



A CONCEPTUAL FRAMEWORK AND EMPIRICAL RESULTS OF THE RISK AND POTENTIAL OF JUST IN SEQUENCE

– A Study of the German Automotive Industry^{*}

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Abstract

The purpose of the paper is to develop a research framework of just-in-sequence –as refinement of just-in-time– and to analyze the potential and limitations of this concept empirically. For this study, more than 20 managers from the automotive industry were asked about their estimations in this regard. This paper discusses how just-in-sequence can unfold its potential to improve the delivery process by providing parts in a predefined sequence so that exactly the right part is delivered to the manufacturer's production process when it is needed to produce a particular variant. In order to identify the parts that are suitable for just-in-sequence, a conceptual model is presented in this paper. Furthermore, the key requirements for supplier selection are analyzed. The main implications of the empirical study are that managers express the need for just-in-sequence but also see problems such as quality and supplier dependability.

Key words: Logistics, Just in Sequence, Empirical Study, Automotive Industry

1 Introduction

Many articles have been published since the revolutionary idea of lean production has been developed in the 1950s in Japan [1]. Today, lean production and just in time must be regarded as standards for many industries [2]. Especially in the automotive industry, just in time has evolved as a major concept for improving the delivery process between manufacturers and their suppliers. Just-in-time has the potential to decrease inventories, shorten lead times, etc.

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But today, manufacturers are faced with more demanding market requirements. In a competitive environment, satisfying individual customer demands is indispensable for gaining sustainable competitive advantage [3]. In a global competition, automotive manufacturers as well as their suppliers are confronted with the requirement to produce faster and cheaper, and, particularly, to produce customized products. Accordingly, manufacturers, even in the automotive industry, have to offer a great variety of different products and many variants. For instance, DaimlerChrysler offers 3.9 Billion variant combinations for their Mercedes E-type [4]. Furthermore, the automotive industry is faced with the requirement to reduce the time-to-customer [5]. The inevitable effect of higher variants and cycle time reduction is an increasing product and process complexity that manufacturers have to deal with. It is the primary aim of many innovative production and logistic concepts developed for the automotive industry to enable the mass production of highly customized products and to make the overall production system run more efficiently [6] (see for trends in the automotive industry [7]).

Despite the fact that just in time has the potential to improve the delivery process of standard products by decreasing inventory dramatically it fails to offer a solution for products with many variants. Here, just in sequence serves as an innovative approach allowing firms to cope with the complexity of many variants by considering the right sequence of the variants to be produced by the manufacturer. In the automotive industry, aggregates like engines, axles, and gears as well as sub components like seats, bumpers, exhaust-gas systems, and doors are often delivered on a just-in-sequence basis which demonstrates the tremendous potential for different application of this concept. A reason for the increasing importance of just-in-sequence is the general tendency of automotive manufacturers to concentrate on key processes based on core competencies and to dislocate other value adding processes to suppliers.

Despite the broad usage in practice, especially in the automotive industry, little has been published on this issue in academic literature. Furthermore, there is a lack of empirical research on just-in-sequence. This paper contributes to closing this gap and aims at giving insights concerning the potential and the risk of just in sequence in the automotive industry.

The paper is organized as follows. In a first step, a conceptual framework —the house of just-in-sequence— will be introduced. Based on this framework, the potential and the risk of just-in-sequence will be discussed. In a second step the framework will be investigated empirically based on a study conducted in the German automotive industry. Finally, some conclusions will be drawn and implications for logistic executives will be given. The paper closes with some suggestions for further research in this field.

2 Just in Sequence

2.1 Just-in-Time as origin of Just-in-Sequence

In 1950, Taiichi Ohno had the idea to develop a production concept ensuring an efficient production of cars in the demanding Japanese environment after the second world war. It was Ohno's primary aim to incorporate lean thinking into the production system eliminating waste (*muda*) from the underlying processes wherever it is possible. Accordingly, Ohno can be seen as the father of the revolutionary approach 'lean production'. The Toyota Production System where this approach has been implemented can still be regarded as a shining example for many other manufacturing companies [8].

Besides automation, just-in-time is the main part of Lean Production [2]. Following Ohno, just-in-time means to deliver the right parts in the right amount and at the right time to the assembly line in order to strive for stockless production. Fundamental requirements for the implementation of just-in-time are the thorough selection of few suppliers with the creation of long-term partnerships for high delivery dependability, a high standard information system for quick and reliable communication, and the guarantee of a high quality level since quality control of incoming parts is eliminated. Finally, just-in-time can only be conducted for standard parts fulfilling requirements like stable demand and high value.

By implementing just-in-time, inventory can be decreased with the effect of lower capital lockup and decreasing storage costs as a main advantage. Furthermore, lead times can be shortened. Major risks are the strategic

dependability from key suppliers and production downtimes due to failures at the supplier's site, transport difficulties, or quality problems. All these problems can not be compensated in a just-in-time framework.

