AN ARCHITECTURE FOR ORGANIZING PRODUCTION ORIENTED TO PERSONALIZED PRODUCTS

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Abstract: The management of production lines in traditional systems represents a challenge for manufacturing companies, due to the growing demand for customized products. The lack of information and the asynchronous analysis of the steps involved in product customization, from planning to production execution, limit the organization of the process, which must occur from the supply chain to production scheduling. This work proposes an architecture to efficiently manage flexible production lines to meet the demand for customized products. This architecture is based on the support of an adapted MES (Manufacturing Execution Systems) tool, allowing a more effective integration of the steps, and providing information and analysis in real time.

Keywords: Customized Products; Production Management; MES.

UMA ARQUITETURA PARA ORGANIZAÇÃO DA PRODUÇÃO ORIENTADA A PRODUTOS PERSONALIZADOS

Resumo: O gerenciamento das linhas de produção nos sistemas tradicionais representa um desafio para empresas de manufatura, devido à crescente demanda por produtos personalizados. A insuficiência de informações e a análise assíncrona das etapas envolvidas na personalização do produto, do planejamento à execução da produção, limitam a organização do processo, que deve ocorrer desde a cadeia de suprimentos até o escalonamento da produção. O presente trabalho propõe uma arquitetura para gerenciar de forma eficiente linhas de produção flexíveis para atender à demanda por produtos personalizados. Essa arquitetura se apoia no suporte de ferramenta MES (Sistemas de Execução da Manufatura) adaptada, permitindo uma integração mais efetiva das etapas e fornecendo informações e análises em tempo real.

Palavras-chave: Produtos Personalizados; Gerenciamento da Produção; MES.

1. INTRODUCTION

Emerging digital technologies are valuable for improving the performance of manufacturing systems making it possible, for example, to meet customer demands for increasingly personalized products with attractive costs and deadlines.

There are several concepts related to customized products. According to the definition proposed by [1], personalization is the system's adaptive behavior in response to customer needs, aligning service and production processes and information system components. [2] considers the production system designed to be flexible enough to adapt and meet the specific requirements of each individual customer, with the aim of performing rapid customization of products, while [4] highlights the types of flexibility and what makes a manufacturing system flexible or not. [5] brings as a study a framework that aims to identify the impact of flexibility in the manufacturing system. In consideration of what was stated by [4] and [5], in this article the term "flexible" is conceptualized in relation to the assembly line, referring to the ability of this line to meet new orders in different circumstances.

Flexibility on the assembly line encompasses more than just the ability to respond quickly to changing customer demands. It implies guaranteeing the adaptability of the manufacturing itself, allowing efficient adjustments in the face of the changing conditions of the customized product. This involves the ability to modify processes, allocate resources and reconfigure the assembly line to meet changing needs. The supply chain is made up of physical and digital assets, such as storage center, carriers, inventory management and production planning systems.

Physical and digital assets have specific characteristics, such as storage requirements, delivery time, handling, interoperability, integration capability and availability of information in real time. Proper management of these assets, which make up the supply chain, is essential to provide customers with better customized product solutions with good production efficiency.

From what is presented, the problem to be solved is defined from the following question: how to adequately meet the needs of customers who want customized products, so that the production system is able to respond efficiently and reliably?

This work proposes an architecture able to determine suitable options to organize the production of a flexible assembly line, efficiently integrating customer

relationship processes to deliver personalized products. A customized product is considered to be the set of properly selected items that make up the final product assembled by the customer. These items sometimes come from different geographically different locations and, therefore, it is necessary to coordinate information and processes from the supply chain to meet the specific demands of each customer. As a result, assembly lines need to be flexible enough to meet this changing demand. From the launch of a customer order, the cycle of activities must involve the entire process, which includes suppliers, production, inventories, transportation and distribution. [3].

The article is organized as follows: Section 2 presents works that proposed analysis of production line management and the use of the MES system. Section 3 presents the proposed architecture to solve this challenge. Section 4 concludes the article with considerations about the work carried out.

2. RELATED WORKS

It is considered that the customization of a product implies the composition of multiple items. And that these items come from several suppliers who, in turn, supply the production lines. In this supply chain there are several assets, both physical and digital, that somehow need to be integrated.

[6] present an architecture for the complete management of a manufacturing system, covering planning, programming, execution and production control. They propose the implementation of a ticket-based management system for placing physical assets. In addition, the authors propose the incorporation of Industry 4.0 (I4.0) concepts, such as the Digital Twin and the Internet of Things (IoT), to organize and control production operations. These approaches aim to improve system efficiency and optimize the manufacturing process, making it more adaptable and responsive to the demands of custom production.

In the work carried out by [7], the assets that make up the system for analyzing and directing orders were tracked. For this analysis, the entire life cycle of the product was considered, ranging from machinery, workers on duty, inventories, order urgency, available carrier, freight calculation to product customization. The author suggests the

use of a Digital Twin to assist in this process, however, he does not mention any specific method that can support order management decisions.

