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Optimal production model for EVs manufacturing process in Turkey: A comparable case of EMQ/JIT production models for EVs' battery production

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Abstract

In order to keep pace with the ever-changing global community, numerous manufacturing companies have switched to the Just-In-Time (JIT) production model, and many others are considering this approach as well. The competition in global markets pressure domestic and Multi National Corporations (MNCs) to meet "global production" standards that enable simultaneous production, or concurrent engineering. Various benefits have been asserted for the companies that utilize the JIT production model for inventory management such as reduced process inventory costs and holding costs.JIT production strategy – also called "Toyota Production System" – is implemented successfully by various automotive manufacturing firms. Turkey has beenmanufacturing the Electric Vehicles (EVs) for the domesticand global markets as well as establishing a production strategy for EVs. Considering that EVs will be penetrating the Turkish auto market for the first time after several unsuccessful attempts (by other countries) throughout the 20th century, it is left up to manufacturers to determine the production strategy due to inadequate supply-demand forecasts. Since the EVis still in its early stages in Turkey, the traditional economic production models(EPQ)might not be the best reference for manufacturers. This paper focuses its investigation on which optimal production model is suitable for a EVs' battery manufacturing process, and at what point should producers switch from JIT to EMQ in order to reduce costs.

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1. Introduction

In today's global world, the real challenge for manufacturing firms is providing excellent quality, cost, and delivery performance to attain customer satisfaction. The only way to achieve staying ahead of the

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competitors is through maintaining customer satisfaction (Amasaka, Applying New JIT-Toyota's global production strategy: Epoch-making innovation of the work enviroment., 2007).The global market has been pressuring manufacturing firms to reduce costs and the adoption of Supply Chain Management (SCM)relationships lead firms to revise their inventory management systems (Zomerdijk & Vries, 2003).In order to expand into the global markets, firms are required to make more efficient and less costly means of production than the domestic manufacturers. Therefore, the result is a more intense competitive atmosphere for international corporations than for domestic corporations (Ustaoğlu & Yıldız, 2011).For the past 40 years, JIT operations have been drawing interest from manufacturing firms in industrialized and developing countries. These manufacturing firms have acknowledged many benefits; Japanese firms' main key to success was claimed to be the JIT systems. As previously mentioned, these systems are also called "Toyota Production System" and are manifest under names such as JIT manufacturing, lean manufacturing, and stockless production (McLachlin, 1997). JIT manufacturing systems were presented as a new production management principle for 21st century production systems (Amasaka, 2000).KakuroAmasaka believed that the key to success of a manufacturing company is a "global production strategy" that allows the supply of leading products with high quality assurance in industrialized and developing countries (Amasaka, 2007).Vosstakes a further step by defining JIT as a disciplined approach to improving overall productivity and eliminating waste. These enable cost effective manufacturing and delivery of quality parts at the right quantity utilizing the least resources(Voss, 1987).

The implementation of new policies under green technologies by many industrialized and developing countries throughout the world enabled sustainable innovations. These innovations played a vital role in the economic and technological development of the automotive industry. Turkey, as a developing country, has adopted these policies and its government enacted a law for registration of EVs. Some car manufacturers in Turkey planned to introduce new EVs models to the Turkish automotive market byend of the 2012(Ustaoğlu & Yıldız, 2012). Although the government offered incentives to EV manufacturers and R&D investments are planned , the number of charging stations and the necessary infrastructure are not at the forecasted level(Deloitte, 2010). Considering these facts, plus the ambiguity of the actual demand of the automobile, JIT management – which allows manufacture by the order quantity – might be much more economical for the EV manufacturers compared to mass production. This paper focuses its investigation on whether JIT management is superior to the conventional EMQ systems for EV production and based on EVs potential market share and governmental subsidies, does JIT production model suit Turkish automanufacturers and meet final consumer expectations?

2. Literature Review And Hypotheses

To endure global competition, large manufacturing companies throughout the world have been promoting global marketing goals to achieve the same quality and production levels at optimal locations. Thus, manufacturing companies require a new strategic management technology to succeed(Amasaka, 2007). The classical economic quantity models (EMQs) aim to find the optimal order quantity. EMQ has become one of the most important inventory management strategies in the manufacturing world since Harris' work (Harris, 1915). The conventional EMQs do not necessarily cover all the relevant holding costs since they are too complex or are sometimes neglected in the model (Wacker, 1986). Inventory holding costs such as depreciation, rent, and housing costs are usually ignored in the inventory costs but they represent up to 40% of the total inventory costs (Heizer & Render, 2001). The EMQ and JIT usually focus on two categories of costs such as running and holding costs (Cao & Schniederjans, 2004). Corbey and Jansen studied the economic lot size and set up costs and claimed utilizing EMQ models might not be the best option since opportunity costs are lost in the calculations (Corbey & Jansen, 1993). Schonberger and Schniederjans stated that opportunity costs, material control costs, and physical storage space costs

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