SCHEDULE INSTABILITY IN MANUFACTURING COMPANIES

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ABSTRACT

Schedule nervousness or schedule instability, which represents changes to the production schedule due to various reasons, has been a topic of academic research for more than 3 decades. However, most of the published works in this field have addressed various relevant issues by using simulation experiments or analytical models. There is virtually no study that attempt to solicit practitioners' opinion on how schedule instability is viewed in practice. This paper reports a survey of schedule instability issues in Indonesian manufacturing companies. The overall results suggest that the majority of the respondents perceive that schedule nervousness is either an important or a very important issue in their operations. Furthermore, we show that the degree of schedule instability is negatively correlated with the supplier relationship, the internal management, and the buyer relationship scores. This implies that schedule instability is not only something to do with factors on internal operations but also affected by relationships with buyers and suppliers as external parties within a supply chain.

KEYWORDS: schedule nervousness, electronic survey, supply chain.

INTRODUCTION

Revisions to production schedule or production plan are common occurrences in most manufacturing companies. Such revisions could happen due to errors in demand forecasts, materials unavailability, or various internal problems such as machine breakdown and employee absenteeism. Today, where markets are becoming more and more volatile and the materials or sub assemblies are often sourced from global suppliers with long and uncertain lead times, changes to production schedule have become a norm in most manufacturing companies. Whilst changes in production schedule could reflect responsiveness with respect to market demand, they can lead to various negative impacts such as less effective operations (Blackburn et al., 1987), higher production and inventory costs (Xie et al., 2003), and general loss in planning / scheduling confidence (de Kok and Inderfurth, 1997; Heisig, 2001).

Although schedule nervousness has received considerable attention from academics for almost 3 decades, various relevant issues are still unanswered. First, although the sophistication of the planning and scheduling systems has evolved significantly, schedule instability is still a long-standing problem in practice. Second, the published works in this area are largely experimental-based and lot-sizing model driven. Almost all studies on schedule nervousness have looked at it as one performance to be measured in lot-sizing decisions (see for example Sridharan & LaForge, 1989; Metters, 1993; van Donselaar and Gubbels, 2002). Thus, factors evaluated are those which have direct impact on lot-sizing decisions such as cost structure, the lot-sizing methods, the degree of forecast accuracy, the effect of safety stock, the re-planning frequency, the length of frozen period, order release mechanisms, etc.

In practice, schedule instability may also be affected by other factors beyond those related to the lot-sizing decisions. A study conducted by Inman and Gonsalvez (1997) in an automotive industry revealed that schedule instability is also much attributable to the internal production system such as gain and losses in material consumptions, scraps, and engineering changes. In a shoe industry observed by Pujawan (2003), schedule instability has been mainly due to volatility in the demand from the customers and uncertainty in the availability of materials.

Recent development in supplier relationships may have some impact on schedule instability. For example, being able to access inventory and capacity information from the supplier may in turn help the manufacturer to reduce schedule instability. On the other hand, better customer relationship may also have some impact on schedule instability. Field research involving two pairs of manufacturing companies conducted by Pujawan and Kingsman (2000) suggested that better relationship with buyers and suppliers in a supply chain might result in lower schedule nervousness. However, there is no clear evident in the current literature that confirms or rejects the above assertion. This study is an attempt to obtain better understanding on schedule instability through a survey of the relevant practitioners. More specifically, we attempt to examine factors such as relationship with suppliers and buyers as well as various factors related to internal operations of the manufacturing companies on the perceived schedule instability. Our methodology will enrich the current development in this field which to date has been almost entirely based on experimental studies and quantitative modelling.

LITERATURE REVIEW

Schedule instability has been a subject of academic research for almost 3 decades. Steele (1975) is among the early authors who recognised this phenomenon. Following his publication, quite a large amount of studies have been conducted to learn the behaviour of schedule nervousness or to find ways to mitigate it. Authors have investigated the effect of various factors - such as the cost structure, the lot-sizing methods, the order release mechanisms, the length of planning periods, the re-planning frequency, the degree of forecast errors, and different complexity of product structure – on schedule instability. A number of authors proposed mathematical models that include the cost of schedule changes in lot-sizing algorithms (e.g., Carlson et al., 1979; Kropp, et al., 1983; Kazan, et al., 2000). Different safety stock models have also been considered as a mechanism to dampen schedule instability (see for example Sridharan and LaForge, 1989; Metters, 1993; Zhao et al., 2001.a). Other authors evaluated the effectiveness of freezing a certain portion of the planning period (Blackburn et al., 1985; Kadipasaoglu and Sridharan, 1995; Zhao et al., 1995; Xie et al., 2003). A stream of papers proposed the use of lot-for-lot batching policy for items below level 1 (Mather, 1977; Blackburn et al., 1985; Kadipasaoglu and Sridharan, 1995; Zhao et al., 1995).