Based on the idea of just-in-time, another concept has been developed for the demand-driven supply of parts commonly referred to as just-in-sequence. Synonyms for Just-in-Sequence are Just-in-Time in Sequence, In Line Vehicle Sequencing (ILVS), Sequenced Parts Delivery (SPD) und Supply in Line Sequence (SILS). Just-in-sequence adopts the basic procedure of just-in-time and adds the aspect of sequencing. Accordingly, Just-in-Sequence can be regarded as a refinement of the just-in-time principle that beside delivering parts at the right time, at the right place, in the right amount, and in the right quality also strives for the right sequence of the parts to be delivered [10]. In the following, a conceptual framework for just-in-sequence will be developed.

2.2 Conceptual framework

In this paper we regard just-in-sequence as a stockless form of supply based on the just-in-time philosophy. It is the primary aim of the concept to eliminate waste by realizing a flexible and lean production by the reduction of work in progress, floor space requirement, lead times, and complexity. Through just in sequence, receiving store will be eliminated completely. Parts will be delivered to the exact point of use in the predefined sequence. Just-in-Sequence makes it easier to control the complexity of many variants, in fact, it is the only possible way to do so effectively. Required parts will be delivered directly in the sequence to be assembled to the place of final assembly and are taken directly from the loading carrier by the assembler. This reduces the place required for final assembly and avoids additional storage of different variants so that inventory will be decreased.

By a just-in-sequence, suppliers can satisfy the requirement of automotive manufacturers to offer many variants. For suppliers, the delivery of parts on a just-in-sequence basis has become an order winner and is a key characteristic of competitive suppliers because it is hard to imitate and therefore offers the opportunity for sustainable differentiation in competitiveness. Accordingly, suppliers are forced to reorganize their own production processes. This reorganization effort can function as an entry barrier of the supplier market. Furthermore, the requirements and challenges of just-in-sequence can be mitigated by expanding this approach to sub suppliers. The following figure gives an overview of the advantages of just-in-sequence for automotive manufacturers as well as for suppliers.

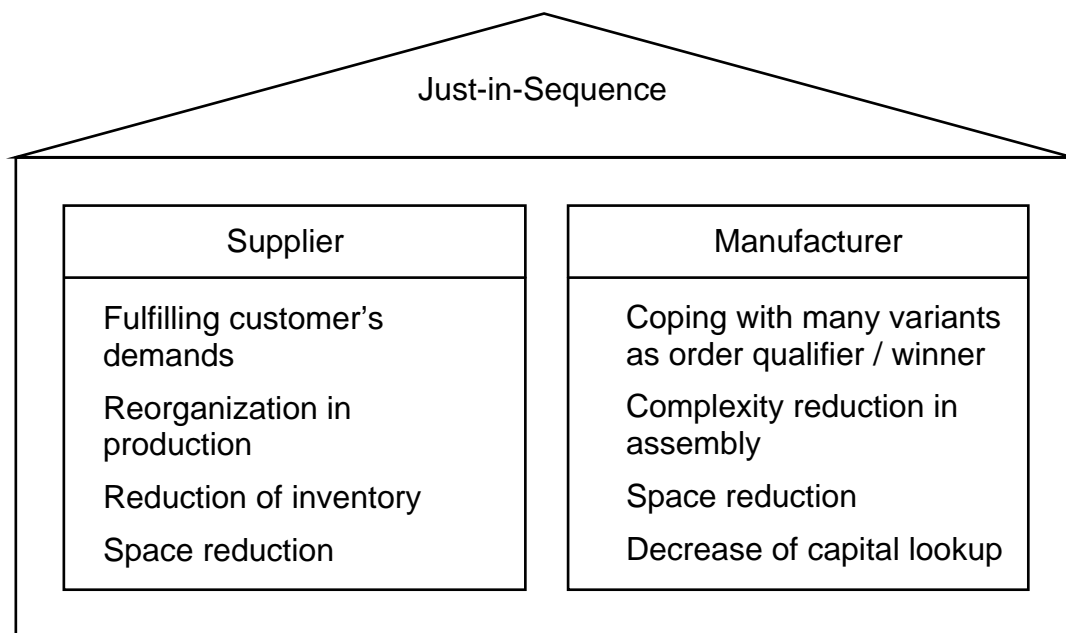


Fig. 1. Advantages of Just-in-Sequence

But just-in-sequence is also accompanied by some risks that have to be mentioned. They will be discussed briefly in the following. The increased sensitivity in terms of disruptions of the production process by missing, wrong or defective parts, delivery delays, or quality problems is a key aspect concerning the risks of just-in-sequence. Disruptions often lead to a complete shutdown of the assembly line. The main reason for such a shutdown is that disruptions can not be compensated by replacement parts, because the parts that should have been delivered are specially produced parts according to the predefined sequence. Accordingly, process capability is an important issue for just-in-sequence. Furthermore, just-in-sequence supply is quite complex, because the precise sequence of the parts to be delivered will be transmitted just right before the actual assembly of these specific parts. The dependence of the automotive manufacturer on the supplier in terms of delivery dependability increases. From a strategic viewpoint, this indicates a strategic mutual dependence, because of a highly specific supplier relation.

