Feasibility of Autonomous Logistic Processes by Reconfiguration of Business Processes

Nowadays, industries are not just working in an isolated form, but rather as integral components of supply chains and delivery networks. Upstream and downstream of a chain, companies have to deal with several aspects of dynamics within their businesses. Some examples of existing dynamics are rising, fluctuating and turbulent demand, product customization (product individualization), right product at the right time, location and size, and bullwhip effect. These make logistics very complex systems. Two appropriate keys to dealing with dynamic behaviors within industries are the adoption into own processes and the compensation of their effects. Regarding the rising dynamics in material control and planning throughout supply chains and production networks, an inquiry into new methodologies for intelligent material handling, production planning & control, and information sharing initiates the development of "Autonomous Systems" (as the CRC 637-Autonomous Cooperating Logistics Processes is working on).

To make logistics and their associated material handling more agile, flexible, and reactive, the "Autonomy" paradigm is a promising approach. In particular, "Autonomous Logistic Processes" is a concept of self-organizing and self-optimizing the current state of a system by means of the self-control and self-decision making capability of logistic objects and processes. An absolute characteristic of autonomous processes is heterarchical structure which leads to local decision making. The logical consequence of these local performances is a quasi-optimized global system. However, the autonomy concept has a broad scope of applications, which will not be successful without adequate compatibility with industries' abilities, deficits, and requirements.

Business processes have a general definition that covers any kind of activities in a business, in particular, for material handling and flow. It is noticeable that reconfiguration of business processes has a mutual effect, both on con-ventional processes and on the development of autonomous ones. This is specifically true for logistic objects.

Potentials for Developing Autonomy

Autonomy in logistics is yet not mature enough to be implemented by industries. There are several reasons for this, some of which are as follows:

- Existence of inefficient approaches to its performance, and placing in the phase of trial and errors, (learning phase in single loop/double loop),

- Under research methodologies for compatible autonomous processes with state of the art in industries,

- Ambiguity in suitable level of autonomy for logistic sections, e.g., inbound/outbound logistics,

- Contribution requirement to the conventional strategies dealing with dynamics, e.g. push/pull, as well as solving existing planning and control problems by means of feasible framework of autonomous logistic processes, e.g. how to share real-time decisions.

Here, the research context defines feasibility as merit of adaptability to the requirements of industries and capability to get installed on the current systems, neither in parallel nor in opposition. For this purpose, after a deep research, the idea of adopting learning pallets (Lpallet) for inbound/outbound logistics is developed (figure 1).

Motivation

The task is to work on two central research topics:

1. Industries with lot material handling are chosen. Level of autonomy for their inbound/outbound logistics should be experimented. Several likely logistic processes can be considered to measure autonomy's performances in an specific industry, concerning their constraints and requirements,

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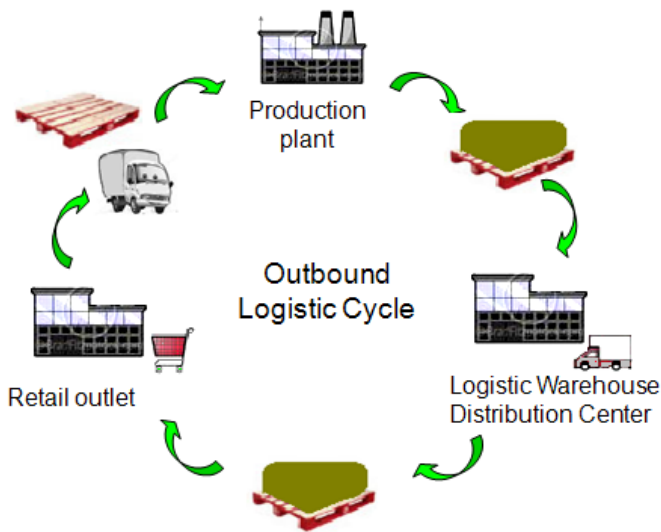Tehran, Iran
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Figure 1: Outbound logistics using Lpallets.

2. Developing, improving, and modifying specific algorithms and processes for realizing autonomy in internal/external logistics, e.g. shop-floor (figure 2), warehouse, network, regarding work in process (WIP), transportation, utilization, throughput time, and due date. Particularly, for progressing towards adaptable and learning logistic objects, learning pallets (Lpallets).

Procedure and Methodology

The cyclic proceeding approach for development of autonomous processes consists of the following steps:

1. Introduction of several scenarios initiates the development of concepts compatible with autonomous objects and specific logistic processes,

2. Investigation for methodologies suited to autonomous logistic objects and the respective processes, regarding existing problems in production and logistics,

3. Employment of specific strategies in production systems, suitable for fostering autonomy in logistics,

4. Development of processes and Lpallets by using intelligent methods as "Genetic Algorithm", "Fuzzy Set Theory", and "Artificial Neural Network" in a collaborative form,

5. Exploitation of learning advantages to compromise the lacks between centralized and decentralized control, requirement of adapting to the current system,

6. Application of business processes improvement techniques to calibrate and improve the processes,

7. Analysis and comparison of simulation outputs in terms of compatibility and feasibility of processes, methodology and scenario in practice. Finally, iteration of this cycle is mandatory.

Learning Ability and Improvement Method

The nature of dynamic systems is exposed to continuous changes. Thus, adaption to, in order to achieve up-to-date states, and control of them in real-time are required. So, application of continuous improvement methodologies as well as learning capability is an appropriate choice to realize and calibrate dynamic systems. For instance, industrial improving programs are proper for improving systems in macro-scale. However, using learning capability and methods is adequate for adapting to the current situation in micro-scale, e.g., material flow control in shop-floors. The intention is to initiate corrective actions to meet real-time demands in logistics.
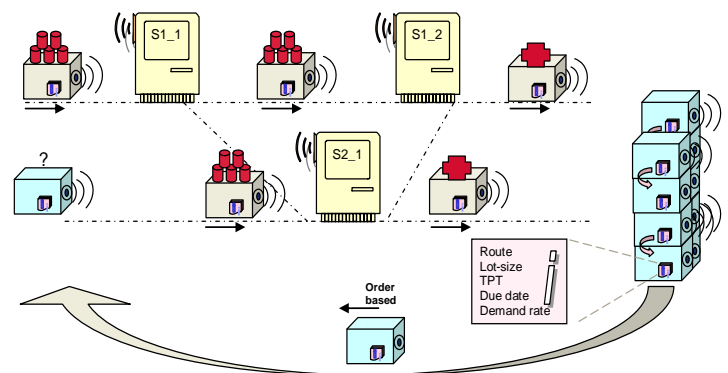

Figure 2: Inbound logistics in shop-floor, using Lpallets.

Vision and Outcome

This study develops a feasible framework of "Autonomous Logistic Processes" by employing learning logistic objects. The due framework is going to enable the autonomy to be adopted by current industries. It should be compatible with the state of the art in dynamic material flow.