Various ways have been suggested to cope with schedule nervousness. For example, numerous authors have studied the effectiveness of freezing the production schedule in reducing schedule instability. Sridharan et al. (1987) evaluated three variables in freezing the MPS: the freezing method, the length of frozen interval, and the length of planning periods. Kadipasaoglu and Sridharan (1995) evaluated three strategies in reducing schedule instability under multi level MRP system, i.e., freezing MPS, end item safety stock, and lot-for-lot scheduling for items below level 0. Yeung et al. (1999) evaluated multiple freeze fences in multi-product multi-level MRP systems. This strategy allows the manufacturer to react more responsively to changing demand information while also maintaining a certain level of stability. Xie et al. (2003) extended the study of freezing the master production schedule to a system with capacity constraint. The authors suggested that considering capacity constraint could affect the conclusions regarding the performance of freezing parameters.

The effectiveness of using safety stock to reduce schedule nervousness has also been investigated. Sridharan and LaForge (1989) evaluated different strategies in using safety stock at the MPS level and concluded that different buffering strategy has a differing impact on system nervousness. However, if not planned carefully, safety stock could have an adverse impact, i.e., increasing nervousness of the production system. Later, Metters (1993) and Metters and Vargas (1999) compared different buffering strategies on schedule instability for a single level stochastic MPS model under rolling planning horizon. Zhao et al. (2001.a) evaluated 3 alternative methods of determining the safety stock level.

The above publications clearly suggest that the studies of schedule nervousness have been mostly lot-sizing model driven. Few of the authors developed analytical models to evaluate schedule nervousness in lot-sizing decisions whilst most of the rests have used simulation as a means by which various factors that affect schedule nervousness are evaluated. To our knowledge, there is no literature on schedule nervousness that attempts to document the perception of practising managers on various aspects of schedule nervousness. It is also important to link schedule nervousness with factors beyond those related to lot-sizing decisions to gain more holistic understanding on what factors affect schedule nervousness in practise.

RESEARCH FRAMEWORK

Schedule Nervousness and Buyer Relationships.

Achieving better schedule stability is critical in manufacturing companies. A volatile schedule could be a result of various things. Order volatility from the buyers is one of the factors that is often suspected as a major cause of schedule instability in practice. Buyers frequently imposed changes to the order quantities and due dates. Such changes, especially if not communicated well in advance, could introduce nervousness to the planning systems. Literature on supply chain management has advocated the importance of frictionless information sharing with the customers. More accurate and timely information of demand from the customers enables the manufacturers to better plan their production and deliveries, and hence could reduce inventories as well as improve service level across the supply chain. It may be the case that better relationships with customers would also affect the schedule nervousness experienced by the company. Van Donselaar et al., (2000) suggested that different demand information used in the planning processes influence planning stability in a supply chain. Thus, our first hypothesis in this study is:

H1*: Better customer relationships leads to less schedule nervousness*

Schedule Nervousness and Supplier Relationships.
Supplier relationship has been one of the most important aspects of supply chain management in recent years. A good relationship with suppliers could improve both strategic as well as operational performance of the manufacturing firms. An investigation conducted by Carr and Pearson (1999) concluded that partnerships could improve financial performances of both the buyer and supplier. To our knowledge, the effect of supplier relationships on schedule instability has never been investigated. However, we suspect that the ability of the company to manage the suppliers is also a potential determinant of schedule instability. Our second hypothesis is therefore:

