be feasible to obtain the quantity of defined products considering also the process time (internal logistics). It will also define the quantities to be ordered by the part number indicating, according to the size of the batch loaded, how many batches are to be ordered and in what times it is estimated that they are in the plant to run the product; allowing a constant monitoring of the transit of the material in the supply chain because it will include with the date of generation of the purchase order and the current date of the day a comparative or compulsory between the time elapsed and the time remaining to receive the material.

Figure 2 Entry elements defined in the logistic model of provisioning of Silva et al., (2017).



III. Results

The proposal is made of a system with two information outputs, one with the intention of continuous monitoring for the purchasing staff or materials where they can check, corroborate or manage the supply of the part numbers in the agreed time corresponding to goods and they may also add comments or updates derived from negotiations with suppliers, with transport chains or with some element of the supply chain. The other information output will be for informational purposes and will serve as an element of value for decision making. It will be displayed in a general informative display where the interested parties of diverse areas will take the pertinent forecasts for the adaptation of the production program and its implications. This system will have as fundamental characteristics the following:

- Strengthens the elements of control of the supply chain.
- Integrates the impacts of intermediate decisions taken in the course of the supply chain.
- Promotes a reliable database of raw materials (part numbers) of assemblies and purchased parts.
- Strengthens the link with suppliers, performance indicators and their evaluation system.
- Strengthens the income management systems of raw materials.
- Integrates elements of industry / logistics 4.0.
- It is customizable for other types of products and for more complex assembly trees.

The system will contain a comparative scheme under the semaphore format that will work with the following catalog:

Green: Number of parts that are within the delivery time contemplated in the run of the system and that its arrival is expected in time. The display of this list is on the buyer's monitor.

Yellow: Part numbers in which 80% of the delivery time has been completed and there has not been an update or confirmation of delivery by the buyer or negotiator on time. The deployment of this information is in the general monitor for decision making.

Red: Part numbers whose delivery time has expired and were not received in stock. They require immediate corrective action with root cause analysis and will most likely cause a reprogramming of the product run if it is a product in the critical path. The deployment of this information is in the general monitor for decision making.

When the part numbers have elapsed properly (according to plan) the supply chain path should enter the incoming inspection area where they will be audited according to the quality sampling specified in their technical sheet. In this process the elements of 4.0 will be included for its acceptance, such as, comparison of customized pieces with pieces developed in additive manufacturing (3D) and / or scanning and comparison with augmented reality as long as this method is applied for that part number in compliance with the product's technical sheet. The information generated from the results of all the inspections must be recorded in the electronic system and will be available for consultation, for the evaluation of the suppliers, for the traceability of the parties and / or for the re-design of the product (if required). The cloud computing and big data scheme will be integrated in later versions, which will define additional characteristics of Industry / Logistics 4.0.

The proposal will make it possible to establish an updated and pertinent information system that offers better alternatives for communication among workers in the plant, and provides the vehicle to share information about the manufacturing process. Owning this facility gives an advantage to those companies whose purpose is to remain valid in a highly competitive market since this requires predictable and reliable production. Predictability has become a prominent element, as well as being an indicator of the management capacity to control the production of the plant.

IV. Conclusions

A proposal is made to establish an updated and pertinent information system that offers better alternatives for communication among plant workers, and provides the vehicle to share information about the manufacturing process.

The input elements for the proposed system are identified, based on the logistical requirements.

The proposed System includes elements of industry 4.0 that favor the development of the manufacturing process.

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