Another requirement of just-in-sequence is a highly elaborated IT-system to guarantee the transformation of accurate data on time. The direct transfer of the delivery schedules is important for frictionless supply and production. A loss of data would immediately lead to problems at the manufacturer's assembly line. The data transfer process is much more complex than for just-in-time because not only a serial number has to be transferred but information details concerning the specific variants that have to be delivered. Accordingly, a zero defect data transfer is indispensable in order not to bear the risk of data losses. The following table gives an overview of possible disruption in the categories IT, supplier, transportation, and customer.

Table 1

Risks of just-in-sequence	
Categorie	Disruption
IT	• Malfunction of the electronic data processing system
	• Incorrect data
	• Data transmitting delay
Supplier	• Wrong requirement figures
	• Production disruptions by machine breakdowns, delivery problems of own suppliers
	• Wrong labeling of parts
	• Quality problems
Transport	• Extension of period of transportation due to congestion, weather, barriers, accident
	• Damage of parts due to bad packaging
Customer	• Damage at assembly
	• Serious production disruptions
	• Short-terms changes of the production schedule

Although some of these risks are also valid for just-in-time, in terms of just-in-sequence their negative consequences are much higher due to the fact that for most of these risks a compensation will not be possible.

2.3 Identification of relevant parts

An important aspect for the implementation of just-in-sequence is the identification of the right parts. Analogous to just-in-time, only parts with certain characteristics are reasonable to consider for just-in-sequence. Neither just-in-time nor just-in-sequence strives for a synchronous and sequenced delivery for the entire spectrum of parts. Only a few parts will be considered for just-in-sequence. To identify the suitable parts the following analysis is recommended.

By the ABC-analysis those parts are identified having the highest value of purchasing [11]. Often, a relatively small proportion of the total range of items contained in an inventory will account for a large proportion of the total usage value. This phenomenon is known as the Pareto law (also referred to as 80/20 rule). Accordingly, only a small proportion of all parts is responsible for a high proportion of the overall purchasing volume on a value basis. These parts are commonly referred to as A-parts. Concerning these A-parts, the potential of just-in-time for cost reduction due to decreasing inventory is very high.

Furthermore, the parts are classified concerning their kind of demand by an XYZ-analysis. The key criterion is the forecast accuracy or the steadiness of demand. The demand can be regular, seasonal, or sporadic consumption. For just-in-time or just-in-sequence it is important that the demand is predominantly stable (X-parts). Accordingly, a combination of both analysis leads to the fact that parts suitable for just-in-time and just-in-sequence should be A-parts as well as X-parts. But for the identification of just-in-sequence parts, the approach must be extended.

In terms of just-in-sequence, the parts have another property. Contrary to just-in-time where only standard parts are considered, just-in-sequence enables the handling of many variants. Correspondingly, another dimension must be added for the identification of suitable parts. The following figure gives an overview of the categories, whereby s stands for standard products and v stands for products with variants.

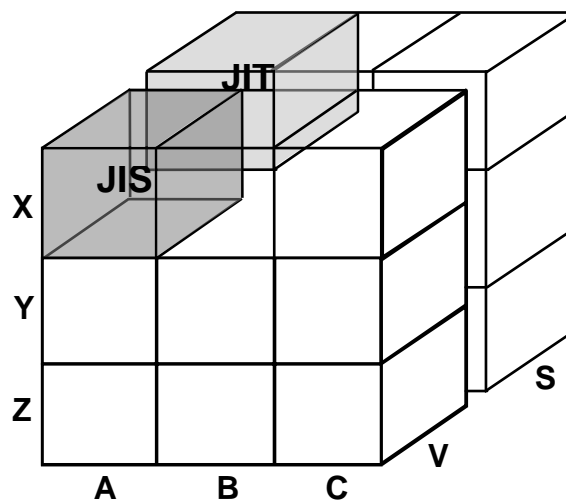


Fig. 2. Identification of parts for the JIS delivery process

Besides the aspects of value, constant demand, and variants, parts suitable for just-in-sequence are often complex and voluminous components like the classical examples seats, bumper, and door covering. Other examples are cooling systems, ceilings, tires and wheels, tanks, exhaust-gas systems, cardan shafts, airbags, and steering wheels [12].

Identification of suppliers

Besides the identification of suitable parts, the selection of capable suppliers is another important criterion for synchronous and sequenced delivery. The most relevant criteria are quality standards, price, on-time delivery ratio, and geographical proximity. Product quality is regarded as the main criterion. Note that, in terms of just-in-sequence the aspect of quality plays a more important role than in terms of just-in-time. Due to their heterogeneity, defective parts can barely be substituted. Accordingly, a product quality on a zero defect level is a

conditio sine qua non for just-in-sequence. Only those suppliers showing excellent quality will be considered, so that quality has to be seen an important order qualifier.

Furthermore, conjoint product development together with suppliers is an important issue for supplier selection. Particularly in the light of the tendency of manufacturers to purchase complex modules and systems, the collaboration with suppliers becomes a critical aspect for supplier selection. To which extent this is done, depends on the question to which extent manufacturers are willing to assign competences to their suppliers. Especially in terms of modules with many variants, this approach has a significant potential for the suppliers to reduce the product complexity by considering aspects of just-in-sequence supply during the development phase.