H2*: Better supplier relationships leads to less schedule nervousness*

Schedule Nervousness and Internal Operations.
We conjecture that the quality of the internal operations of manufacturing companies affects the level of schedule nervousness they experience. Within the internal operations factor, a number of sub factors are relevant including the reliability of the production system, component commonality, skills of the PPIC staffs in managing planning and scheduling activities, the existence of an effective time fencing system, and the flexibility of the scheduling system. Experimental studies have proven the significant impact of various internal factors, such as the lot-sizing rules, the safety stock, and the time fencing mechanism on schedule instability (see for example Kadipasaoglu and Sridharan, 1995; Zhao et al., 2001.b). Moreover, an effective cross-functional team may also affect schedule nervousness. It is well recognised that conflicts often arise between different functions in manufacturing companies, especially between marketing and production. While production function normally prefers stable schedule, marketing is more concerned with customer service level. Hence, a good cross-functional team is potentially effective in improving schedule stability. We are interested to prove that better internal operations - which involves the above six factors - leads to less schedule nervousness. Hence, our third hypothesis is formulated as follows:

H3*: Better management of internal operations leads to less schedule nervousness*

Figure 1 presents the research framework that summarises the relationships of the above hypotheses. As can be seen from the figure, the three factors have either five or six sub-factors.

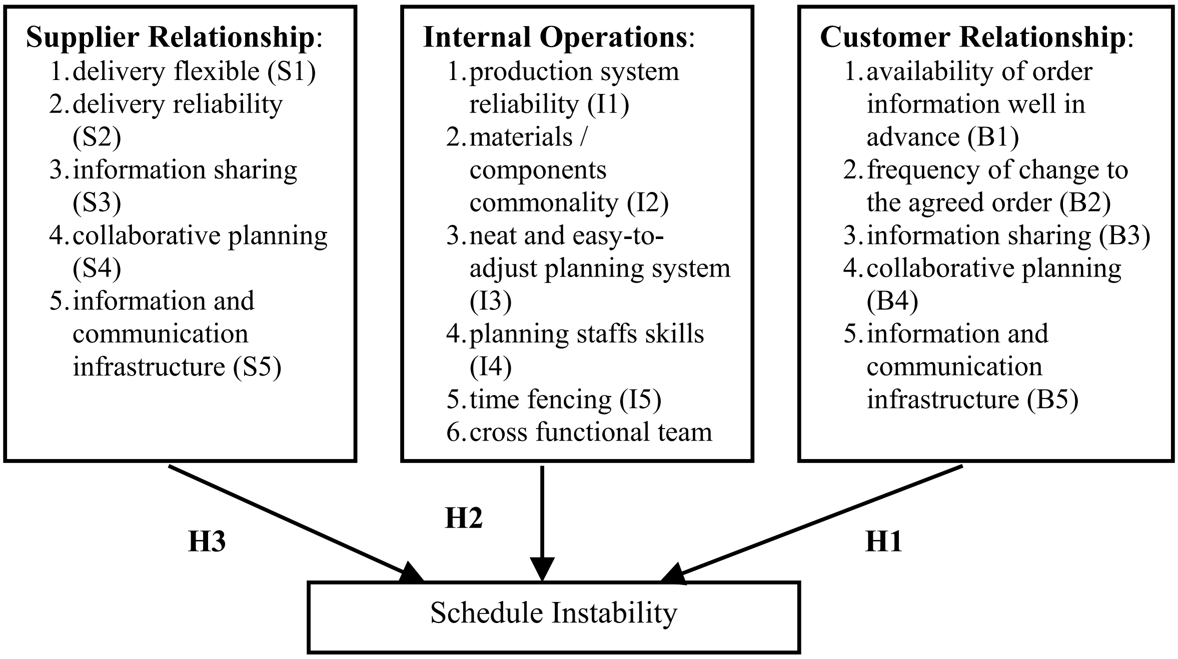

Figure 1 Research framework

THE QUESTIONNAIRE AND THE SAMPLE

The questionnaire was divided into three parts. The first part of the questionnaire consisted of questions on general information of the company such as their products, the company address, the company ownership status, the number of employees, and the name and position of the respondent. In the second part, we asked their opinions on various statements related to supplier relationships, buyer relationships, and internal operations. We will refer to the three classifications above as factors, while each statement under the above three factors will be referred to as sub factor. The respondents were asked to rate each statement by using a 1-5 likert scale where 1 represents strongly disagree and 5 represents strongly agree. Table 1 presents the 16 statements to be rated by the respondents. In the third part we asked them to rate the statement “schedule instability is a major issue in our company” by using the same likert scale.