[8] reviews current researches to identify future trends and study the influence of the development of Manufacturing Execution Systems (MES) according to the requirements of . For the authors, MES properly links enterprise-level operations with shop-floor control. The MES must extract useful information about the current state of production from a fast stream of raw data to be processed. The information generated therefrom can be used to evaluate the performance of processes, machines and equipment and, consequently, of production.

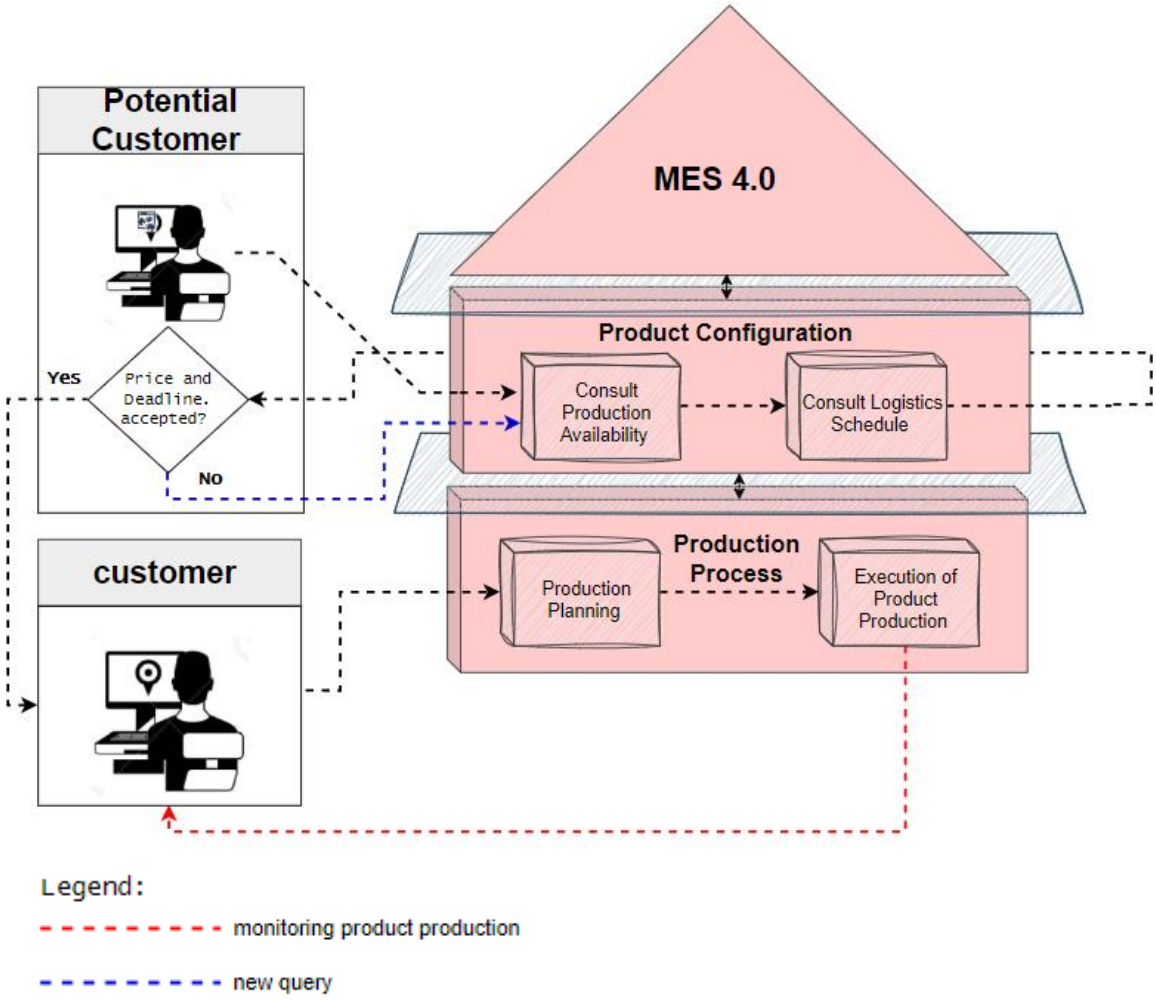
3. PROPOSED ARCHITECTURE

This work presents an integration architecture between the structures present in the supply chain, to evaluate and select the most adequate options for the organization of the production of personalized products. The organization is based on information obtained in real time from the supply chain.

The organization of production of customized products, based on production availability and dynamic logistics scheduling, is essential to add value to the product. The management of interconnected structures in the proposed architecture must be organized in order to provide satisfactory responses and meet customer expectations.

