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SHORT COMMUNICATION

Application of preference selection index method for decision making over the design stage of production system life cycle

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Abstract The life cycle of production system shows the progress of production system from the inception to the termination of the system. During each stage, mainly in the design stage, certain strategic decisions have to be taken. These decisions are more complex as the decision makers have to assess a wide range of alternatives based on a set of conflicting criteria. As the decision making process is found to be unstructured, characterized by domain dependent knowledge, there is a need to apply an efficient multi-criteria decision making (MCDM) tool to help the decision makers in making correct decisions. This paper explores the application of a novel MCDM method i.e. Preference selection index (PSI) method to solve various decision-making problems that are generally encountered in the design stage of production system life cycle. To prove the potentiality, applicability and accuracy of PSI method in solving decision making problem during the design stage of production system life cycle, five examples are cited from the literature and are compared with the results obtained by the past researchers.

1. Introduction

The production system is the collection of people, equipment, and procedures organized to accomplish the manufacturing operations of an organization (Groover, 2001; Cochran et al., 2000; Attri and Grover, 2012). The above requirement of a production system depends on the type of the product that the organization offers and the strategy that it employs to serve its customers (Panneerselvam, 2010).

Like the product life cycle, the production system has its own cycle. Chase and Aquilano (1977) have described that the production/productive system life cycle (Fig. 1) has four general phases: design, start-up, steady state, and termination.

Besides this, Chase and Aquilano (1977) have also discussed the effect of product life cycle on the production system life cycle. Moreover, Attri and Grover (2012) have differentiated between product life cycle and production system life cycle. Several researchers e.g., Chase and Aquilano (1977),

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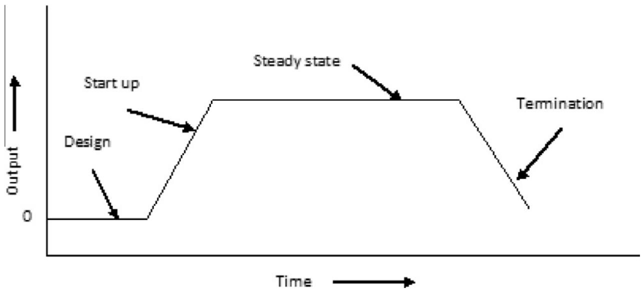

Figure 1 Production system life cycle (Chase and Aquilano, 1977).

Table 1 Decision to be taken during each stage of production system life cycle.

S. No.	Stage name	Decision to be taken
1.	Design stage	• Product design selection • Facility location selection • Facility layout selection • Process selection • Technology selection • Machine selection • Material selection • Material handling selection • Inspection/Measuring equipment selection
2.	Start-up stage	• Personnel selection • Vendor/supplier selection
3.	Steady state stage	• Failure cause analysis of machine tool • Technology selection in light of environmental change
4.	Termination stage	• Decision on salvage of resources

Nakano et al. (2008), Bellgran et al. (2002), Wiktorsson (2000), Bellgran and Säfsten (2010), Kosturiak and Gregor (1999), Preiss et al. (2001), Attri and Grover (2012) have documented different life cycle models of production system.

During each stage of the production life cycle different decisions (generally strategic in nature) have to be taken. Table 1 shows the brief view of decisions to be taken during different stages of production system life cycle.

A lot of applications of MCDM methods in various fields of design stage can be found in the literature such as, material selection by preferential ranking method (Chatterjee and Chakraborty, 2012), non-traditional machining process selection using analytic network process (Das and Chakraborty, 2011), selection of industrial robots using compromise ranking and outranking method (Chatterjee et al., 2010), design of material handling equipment selection model using analytic hierarchy process (Chakraborty and Banik, 2006), evaluation of flexible manufacturing system using digraph and matrix methods (Rao, 2006), rapid prototyping process selection using graph theory and matrix approach (Rao and Padmanabhan, 2007), facility layout design selection using weighted euclidean distance based approach (Rao and Singh, 2012), evaluation of product design using TOPSIS approach (Rao, 2007), selection of manufacturing process for manufacturing a product using graph theoretic approach (Singh et al., 2011), selection of facility layout using graph theoretic approach (Rao, 2007), selection of machine tool using data envelopment analysis (Sun, 2002) and automated inspection system selection using PROMETHEE method (Pandey and Kengpol, 1995).

The selection decisions in design stage of production system life-cycle are complex, as decision making has become more challenging now a days. Moreover, decision makers have to assess a wide range of alternatives based on a set of conflicting criteria. Thus, there is a need for simple, systematic, and logical methods or mathematical tools to guide decision makers in considering a number of selection attributes and their interrelationships. Although, a number of multi-criteria decision making (MCDM) techniques are available in the literature to assist the decision makers in making good judgments. It is observed that in all these methods, the ranking of alternatives is affected by the weight of criteria. Moreover, some of these methods are quite difficult to understand and complex to implement requiring extensive mathematical knowledge. Thus, there is still requirement of a simple, logical and systematic approach to solve the decision making problems without taking the criteria of weight into consideration. This paper endeavors to explore the applicability of a novel MCDM method, i.e. Preference selection index (PSI) method to deal with the decision making problems in the design stage of the production system life cycle.

2. Preference selection index (PSI) method

Preference selection index method was developed by Maniya and Bhatt (2010) for solving the multi-criteria decision making (MCDM) problems. In the proposed method it is not necessary to assign a relative importance between attributes. Moreover, there is no requirement of computing the weights of attributes involved in decision making problems in this method. This method is useful when there is a conflict in deciding the relative importance among attributes.

In the literature, a number of MCDM approaches are available such as graph theoretic approach (GTA), data envelopment analysis (DEA), grey relational analysis (GRA), compromise ranking method (VIKOR), analytic hierarchy process (AHP), analytic network process (ANP), multi-objective optimization by ratio analysis (MOORA), preference ranking organization method for enrichment evaluation method (PROMETHEE), technique for order preferences by similarity to ideal solution (TOPSIS), weighted euclidean distance based approach (WEDBA) etc.

In the graph theoretic approach, the decision making problem is solved by computing the determinant, which requires a lot of calculations. In the data envelopment analysis, it becomes necessary to discriminate the input and output attributes. Moreover, the decision maker must have the knowledge of linear programming (Maniya and Bhatt, 2011). In case of GRA and VIKOR Method, value of distinguishing coefficient (ξ) and weight of the strategy of the majority of attributes (v) play an important role on the final ranking of the alternative. This has necessitated the decision makers to perform the sensitivity analysis to evaluate the effect of ξ and v on the ranking of the alternative. But in the case of our proposed PSI method, there is no need to perform the sensitivity analysis. In the AHP method, relative importance of each factor is determined with respect to objective in order