We did not mail the questionnaire to the prospective respondents as most researchers have done, but instead, asked people participation through electronic mailing lists.

Recently, researchers have used electronic survey as an alternative to more traditional mail survey (e.g., Jeong et al. 2003). According to Boyer et al., (2002), if designed carefully, the two data collection techniques are generally inter-changeable. We have chosen electronic survey as a methodology in this study because of two reasons. Firstly, it is not easy to obtain well-documented addresses of the prospective respondents to where we could send the printed questionnaire. Secondly, many of the potential respondents are members of certain electronic mailing lists / newsgroups. Cheyne and Ritter (2001) suggested that newsgroups maybe a good source of finding audiences that have some interests in the subject matter of the survey. In Indonesia, there are a number of electronic mailing lists with large members whose interests are in the area of manufacturing operations. We selected two mailing lists which have quite a large member base and are relevant.

In the e-mail, the objective of the study was explained. We also explained that the types of the question was multiple choice and the people expected to participate were those who worked in the production planning and scheduling function or those whose activities were highly relevant to this function. Those who were willing to participate were directed to a web site where the questionnaire can be answered easily by clicking the appropriate options. Alternatively, the prospective respondent may ask us to send the questionnaire via e-mail and then send the filled questionnaire back using the same mode.

In total, 17 respondents used the web site to answer the questions. Two of the answers were incomplete, thus only 15 answers from this mode is used. On the other hand, 36 answers were obtained via e-mails. Three of them were discarded due to different reasons. The first one was because the answers were incomplete, the second one was because we considered the company represented to be inappropriate for our study, and the third one was because we received two respondents from the same company. Thus, we obtained 33 useful responses from e-mails leading to a total of 48 useful responses. Unlike traditional mailed survey, the response rate cannot be easily known in the electronic survey that we used in this study.

Although the number of respondents is relatively small, we obtained responses from a wide range of industry sectors. Both the purely domestic and the joint venture or multinational companies are represented. However, the statistics on the number of employees suggests that most respondents were medium or large companies. More than 50% of the respondents had a position related to production planning and inventory control, whilst one third of them were production / operations manager, plant manager or manufacturing manager. There was a small proportion of the sample worked as logistics or supply chain managers, and about 8% worked on other, less relevant functions, such as quality or warehouse. Respondents in the last group were contacted to make sure that we obtained responses from credible sources. We were convinced to include them as our respondents because all of them used to work in the PPIC function in the past and their current positions have extensive interaction with PPIC function. Some of the respondents were also contacted via e-mails to enable us to obtain better understanding on several related issues from them. Some of their answers will be incorporated in the discussion of the results in the next section.

RESULTS

The first interesting result that we obtained is that most companies experience schedule nervousness. The results suggest, as can be seen from figure 2, that two third of the respondents either agree or strongly agree that schedule nervousness is a major issue in their company. Only 7 (about 15%) of the respondents either disagree or strongly disagree that schedule nervousness is a major issue in their company. These confirm the claims that schedule nervousness is an important issue that exists in most manufacturing organizations.

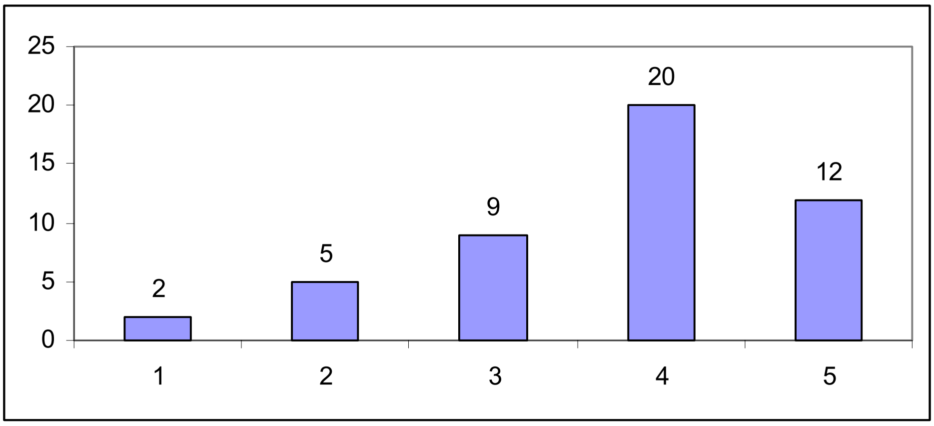

Figure 2. Answer to the question "Schedule nervousness is a major issue in our company" (1: strongly disagree – 5: strongly agree)

