DECISION MAKING ON THE SHOP FLOOR: ITS EFFECTS ON MIX FLEXIBILITY

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ABSTRACT

On today's modern shop floors, machine breakdowns are often random and complex. To restore failing capabilities, operators have to make decisions under time pressure. This paper examines the roles of decision making as: 1) mediator between emphasis on speed and mix flexibility, and 2) moderator of the machine-mix flexibility relationship. The results of an empirical study indicate that decision making assumes both roles. An emphasis on speed boosts decision making which, in turn, has a positive impact on mix flexibility. When machines are less reliable across operations, greater operator involvement in decision making increases the range of products made.

Introduction

To appeal to increasingly sophisticated and diverse markets, many manufacturers have made flexibility the new focal point of their operations strategy. Flexibility is "the ability to precipitate intentional changes, to continuously respond to unanticipated changes, and to adjust to the unexpected consequences of predictable changes" [1]. Both workers and equipment play an important role in ensuring the production of a varied mix. Empowered employees make fast decisions (decision-making) to handle unexpected situations such as failing machine reliabilities (machine flexibility), especially under time pressure (emphasis on speed). The purpose of the present study is to assess empirically the contributions of decision making to mix flexibility when speed is emphasized. More specifically, it attempts to uncover: 1) whether decision making acts as a mediator between emphasis on speed and mix flexibility, and 2) whether it moderates the machine-mix flexibility relationship. Consistent with a behavioral focus, the unit of analysis is the individual.

Speed and mix flexibility

Speed and flexibility are well known competitive priorities [e.g. 5]. As a challenge to the trade-off approach [13], the cumulative model [4] [11] has established that successful companies tend to accumulate capabilities sequentially, starting with quality first, followed by dependability, then by cost efficiency, and finally by flexibility [4]. The conceptual model proposed in this paper builds on these cumulative effects. A focus on speed lays the foundations for flexibility. Agility in manufacturing requires a quick response to change the product range and variety mix without losing productivity [9].

Hypothesis 1: An emphasis on speed has a positive effect on mix flexibility

Emphasis on speed and decision-making

The increase in time pressure that organizations place on their employees requires them to make decisions in a fast and efficient manner. Time pressure may be a factor that affects the amount of decisions made in a given time period and the performance of decision-making [2] [7]. Advanced manufacturing technologies (AMT) provide real-time information, which is likely to reduce employees' inherent uncertainty and foster increased participation in decision making. The argument for increased decision making is thus a good one in AMT environments.

Hypothesis 2: An emphasis on speed increases workers' involvement in decision making.

Decision-making and mix flexibility

The Idealist perspective claims that employee empowerment leads the workforce to exercises its diagnostic and problem-solving skills and thus increases its flexibility [6] [17]. Operators' knowledge of complex technologies is essential to improve flexibility. When workers are more involved in solving problems and making decisions on their own, the number of problem referrals to supervisors and support staff decrease while flexibility increases [12]. This flexible workforce is critical because it increases the firm's ability to: 1) meet varying customer customization and volume requirements in an efficient manner; and 2) to increase responsiveness to customer demands [14].

Hypothesis 3: Increased participation in decision making has a positive effect on mix flexibility.
Hypothesis 4: Decision making mediates the relationship between an emphasis on speed and mix flexibility.

Machine flexibility (uniformity) and mix flexibility

Machine flexibility is central to the capacity of the equipment to accommodate new products and some variants of new products [15]. Technological advances such as adaptive control, direct numerical control, automated setup and changeover, and multi-axis capability enhance a machine's capabilities to produce in smaller batches and deal with a more varied product mix. Current studies have not addressed the uniformity element of machine flexibility [10]. However, a lack of reliability across operations would counteract the effectiveness of all other flexibility-enhancing properties such as automated setup and tool change.

Hypothesis 5: Higher levels of machine flexibility (U) have a positive effect on mix flexibility

Machine flexibility, decision making, and mix flexibility

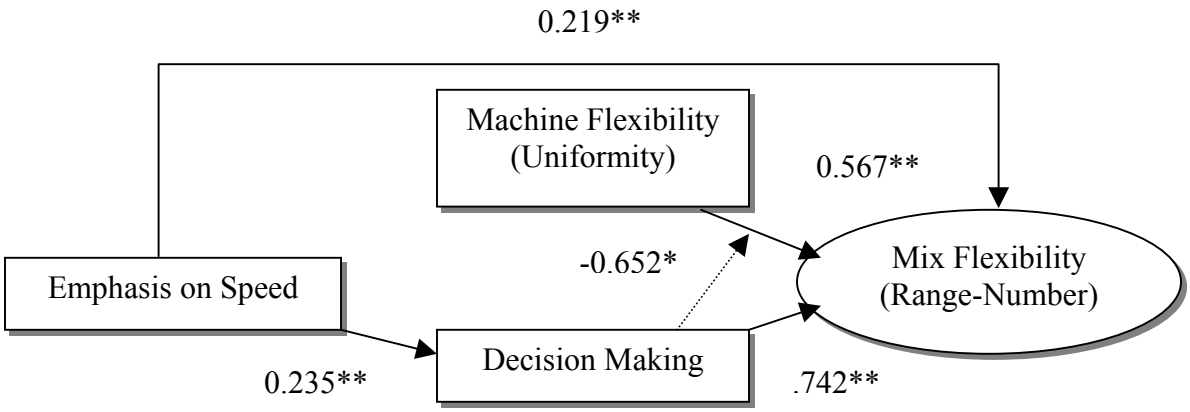
Without a flexible workforce, the gains from AMTs cannot be achieved. Machine errors and failures must be predicted and thus prevented, or solved rapidly by the operator. An extensive set of skills is necessary to handle these situations. Furthermore, when the need for decision making under time pressure is increased [8] [18], workers need to have the authority to contribute to problem solving [3] [16].

Hypothesis 6: Increased participation in decision making and machine flexibility (uniformity) interact to predict mix flexibility. More specifically, the impact of decision making on uniformity will be greater when machine uniformity is reduced.

Results

Hierarchical regression was used to test the six hypotheses and indicate whether: 1) decision making moderates the relationship between machine flexibility (U) and mix flexibility, and 2) decision making mediates the relationship between emphasis on speed and mix flexibility, as shown in the path model depicted in Figure 1. The path coefficients are shown on the model itself.

Figure 1: Path Coefficients



Decision making emerges as a critical tool for enhancing mix flexibility. It acts both as a mediator and a moderator. On one hand, it mediates the relationship between an emphasis on speed and the dependent variable. Furthermore, decision making moderates the relationship between machine flexibility (U) and mix flexibility. This role is very similar to the "tactical flexibility" mentioned by Pal and Saleh [12]. A plot of the interaction shows that the benefits of decision making are not without limits. The human contributions do not seem to have much effect on mix flexibility when the reliability of the equipment is high. It seems that both resources complement each other rather than compete with each other. The main implication from this finding is that much care has to be devoted to the allocation of human resources to machine centers in order to fully exploit the potential that each one has to offer.

Conclusion

Overall, the results suggest that limiting labor flexibility to various facets of job enlargement might reflect a myopic perspective on the subject. Like any study, this one also has some limitations. The main one was that it was conducted in a single organization. Nevertheless, the results support general theories of manufacturing strategy. At a minimum, this study provides some insights into the potential refinement of labor flexibility measures and sparks interest for further research. An examination of team characteristics and dynamics might offer additional insights into labor flexibility deployment under time pressure. This line of research is certainly open to inter-disciplinary collaboration.

References

Available from the first author upon request