Due to the importance of supply chain management for the efficient organization of the production of customized products, the proposal is presented as follows. First, Figure 1 illustrates an architecture that encompasses the steps and structures present from product configuration by the potential customer to production monitoring by the customer. Figure 2 demonstrates the relevant structures that guide the query step mentioned in Figure 1, In this way, a connection is established between the stages and the structures present in the architecture.

Figure 1. Proposed Architecture

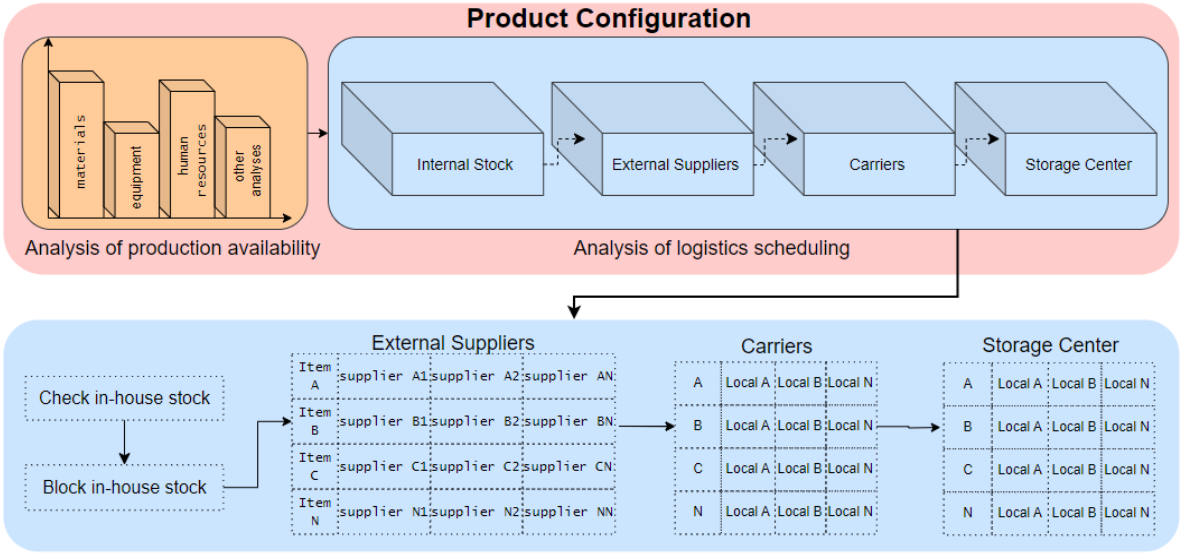


Source: Authors

The architecture begins with the potential customer selecting items from the available options for the composition of the customized product. During product customization, the MES 4.0 tool consults production availability and logistics scheduling, thus establishing an interconnection between the potential customer and product customization in the product configuration layer.

In the consultation stage, a cut is made to show the structures present in the architecture, as shown in Figure 2.

Figure 2: Product configuration layer



Source: Authors

The availability of production includes the whole process, such as equipment, materials and employees qualified for the activity. The generation of information comes from the information flow of the production process, including evaluating the windows available in production planning and its effective execution.

Simultaneously, an analysis of the dynamics of logistics is carried out, which basically corresponds to the composition and delivery of the product to the customer. It is important to first check the in-house inventory to avoid unnecessary movement of items. If an item is available, it is blocked to provide the customer with the product already in stock. Consultations are also carried out with suppliers, carriers and storage centers to ensure that availability for production is adequate, considering the delivery of items at the factory and the possibilities of delivering the final product to the customer at home.

After completing the consultation stage, the potential customer is returned, who evaluates and decides whether or not to accept the purchase proposal. Following the acceptance of the proposal, the potential customer transitions to the condition of a customer, being able to monitor the development of the production process of the customized product. If the proposal is not accepted, the query is returned to the MES 4.0 system and a new possibility is presented to the potential client.

Once the customer has already chosen the customized product, two steps are highlighted in the production process layer by the MES 4.0: production planning and product production execution, and production is already on alert to meet the demands. Functionalities such as separating items from internal inventory, scheduling production and monitoring the delivery of items, among other activities related to production planning, control and execution, can and should be accompanied by the main interested profiles: the customer and the production manager.

The presented proposal defines steps and structures to organize the production of a flexible assembly line, with a customized product. The supply chain is consulted using MES 4.0.

4. CONCLUSION

Following concepts and directions present in the literature, this article sought to show an architecture aimed at managing the availability of production and logistics in the composition of personalized products. The objective is to consult and analyze, for the customer, the organization of the production system from the selection of customized items to the final delivery to the customer. To achieve its purposes, this architecture is based on decisions based on accurate information about production availability, logistical aspects, and customer demand. As a result, it brings significant benefits to the production process, allowing decisions to be made based on up-to-date information. This information is obtained through historical analysis and monitoring in a synchronized way, which results in an efficient system and provides an improved service to customers.

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