The spatial proximity is another criterion for supplier selection. In terms of just-in-time it is not regarded as most critical aspect [13]. Contrary to this, in a just-in-sequence framework spatial proximity plays a crucial role and is a deciding factor for supplier selection [3]. The settlement of suppliers nearby, commonly referred to as supplier parks, is an indicator for this tendency in the automotive industry. But there do also exist some examples where suppliers deliver parts just-in-sequence even from foreign countries. Cable looms for an automotive manufacturer's commercial vehicles are delivered from the Czech Republic to Germany just-in-sequence. In this context, the stability of the sequence of the manufacturer comes into play. A consequence of a stable sequence of the manufacturer is that the circle of supplier candidates that can be considered for just-in-sequence-deliveries can be enlarged. It is also possible to choose suppliers which are farther away [3]. Accordingly, this opens new opportunities to expand the proportion of parts delivered just-in-sequence. But generally, it is reasonable to locate supplier nearby to mitigate risks of just-in-sequence like congestions, accidents, etc.

Finally, process quality is an important issue for supplier selection. Additionally to a high quality standard of the parts, processes must run absolute precisely in order to guarantee an on-time and sequenced delivery. This includes the whole process from sequencing itself to the point of use at the manufacturer's assembly line. Despite the complexity of the logistic processes, their transparency and stability must be assured. The underlying processes must be capable on a very high level. Here, six sigma might be helpful to reach processes with a process capability index close to 2 [14]. Also trust is regarded as important aspects within a just-in-sequence relationship.

3 Implementation of Just-in-Sequence

3.1 Supplier

In the following, three different ways to implement just-in-sequence will be briefly introduced. Firstly, the supplier can chose the classical batch production with a subsequent sequencing. The consequences for the supplier are relatively small, because he can produce the modules according to the given demand of the manufacturer. The main disadvantage for the supplier is the high inventory and the huge space required for the different variants. The sequencing can also be done by an external logistic service provider. The advantage is that the supplier as well as the logistic service provider can focus on their competences. A necessary requirement is that the third-party sequencer is highly integrated into the delivery process between the supplier and the manufacturer. Another possibility is the sequencing at the manufacturer's production site. But, this approach is rather unusual.

Secondly, the supplier already produces in the required sequence and delivers subsequently to the manufacturer. This approach is regarded as the ideal form of just-in-sequence, because the complexity of material handling is once more reduced. But it is also accompanied by substantial consequences for the supplier, because he has to reorganize his production according to the sequenced delivery. The advantages of such an approach are analogous to those of the manufacturer. The supplier can decrease his inventory of semi-finished products and raw material, because he produces exactly following the real demand [15]. Sequenced production has the crucial disadvantage that production disruptions at the supplier, e.g., machine breakdowns, immediately have an impact on the manufacturer, because the sequenced delivery can not be guaranteed anymore.

Thirdly, the supplier produces sequenced but he is located nearby the manufacturer in a so called supplier park. This is a special form of the second approach discussed above. Modules are assembled according to the

sequence in a plant which is directly connected with the assembly of the manufacturer's plant by an integrated transportation system like an automated conveying system. Accordingly, additional material handling can be eliminated leading to a cost reduction for transportation and packaging. Also transportation risks are completely limited. This approach realizes the idea of an "elongated workbench". A popular example for such a supplier park is the "FORD Industriepark" in Saarlouis. Here, 9 supplier are directly located at the manufacturer's production site. Such an approach is accompanied with high investments for the supplier. Accordingly, the manufacturer as well as the supplier goes into a mutual dependency. Often, life cycle contracts are used in order to limit the risk of the supplier that the high investments will be amortized. The following figure illustrates the three variants of just-in-sequence.