The results were also statistically analysed to examine the correlation between the factors mentioned above and the perceived schedule instability. Table 1 presents the mean and the standard deviation of the score for each factor as well as their sub factors. The overall results show that the average score for internal operations is 3.60 while those for supplier and buyer relationships are 3.32 and 3.48 respectively. This indicates that the respondents perceive their internal operations being slightly better than their relationships with buyers and suppliers. In addition, we also calculated the coefficient of correlation and the associated degree of significance, which are also presented in table 1. The standard deviation and the coefficient of correlation of the three factors (ASR, ABR, and AIO) were obtained by firstly averaging the scores across all of the associated sub-factors. We can see from the table that, on the effects of the above three factors on schedule instability, the respondents seem to believe that the relationship with buyers is the most influential factor. This can be seen from the coefficient of correlation of the three factors where relationship with buyers has a coefficient of correlation of –0.379 while those for supplier relationships and internal operations are –0.319 and –0.354 respectively. We will discuss more on the effects of those factors and their associated sub-factors in the following sub-sections.

Table 1 The variables and their correlations with schedule nervousness

Variable	Mean (std)	Correlation with NERV (P-value)
Supplier relationships		
1. Suppliers are generally flexible in delivering ordered items (S1)	3.15 (1.03)	-0.340 (0.018)*
2. Suppliers are generally reliable in providing on-time delivery (S2)	3.10 (1.12)	-0.358 (0.012)*
3. Suppliers are willing to share information on their inventory levels, production capacity, and delivery schedule (S3)	3.58 (1.07)	-0.049 (0.742)
4. We do collaborative planning with the key suppliers (S4)	3.48 (1.07)	-0.202 (0.169)
5. Most suppliers have good information and communication infrastructure (S5)	3.29 (1.03)	-0.230 (0.115)
Average supplier relationships score (ASR)	**3.32 (0.79)**	**-0.319 (0.027)***
Buyer Relationships		
1. Buyers provide information on order quantities and the associated due dates well in advance (B1)	3.54 (1.09)	-0.148 (0.314)
2. Buyers rarely change the agreed order quantities, specifications, and delivery times (B2)	2.93 (1.13)	-0.287 (0.050)*
3. Buyers are willing to provide information on stock levels, sales and promotion planning, and other relevant information (B3)	3.50 (1.05)	-0.412 (0.004)*
4. We do collaborative planning with buyers (B4)	3.63 (0.98)	-0.413 (0.004)*
5. Buyers have good information and communication infrastructure (B5)	3.73 (1.01)	-0.100 (0.500)
Average buyer relationships score (ABR)	**3.48 (0.75)**	**-0.379 (0.008)***
Internal Operations		
1. We have a reliable production system, sudden system breakdown rarely happens (I1)	3.40 (0.96)	-0.181 (0.218)
2. We use many common materials / components (I2)	3.71 (1.15)	-0.126 (0.392)
3. We have a neat and easy-to-adjust planning system (I3)	3.75 (0.79)	-0.276 (0.058)**
4. Our planning staffs are skilful and able to handle well the planning, scheduling, and rescheduling activities (I4)	3.73 (0.74)	-0.273 (0.061)**
5. There is a clear time fencing in our planning system that staffs and managers can use as a basis for making rescheduling decisions (I5)	3.29 (1.11)	-0.341 (0.018)*
6. There is a solid cross functional team in our organisation (I6)	3.71 (0.82)	-0.249 (0.087)**
Average internal operations score (AIO)	**3.60 (0.82)**	**-0.354 (0.014)***

* significant at alpha 0.05
** significant at alpha 0.10

1. The effect of Buyer Relationship on Schedule Instability
There are five sub factors under the buyer relationship. The average score is 3.48 indicating that most respondents perceived that their companies have good relationships with their buyers. The only sub factor that has a score of less than 3.0 is B2 "Buyers rarely change the agreed order quantities, specifications, and delivery times". This suggests that the companies have little confidence in the firmness of their buyers' orders.

