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Evaluation of the conversion from central storage to decentralized storages in cellular manufacturing environments using activity-based costing

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Abstract

Most of the production systems, which are arranged according to cellular manufacturing, have still been using central storage sites as a continuation of their past habits and they have been supplying materials and parts to the manufacturing cells from these sites. This both violates the independence of the cells from the entire production system in terms of facilities and prevents the reduction of both materials and parts transportation. The structure with mini-storage facilities, which are located very close to the cells and serve in connection with the cells in a decentralized manner, has many benefits in comparison with the structure of the central storage. However, estimating the economic value of the decentralized approach is not easy because of the difficulties of measuring non-value adding activities. In order to provide decision support for conversion to the decentralized mini-storages, a methodology based on an activity-based costing (ABC) model was developed. The methodology was also evaluated with an example.

Keywords: Cellular manufacturing; Central storage; Decentralized storages; Activity-based costing

1. Introduction

Lean Production/Management is needed in order to improve the performance measures for quality, delivery, cost, and moral concurrently (Baudin, 1999). An important component of Lean Production/Management is cellular manufacturing (CM), which has recently become more popular.

The basic principle of CM is to divide the production system into sub-systems that are independent and autonomous from each other as much as possible and which reflect the quick and effective work of these sub-systems into the whole production system. For that purpose, CM divides the system into part families and machine groups, and the machine groups constitute the cells. The cells ensure decentralization.

The principle of the cells' independence implies the allocation of the functionally arranged (centralized) machines and facilities into the cells (Vakharia and Wemmerlöv, 1990). From this point of view, central storage facilities prevent the independence of

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the cells. Therefore, mini-storage facilities that will serve one or more cells need to be established in order to ensure the independence of the cells. In this way, the requirement for central storage will be decreased and it will be possible to remove this structure in the course of time, which is generally the origin of non-value adding activities. Karle (1987) explained a real world implementation of decentralized multiple storages. However, most production systems that use CM are used to facilitate only central storage facilities to supply parts and raw materials to the cells as an extension of their past applications. This results in an intensive material traffic between the cells and the central storage facility. However, since the decentralized mini-storage facilities are located near the cells, this material traffic will be considerably reduced.

Storage and material handling are non-value adding activities and occur more frequently in central storage facilities. Moreover, non-value adding activities result in a cost increase of processes and products. For that reason, any effort to eliminate the non-value adding activities will provide benefit to a manufacturing company by decreasing the process and product costs. As these types of activities occur more frequently in central storages than the mini-storages, conversion from central to decentralized storages will be beneficial to the manufacturing company in delivery and cost performances. This is the fundamental reason this subject is worthy of study.

However, the influence of storage and material handling activities on the cost of processes and products cannot be determined by using a traditional cost accounting system because these activities are accepted as untraceable or indirect in this system. The overhead cost is allocated to the products on the basis of a certain cost driver, such as the number of direct man-hours consumed. This ignores the significant factors, such as the storage and material handling, in assigning overhead cost to products. For that reason, the traditional cost system results in inaccuracy in determining the actual costs of the processes and products. On the contrary, through the activity-based costing (ABC), we have been able to identify the overhead costs that are traceable to each product and thus derive more accurate cost data (Garrison and Noreen, 1994). Since this paper is mainly focused on the storage and material handling activities in manufacturing systems, ABC is preferred.

The purpose of this study is to develop a methodology based on the ABC model in order to measure the cost of non-value adding activities for both central and decentralized mini-storage facilities, to observe the differentiation of process cost between the two cases (systems) and to provide a useful approach and decision support for the companies which aim to convert to decentralized mini-storages.

This study is unique since the advantages of ABC are utilized in order to estimate the cost differentiation between the central and the decentralized storage systems. However, past academic studies on ABC have not covered this approach. Moreover, in CM literature, the decentralization of support facilities in CM environments has not been studied yet. In addition, the proposed methodology can be usefully applied in real world CM environments.

2. Literature review

Most of the research on cost analysis has compared the traditional cost system to the ABC system. The research on the ABC applications in CM (Dhavale, 1992) determined the resources, activity centers and the drivers. In another study the sequencing problem in CM (Rasmussen et al., 1999) was examined through the integration of ABC and the simulation technique. The job sequence, which minimized the inventory costs within the cells and the time that the parts spent in the system, was determined. An investigation of ABC in manufacturing systems (Spedding and Sun, 1999) also used the simulation technique and modeled the cost calculations of main manufacturing aspects by using ABC. This research concluded that in companies that produce products according to a make-to-order principle, most of the cost incurred belonged to planning, marketing, quality control, etc. Therefore, ABC was claimed to be an appropriate technique in computing the production costs of such production systems. Ozbayrak et al. (2004) modeled the manufacturing and product costs of a system that was run under either material requirements planning or Just-in-time system by using ABC alongside a mathematical and simulation model and compared the two strategies in terms of their effect on costs. Brierley et al. (2006) studied whether there are differences in product costing practice between different types of manufacturing using ABC.

Roztocki et al. (1999) systematically explained the required data and the steps during the application of