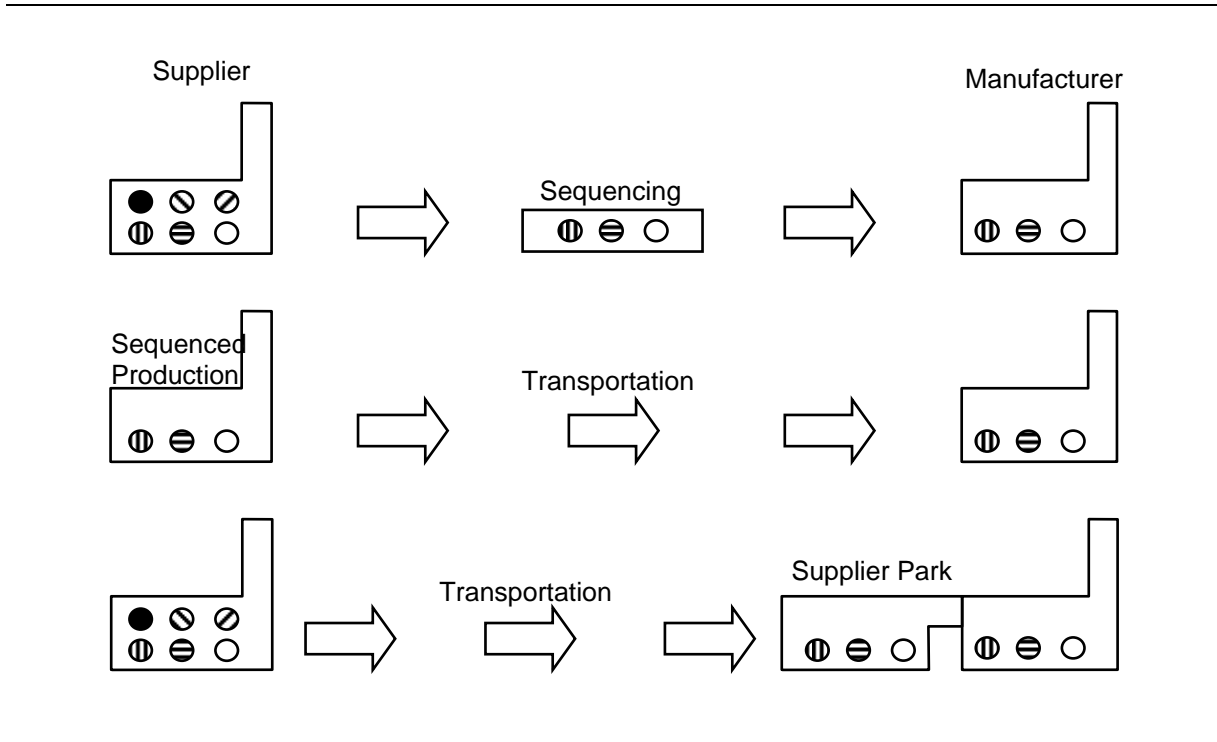


Fig. 3. Variants of Just-in-Sequence

3.2 Information Technology

The operative executive of just-in-time and just-in-sequence has been made possible not until the development of Electronic Data Interchange (EDI). The primary aim of EDI is to substitute the paper-based information transfer by fast and failure resistant data exchange between companies. By standardization of data formats an automatic, software- and hardware-independent data processing becomes possible. Contrary to just-in-time, the data to be transferred is much more detailed. Not only the serial number has to be transmitted but also many variant specific configuration notes. Accordingly, the underlying IT-system must be able to handle this complexity and assign a part to a certain variant. The IT-system is the interface between the communication parties, i.e., the supplier, the manufacturer and eventually a logistic service provider. All systems must be compatible with each other in order to guarantee a frictionless data transfer.

3.3 Employees

Another important aspect in terms of just-in-sequence are the employees. It is necessary to integrate employees into the underlying processes as well at the supplier's process as at the manufacturer's assembly line. The employees are crucial for the implementation and execution of just-in-sequence. They are responsible for the process and they assure a high process capability. Hence, cross training and deployment of workers are important implementation aspects [16; 17]. Furthermore, they can give valuable hints for process improvement because they deal with the process day-to-day.

Another interesting point of employees in terms of just-in-sequence is a refinement of this approach in a way that employees of the supplier will assemble the parts delivered just-in-sequence at the manufacturer's assembly line. This can be regarded as the final step in the development of just-in-sequence. For such an approach, the supplier and the manufacturer have to collaborate very closely on a trusty cooperation.

4 Potential and Risks of Just-in-Sequence

By just-in-sequence many advantages can be achieved. First of all, the cost for capital lockup can be decreased significantly. This is possible by lowering inventories at the manufacturer as well as at the supplier. Furthermore, the negative effects of higher complexity resulting from the high variants can be lowered. Additionally, less space is required.

Concerning the demand site, companies, especially automotive manufacturers, try to increase the degree of customization by raising the proportion of customer specific orders. In this context, manufacturers strive for a higher flexibility and a shorter cycle time which can be achieved by a sequenced delivery. By offering a great variety of different products and variants it is possible to be more responsive to customer's wishes. Furthermore, manufacturers can shorten the customer fulfilment process leading to a shorter time-to-customer. Even in a competitive environment characterized by time-based competition this is an important approach for sustainable competitive advantage [18, 19]. In general, just-in-sequence can be regarded as a promising approach for rising competitiveness in customer oriented markets. In a buyer's market with high stress of competition just-in-sequence will become a key concept for an integration of lean thinking into mass customization [20, 21, 22].

Although the advantages discussed above are quite promising, there the concept of just-in-sequence is accompanied with some risks for the manufacturer as well as for the supplier. These risks can be predominantly equivalent to those of Just-in-Time, but the consequences are much more severe (see for an overview of the benefits and problems of Just-in-Time [23]). As already mentioned before, quality is a critical element of this concept due to the fact that quality problems can barely be compensated. Accordingly, the supplier must guarantee a quality standard on a very high level.

In this regard, employees are a crucial aspect as well. Due to the fact that they play an important role for just-in-sequence, the qualification of employees is important. Accordingly, training is necessary to guarantee a sufficient qualification level. Although employees have high potential for improvements, they must still be considered as the source for potential failures.

Furthermore, manufacturers and suppliers are concerned with the problem of the information system. The IT-system as the interface between them must work properly in order to assure a frictionless data transmission. Problems of the IT-system can result in wrong or late deliveries leading to a breakdown of the manufacturer's assembly line.