The coefficient of correlation presented in the table suggests that schedule instability is significantly affected by the buyer relationship factor. The coefficient correlation is negative indicating that companies that have better relationship with suppliers experienced less schedule instability. However, not all sub factors associated with buyer relationship contribute significantly to the degree of schedule nervousness perceived by the respondents. As shown by the table, sub factors B2, B3, and B4 were proven to have significant negative correlation with the schedule instability. In other words, the schedule nervousness is significantly affected by the volatility of buyer's order, which is reflected by how often they changed the agreed order quantities, specifications, and delivery times, their willingness to provide the company with information on stock levels, sales and promotion planning, and the extent to which the company does collaborative planning with the buyers.

Interestingly, although the other two sub factors show negative correlation with the schedule nervousness, their impacts are statistically insignificant. We suspected that good information and communication infrastructure owned by the buyers could help the manufacturer to reduce schedule instability. Similarly, if the buyers provided information on order quantities and the associated due dates well in advance, the degree of schedule nervousness experienced by the manufacturer would be lower. However, the results proved that these are not the case. This may be explained as follows. Although the buyers provided order information well in advance, there would be no guarantee that they would stick with their original due dates and order quantity. In fact, if orders were placed well in advance, but the buyers keep changing the due dates and quantities to be delivered, the schedule nervousness experienced by the manufacturer would be high. Similarly, a good communication and information infrastructure may in turn help the buyers to better communicate their orders to the manufacturer, but this is also not a guarantee that no changes will be requested by the buyers.

2. The effect of Supplier Relationship on Schedule Instability
The results show that schedule nervousness is negatively correlated with the supplier average relationship score. This indicates that better relationship with the supplier could reduce schedule nervousness experienced by the manufacturer. All sub factors have negative correlation with schedule nervousness, but only two of them are statistically significant. The first significant sub factor is the flexibility of the supplier to deliver materials or parts ordered by the company. The second sub factor is the reliability of the suppliers to deliver parts or materials on time. It is understandable that both of these factors have significant impact on schedule instability experienced by the manufacturer. Late deliveries due to unreliable suppliers are obviously potential causes for the

manufacturer to change the MPS and therefore create nervousness in the production shop floor.

The willingness of the suppliers to provide the manufacturer with the information on inventory levels, capacity, and delivery schedule has no significant impact on schedule instability. This finding is somewhat interesting as we expected that better transparency from the suppliers on the above three information could help the manufacturer to create better schedule stability. It is also interesting to note here that, while collaborative planning with the buyer results in lower schedule instability, collaborative planning with suppliers does not significantly help the manufacturer to reduce schedule instability. Similarly, the impact of communication and information infrastructure is proven to be insignificant.

3. The effect of Internal Operations
In general, the internal operations of manufacturing companies have significant impact on schedule instability they experience with a coefficient of correlation of – 0.354. This suggests that better state of internal operations generally results in lower schedule nervousness. In this factor, we asked the respondents to rate six sub factors as shown in table 1. The results indicate that four out of the six sub factors have significant influence on schedule instability. Sub factors I3 (the extent to which the company had a neat and easy-to-adjust planning system), I4 (the staffs' skills and their ability to handle the planning, scheduling, and rescheduling activities), and I6 (the solidness of the cross-functional team) are significant at significance level of 0.10. Sub factor I5 (the existence of the time fencing) is significant at alpha of 0.05. In other words, the existence of effective time fencing mechanism appears to be most influential on schedule instability. Surprisingly, the use of common materials / components and the reliability of the production systems, that we initially suspected to substantially affect the degree of schedule instability, were proven to have insignificant impact.

DISCUSSIONS AND CONCLUDING REMARKS

This paper presents a result of an electronic survey research on the perception of practising managers on schedule nervousness. It is interesting to note that the majority of the respondents perceive that schedule nervousness is either an important or a very important issue in their operations. The study also attempts to establish and evaluate various factors that were suspected to have impacts on schedule nervousness. Three main factors were considered in this study: relationship with customers, relationships with suppliers, and internal operations. We show that the three factors have significant negative correlation with schedule nervousness, although not all sub factors have significant impacts. The results suggest that schedule nervousness can be reduced by better relationships with customers, better relationships with suppliers, and better internal operations.

