Production Leveling as an Effective Method for Production Flow Control – Experience of Polish Enterprises

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Abstract

The article presents an extensive analysis of the literature on defining production leveling and the methodology for its implementation. The main aim of this article is to show how to change these factors after the implementation of production leveling. The article also presents an example of the implementation of leveling production at the department for the production of surgical instruments at a manufacturing enterprise. The current production scheme, including maps of material flow analysis, orders, and the flow from production are described. Finally, the article presents the successive steps in implementing the production leveling in the enterprise.

1. Introduction

The concept of production leveling has been known for more than 50 years. It was developed by Toyota for automotive industry [18]. The first references and case studies appeared already in the 1960s [3, 4, 12]. Since the very beginning the leveling has played a significant role in the just-in-time system and lean production [9, 13, 14, 22, 26, 30]. Nowadays production leveling is widely used in automotive industry companies as well as in the processing and food sector [10, 16].
As customers’ requirements rise and the competition grows stronger, manufacturers are forced to continue the improvement of their manufacturing processes. Its aim is to maintain the required level of manufacturing quality and to enhance the efficiency while, at the same time reducing the manufacturing costs. To achieve that, companies use tools and methods developed under such manufacturing improvement strategies as Lean Manufacturing or the Theory of Constraints [5]. One of the methods is the so-called production leveling which enables to create a leveled manufacturing process.

Production leveling is widely known as a method for defining the sequence of manufacturing various products in a mixed manufacturing model, mostly in order to balance production, enhance the efficiency and flexibility by eliminating waste and minimizing differences in the work station loads [11, 19, 34]. Balancing production is construed as avoiding sudden peaks of the value of manufactured goods in the production schedule [15]. Without the production leveling an enterprise cannot accurately control and predict the production schedule and the stock of finished products and materials.

The objectives of production leveling are as follows:

- continuous flow throughout the entire supply chain [21]
- eliminating the production peaks [1]
- reducing the stock [10]
- avoiding work overload [24]
- improving the production capacity [33]
- maximizing efficiency [32]
- improving competitiveness [29].

The common point of all the above-mentioned objectives is focusing only on the production process. Shah and Ward propose a different approach [27]. In their paper Hüttmeir et al. studied the relationship between heijunka and just-in-sequence. According to the presented conclusions heijunka is a more favorable solution for smoothing out peaks in the schedule [15].

An example of implementing leveled production is described in the paper by Araujo et al. [2]. The article describes a new method of leveling a production batch. It includes two basic stages of implementation: prioritization of products and designing a level production plan.

The procedure of implementing leveled production with high diversity of goods and low quantity of production can be also found in the paper by Bohnen et al. [6].

It begins with developing and analysis of value stream maps and the customer demand – if required. At that stage all bottlenecks in the process are identified. Based on those analyses the so-called leveling model is developed, made up of 4 basic elements. The first one describes the production volume which is the quantity of a given product which must be manufactured within a given time. The second element specifies the aggregation level which is levelling of product families or types. The third one defines the scale – production planning interval, e.g. one day or one shift. The last one shows the specific type of leveling – leveling only one sort of products or a mix of products [7].

The second stage of implementing leveled production is dividing the products into families, usually according to their manufacturing similarity or structure of products. Product families are formed according to the following phases [6]:

- selection of grouping criteria
- using various cluster analysis algorithms
- validation of the clusters with useful indexes.

Another stage is the constitution of a leveling pattern. The pattern is reflected in the EPEI (Every Part Every Interval) value. The value indicates the frequency of manufacturing products under a defined schedule in a defined scale [8]. The pattern is based on product families. Each family is manufactured within a repetitive period. In contrast to the presented approach production may be quantified by the EFEI (Every Family Every Interval) value.
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