From a strategic perspective, dependency is an important issue of just-in-sequence. On the one hand, the supplier has to make high investments in order to fulfil the requirements of the manufacturer. Accordingly, he is dependent on the manufacturer. On the other hand, the manufacturer must rely on the supplier's reliability. This mutual dependency can be mitigated by life cycle contracts as stated before [24, 25].

5 An Empirical Analysis of Just-in-Sequence

5.1 Research Methodology

The aim of the study is to show aspects of the concept from a practitioner's point of view and to get empirical insights about the potential and concerns of just-in-sequence in practice based on different cases. This enables the confirmation of critical points of the theory, but also points out some contradictions. The study conducted for the empirical analysis of just-in-sequence is based on a questionnaire. In the questionnaire, items are mainly based on a 5-point-Likert-scale [26], whereby 1 stands for "totally disagree" and 5 indicates "totally agree".

Additionally, some questions are formulated as open questions allowing the respondent to give detailed information about the situation in his plant. The questionnaire is answered within interviews with managers from the automotive industry and the automotive supplier industry. This allows getting a picture from both perspectives: The supplier's site and the manufacturer's site. As respondents logistic executives (mainly logistics directors or plant managers) are identified which are expected to be the most knowledgeable in providing the desired information about just-in-sequence. All in all, the sample consists of 20 logistic experts (6 manufacturers and 14 suppliers) from different companies in Germany. Note, that the size of the data sample is not sufficient to conduct inductive statistical analyses on a significant level. Hence, the analyses of the paper are mostly descriptive in order to give some first empirical evidence for the automotive industry.

5.2 Empirical Results

In the following, the potential of just-in-sequence will be investigated empirically as well as the risks of the concept. These aspects can be examined in more detail by distinguishing between suppliers and manufacturers. Figure 4 shows the evaluation of the main criteria for the implementation of just-in-sequence.

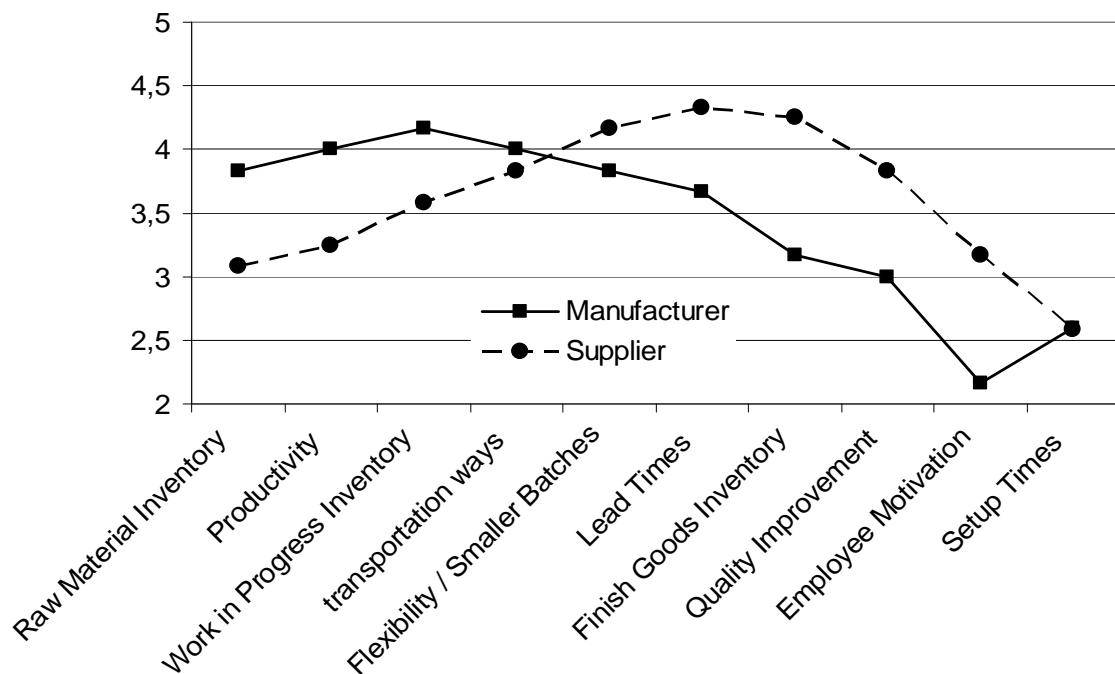


Fig. 4. Criteria for just-in-sequence implementation

Overall, shorter lead times, shorter transportation ways, and flexibility in terms of smaller batches are considered to be the most important issues for just-in-sequence as both, suppliers and manufacturers, rate them high, whereas neither the manufacturer nor the supplier regards setup time reduction as a relevant issue. All other criteria are evaluated differently by the two parties: Employee motivation is, if anything, a subject for the supplier. Not surprisingly, the manufacturer weights the importance of raw material and work in progress inventory more heavily than the supplier, whereas the latter stresses the meaning of finish goods inventory and quality improvement. Furthermore, productivity is important for the manufacturer.