Many manufacturing companies still view that schedule nervousness is something to do with ineffective cross-functional team within the company. Production managers often blame the marketing team as a source of schedule nervousness. One respondent from a pharmaceutical company stated that most changes in the production schedule were indeed occurred because the marketing team was unable to predict the market accurately. It is normally the case that a company assigns different priorities to different customers. When a customer with a higher priority suddenly requests an urgent delivery, the current schedule will likely to be altered. Marketing team who puts more emphasis on making the customers happy would not be in line with the production people who prefer a stable schedule in the shop floor. According to Taylor and Anderson (1979), the conflicting objectives between marketing and production are largely the result of differing evaluative criteria employed in the reward systems of the two functions. The result of our survey also suggests that effective cross functional team is negatively correlated with schedule nervousness. This confirms our initial thought that effective cross-functional team could reduce schedule nervousness.

Most manufacturing companies have a time framework to determine where a change in the master production schedule can be done by the master scheduler and when approval from higher authorities in the organisation is necessary before a change can be made. Such a time framework is usually known as a time fencing system. Companies can use this time fencing framework as a basis for making rescheduling decisions, especially if such a change is initiated by the marketing people as a result of their negotiation with the customers. One of our respondents is a producer of toys. The company has a two-week fixed schedule. Customers are not allowed to request any change if their orders are already scheduled for production within the next two weeks. Changes within the fixed schedule are only possible if the required materials are unavailable or if there is a problem with the internal system such as a machine breakdown, etc.

Obviously the frozen period is a compromising decision that should reflect the operations strategy of the company or the supply chain. A long frozen period would mean that the company is inflexible but able to obtain a better level of efficiency. Thus, a company that aims to win the competition based on flexibility should attempt to shorten the frozen period. Conversely, if the cost is the primary objective then the company should negotiate with the customers to set a longer frozen period. Once it is set and agreed with the customers, a frozen period can be used to determine various related decisions. For example, one of our respondents stated that the financial consequences of any changes imposed by the customers within the frozen period are normally shared with them.

An interesting point to note from the result presented in table 1 is that the state of information and communication infrastructure owned by both the buyer and supplier does not significantly affect schedule instability. For make-to-order (MTO) companies, better information and communication infrastructure might not prevent the buyer from changing orders. However, for make-to-stock (MTS) companies, better information infrastructure owned by the buyer should be able to help the manufacturer to capture more up to date sales data and hence, would improve forecast accuracy and ultimately reduce schedule instability. Unfortunately, our study has not been able to identify the type of operations (MTS / MTO / ATO, etc.) of the respondents and hence, the above reasoning need further justification. We initially thought that better communication and information infrastructure owned by the supplier would reduce schedule instability. However, the results suggest delivery capabilities (S1 and S2 in table 2), rather than the joint planning, information sharing, and infrastructure (S3, S4, and S5) that affect schedule instability more significantly. This is somewhat understandable as owning good infrastructure or doing excellent planning does not necessarily translate into good results. What is more important in practice is the real ability of the suppliers to deliver.

Although providing insightful results, this study has a number of limitations. Firstly, our on-line survey method prevents us from observing the exact response rate. We did not know how many potential respondents actually received an invitation to participate in the study. Secondly, our analysis is based on a rather small sample size. Obviously, to obtain a firm conclusion, more respondents would be desirable. Thirdly, we did not find any similar study which can be used as a benchmark for our results. However, despite the above limitations, this study sheds light on various aspects of schedule nervousness that have never been considered in the previous study. Thus, we extend the current literature on schedule nervousness that has been largely exploited under lot-sizing issues into a broader context of buyer supplier relationships in the supply chains.

This study can be extended to a number of different directions. Firstly, it is interesting to observe the relation between companies manufacturing strategy and the degree of nervousness they experienced. It is likely that a company that puts more emphasis on costs would set longer frozen periods to prevent frequent changes to the production schedule than the company that put more emphasis on delivery flexibility. Secondly, the type of operations may also affect schedule nervousness. A company operating based on MTO (make to order) will likely to suffer more from schedule nervousness than those operating based on MTS (make to stock) principle. Finally, as we mentioned in the discussion above, the market characteristics could be an important determinant of schedule nervousness. Attempt to incorporate those considerations in future studies would improve our understanding on various practical aspects of schedule nervousness.

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