2014 International Conference on Intelligent Networking and Collaborative Systems

Measure characterization of a complex system logistics

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***Abstract*— The logistical network of a company is adaptive, so co-evolves with the environment, constantly changing their connections with suppliers, and internally among its staff structure and processes with distributors, dealers and customers. This coupled with the dynamic growth of organizations, the use of information systems and technologies, the diversity of products and the high degree of market uncertainty, leading to the logistics network of an organization become complex.**
Understand and set limits to the complexity implies an intention to control and therefore a set of measures that allow the decision maker to identify intervention points in the logistics network and guide the ecoevolution intentionally structuring the logistics system and making more efficient provider network , operational network and the customer.
Here, a measuring dynamic variable describing the overall complexity of the system and therefore the associated network structure is proposed.

Keywords-component; complexity measures; complex logistics systems

I. INTRODUCTION

Complexity is a very useful tool to analyze and propose solutions to events or situations that were incomprehensible from traditional science concept. At present, the complexity perspective helps to understand organizational phenomena by analogy and logistics systems. But the way to understand the complex reality is making a measure, establishing a function, designing an algorithm or a model posing. Then these distinctions will be discussed.

A. Complexity

The first thing that arises in the study of complexity is the relevance of knowing the uncertainty that have elements that revolve around the studio system [1]. Complex systems are characterized primarily because its behavior is unpredictable, and facing constant change processes involving adaptation, therefore, systems evolve together with their environment. Although there is no definition to date, accurate and absolutely accepted definition of what is a complex system, different definitions agree with some common characteristics. For example, at a first end, said generally consists of a relatively large number of identical elements, such as the number of cells in an organism, or the number of individuals in a society. Second, the interaction between its elements is local and results in emergent behavior that cannot be explained by these elements in isolation. For example, a desert may contain billions of grains of sand, but their interactions are too simple compared to that can be check on the bees in a swarm. Finally, it is very difficult to predict its dynamics future evolution; that is, it is virtually impossible to predict what will happen beyond a certain time horizon [2].

Given this it is necessary to identify the factors involved in the complexity of logistics systems [3], which can be classified into three, these elements are:

- Amplification of demand
- Deterministic Chaos
- parallel interactions

Once we have identified the factors involved in the complexity of logistics systems, is necessary to identify how can be done the process of managing complexity, it can be summarized in three elements [4]:

- Identify drivers of complexity
- Measure and evaluate the existing complexity
- Develop strategies to deal with the complexity

The first component relates to the identification of complex factors. It is necessary to separate the internal factors (complexity) and the complexity caused by external factors [5].

For the second element there are several approaches to the processes of measuring and evaluation the complexity in the logistics systems by using useful indicators that can be

978-1-4799-6387-4/14 $31.00 © 2014 IEEE
DOI 10.1109/INCoS.2014.141

used organizationally [6] [7], however none of them has been developed to measure the cost and value of complexity.

Finally, once identified the drivers of complexity and measured these components, it is necessary to develop strategies to deal with the complexity of the system, there are several approaches that deal among which can be identified [8].

There is a case of application to the semiconductor industry [4], in which the authors make a description of the different components of complexity that are part of this sector , ending with a simulations of the situations for handling complexity .

There have been developed several theories and descriptions of the complexity in logistics systems, in [9] they describes the components of logistics systems that are part of a complex adaptive system. Three main components that are involved in a complex adaptive system are described in this article, these are:

- Internal Mechanisms
- Coevolution
- Environment

The authors distinguish the factors that are part of the internal components and Mechanisms are:

- Agents
- Self-organization and emergence
- Connectivity
- Dimensionality

The coevolution factors are:

- Quasi balance and status change
- Nonlinear Changes
- Non randomly future

Finally for the environment the factors are:

- Dynamism
- Changing Landscape

With these elements, the authors performed a description of each one of the elements and components in order to see how the dynamic behavior of a logistics system is. Finally, in the paper is made an analysis of how the control mechanisms should be and how much " emergency " should be set free system , ie existing component is that even with control elements cannot be controlled in its entirety, but should be prepared to deal with them.

Another article that discusses the topic is developed by [10], in this paper an analysis of the complexity in logistics systems is made from chaos theory , first it is identified non-linearity of the logistic processes , since these do not determine accurately the changing behavior of these systems. To perform this analysis, a queuing model is formulated and used, where a simulation measures the sensitivity of the input parameters and how can be displayed as chaos with this variation of parameters is done arises.

B. The logistics system and its complexity

Logistics as a discipline [11] [12] [13] [14] is in the social sciences between engineering, management and economics. For example in economics is known as international and domestic logistics. In that sense, it's a trend to consider logistics as a strategic aspect of development of a country, region or company.

Regarding engineering uses quantitative techniques such as descriptive and inferential statistics, linear programming methods and nonlinear optimization techniques and simulation, all kinds of metaheurisitcs as swarm techniques, genetic algorithms, neural networks and many others. As for the administration functions such as planning , management and control are used, many indicators , cost management , which are oriented to comprehensive control systems strategic, tactical and operational level are used.

Regarding the relationship between logistics and supply chain, it is necessary to state that are complementary concepts, which can be understood as critical to increase efficiency, productivity and sustainability of institutions, enterprises or any production or service unit factors. The logistics business in recent years has shown a rigorous development popularizing academic training at technical, professional, specialization, masters and doctorates.

The subject matter of the logistics network processes supports the organization, infrastructure, inputs and resources required for the operation and flow of materials, information and money, made on a system. Then the structure of a logistics system [15] has five components:

- Facilities
- Transports
- Individuals
- Flows of material, information and money
- Suppliers and customers

The number of facilities, types of transport [16], the number of people, the whole raw material, information and money transactions, the number of suppliers and customers, its geographical location and the product completed, determine the dynamics and complexity of the logistics system.

All logistics system has 4 macro processes or subsystems [17]:

- Procurement (input)
- Operations management (transformation)
- Distribution (output)
- Feedback (return)

The fundamental principle of logistics is customer satisfaction, efficiently meet your expectations, this is the goal of any logistics system. It consists of all units to support key business processes, the design is focused on the optimal management in relationships with members of the supply chain. These units are:

Purchasing	Transport
Inventories	Turnover
Industrial maintenance	Delivery
Storage	Distribution