Another interesting question is, whether these goals are achieved by the suppliers and manufacturers. The manufacturers as well as the suppliers are asked about their estimation to which degree the goals of just-in-sequence like they have been discussed above have been achieved. Figure 5 gives an overview of the criteria.

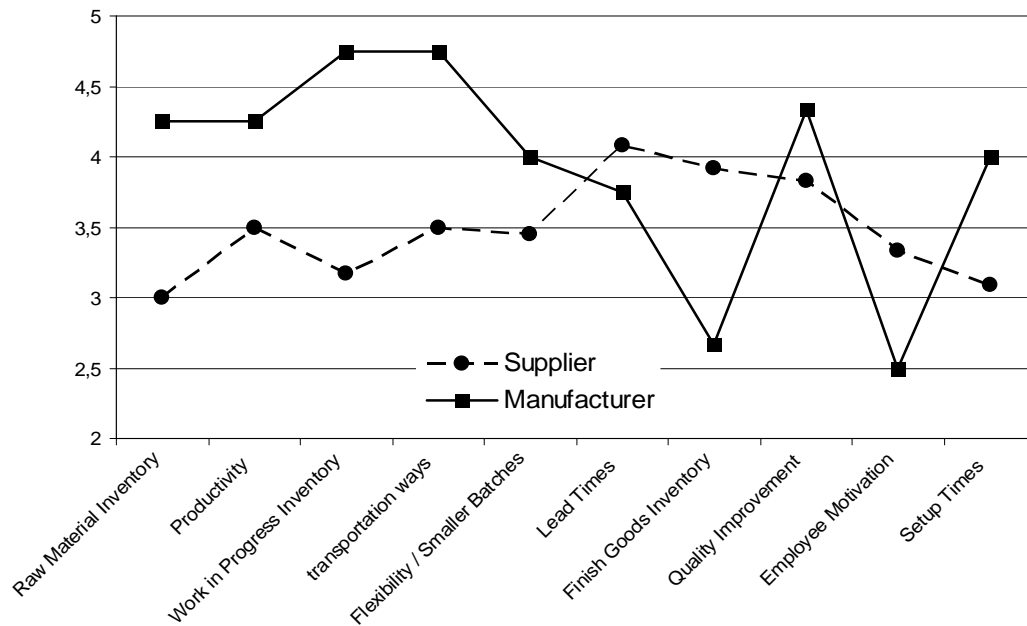


Fig. 5. Achievements of just-in-sequence

As it can be seen from the figure there are differences between the two groups. As expected, the manufacturers achieve a reduction of raw materials and work in progress inventory. Furthermore transportation ways can be shortened, contrary to the outlooks of suppliers. These results can be confirmed by a T-test with significance level of at least $p < 0.1$. Regarding the suppliers, the results show that they achieved a reduction of finish goods inventory and lead times. Additionally, quality has been improved, whereas employee motivation still seems to be a challenging issue for suppliers.

In the next, the risks of just-in-sequence will be investigated. Figure 6 gives an overview of the mean values of the two groups.

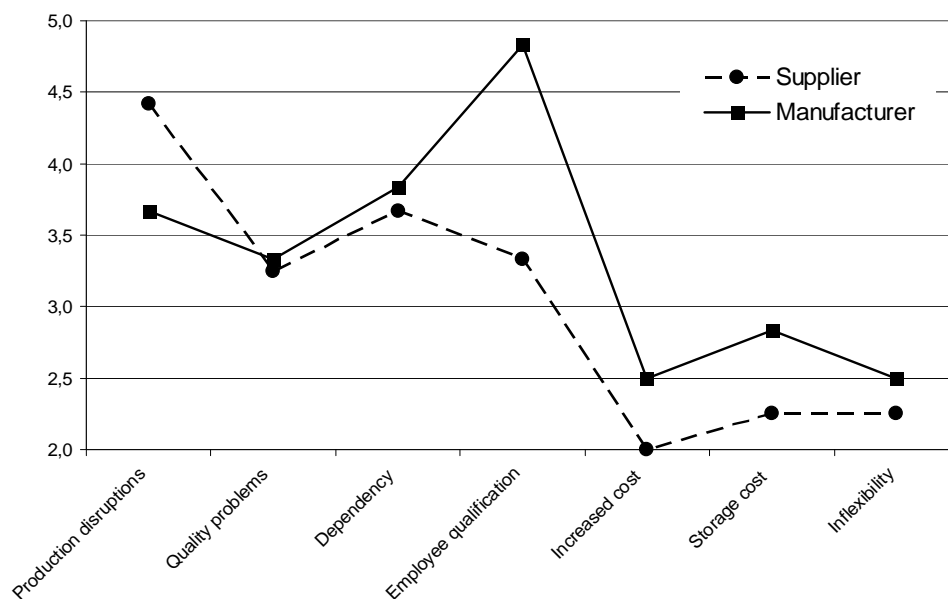


Fig. 6. Risks of just-in-sequence

The figure shows that production disruptions are an important issue for the suppliers and the manufacturers. Quality problems and dependency are evaluated as additional risks. Furthermore, employee qualification is a critical aspect for the manufacturers but not for the suppliers. Increased cost and inflexibility are not regarded as critical issues.

Finally, the mentioned potentials of just-in-sequence will be investigated in terms of potential reductions of lead time, space requirements, quality cost, inventory, and logistic cost.

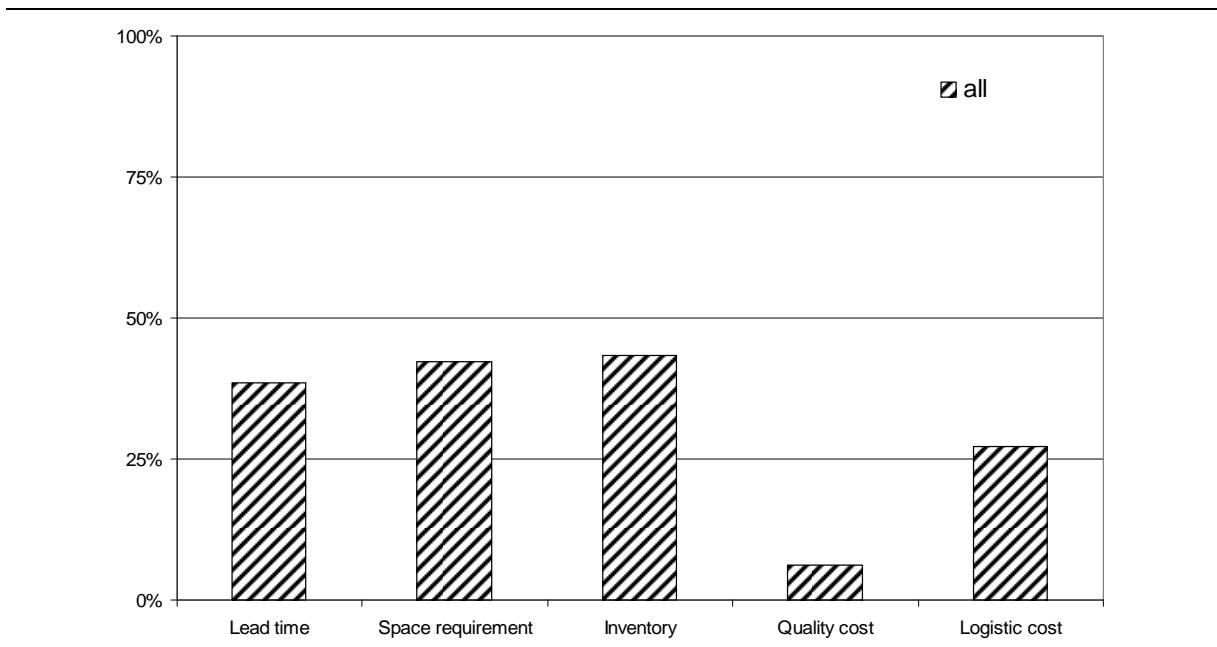


Fig. 7. Potential of just-in-sequence

As figure 7 indicates, just-in-sequence unfolds its highest potential in terms of lead time reduction, a decrease of space requirement and a decline of inventory. Costs for quality and logistics are barely realized. Note that in this analysis, manufacturers and suppliers are not distinguished in order to give a comprehensive picture of all estimations of the respondents.

6 Conclusion and Further Research

From the results the following conclusion can be drawn. In this paper, two approaches have been introduced. On the one hand, a concept for the identification of parts suitable for just-in-sequence has been developed. On the other hand, aspects for supplier selection have been discussed. In this context, three different approaches for the implementation of just-in-sequence are described. Beside supplier selection, also employees and information technology are identified as important points for the implementation of just-in-sequence. Furthermore, aspects for the potential and the risks of the concept are discussed. These aspects are investigated empirically based on a study of 18 logistic experts from the automotive industry.

The empirical study leads to the conclusion that just-in-sequence is an important concept for coping with complexity in terms of high variants. As the results show, raw materials and work in progress inventory can be decreased at the manufacturer and finish good inventory can be lowered at the supplier. These results are consistent with the theory. As expected production disruptions, quality problems, and strategic dependencies have been identified as critical issues for suppliers and manufacturers as well as employee qualification. Especially the latter is a crucial aspect for the manufacturers, which confirms the supposition of challenging requirements of just-in-sequence in terms of new tasks and responsibilities. Also these results are consistent with the theory. The concept is most promising concerning lead times, space requirements, and inventory with a reduction potential between 35% – 45%. It can be concluded that due to its potential even for companies from

the automotive industry, the importance of just-in-sequence will increase in the future. Nowadays, the ratio of parts delivered on a just-in-sequence basis is between 30% and 50%. Until the year 2010 it is expected to increase to a ratio of approx. 70 % (Mixer et al., 2003).

Although the automotive industry must be regarded as a prototype for an implementation of just-in-sequence, a similar study can be conducted in other industries like electronics or machinery. Furthermore, it is interesting to conduct this study in other countries in order to show differences between the participating countries. Finally, it seems to be important to support the results of this study with inductive statistics based on a larger sample giving empirical evidence of the impact of just-in-sequence on several performance criteria in order to show the high potential of this concept.

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