Logistical Crash Barriers
- An alternative method to identify critical products

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Abstract

Companies act in volatile supply networks. The ongoing increase in the degree of customization in the product development process often leads to extremely high variety and consequently to hardly manageable complexity. An apparent cause which makes it even more difficult to handle such material flows is the limited transparency of supply networks. Most of the time, it remains unclear or is judged primarily intuitively which effort, problem or delay in the subsequent value-adding processes is caused by which product variant or customer modification. Companies therefore need methodical support for the identification of those areas which currently offer the greatest optimization potential. This paper provides a possibility to assess material flows with a special focus on logistical parameters. The method should enable the identification of for example cost drivers or especially time-consuming parts in a company to apply cause-related sanctions to reduce those weaknesses.

Keywords: value stream analysis, critical part identification, supply network design, logistical crash barrier.

1. Introduction

Companies act in global supply networks. In the context of this paper, the authors subsume under the term ‘supply network’ according to [1] that all inter-connected companies that exist upstream of any one company are in the company’s value network.

In the observed company (a build-to-order high-end producer in the agricultural engines sector) the common trend of a decreasing depth of added value cannot be identified. A high depth of added value in combination with increasing complexity– caused by a high customized number of product variants – is leading to a high degree of uncertainty in the supply network of the observed company [2] especially in times characterized by far-reaching environmental changes. A possible root of this circumstance can be a lack of transparency in the supply network. Volatile and unpredictable market conditions affect the company and worsen the situation: if the time needed to analyze critical success factors appropriately is lacking, the company will not be able to be flexible enough to remain competitive. In most of cases, logistical parameters to identify the critical transactions in supply networks can only be analyzed roughly because of a lack of time and resources or an insufficiently systematic approach regarding data or method feasibility. According to the research that we executed, it is not yet known how the logistical and economic impact of customized variants can be evaluated in the subsequent value-adding processes.

For efficiency reasons, companies attempt to confront this problem mainly through the use of automatically generated key figures, such as the service level, which measures the supply performance between suppliers and companies as well as between the companies and their customers. An additional performance indicator is the schedule variance. This figure is often substantiated by measuring the supplier’s reliability. It expresses as a percentage how far the realized delivery dates conform to the promised delivery dates [3]. Furthermore, quality is another relevant parameter. It is often approximated by the costs of complaints [4]. Moreover customer satisfaction is an often discussed indicator which is difficult to measure. [5] classify it in basis-, service, and enthusiasm requirements. Basis-factors are the minimum requirements of bought products, which are at least expected by the customer and these factors do not lead to customer satisfaction. The service-factors define product attributes, which contribute to customer satisfaction when they exceed the expectations of the customers. Non-fulfilment of a customer expectation leads to customer

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dissatisfaction. The enthusiasm requirements are different, because these factors, when fulfilled, lead to satisfaction. If they are not fulfilled, this does not necessarily lead to customer dissatisfaction. Such enthusiasm requirements subserve for differentiation as part of competition.

The definition of criteria to determine critical supply network fields is, in many respects, still an unsolved problem up to now. Independent of which of the above-mentioned key performance indicators are used, none of them enables the identification of those parts which are critical in terms of logistical and economic aspects. One reason for this is that most of the mainly externally driven evaluation criteria focus on external links to customer requirements. The evaluation results in an overall and very general statement about the company's performance with respect to the target criteria but gives only marginal insights into the real internal occurrence of the problem. For example an insufficient service level does not necessarily indicate the reason for the occurrence of this problem, such as a long replenishment lead time on the supply side.

In practical business environments there is hardly time for a detailed analysis of the material flows. Therefore, companies usually look into those material flows where an ABC analysis [6] has identified important A-components. Again the problem that these high-value parts are not necessarily those that cause the most relevant deficiencies in performance might arise. For example, a product variant that is relocated back and forth between company-owned production plants would neither appear as critical in customer- nor supplier-related analysis. Nevertheless, exactly this variant can disturb the material flow. In addition, the lack of an integrative overall view is a problem as evaluations are limited to the local view and therefore lead to inadequate results. For instance, a particular product variant appears after a product and customer segmentation to be economically advantageous, this can be problematic of the overall view – for example as a consequence of unreliable suppliers or high internal complexity in production processes. A criteria list which covers the relevant logistical criteria and creates a link between the demand and supply flows should be implemented in the analysis. This list will certainly be based on standardized criteria (e.g. ABC-XYZ classification) but context- and company-specific data/criteria are required too to fully describe the specifics of the analyzed supply network. Altogether, the following research questions (RQ) have been identified.

RQ 1: What are the relevant drivers of logistics performance? Are, for instance, A-components those parts, which cause problems in the material flow and accordingly a disproportionately intense logistical effort?

RQ 2: How can a company identify the relevant logistical drivers within a company-specific context?

The underlying explorative case study with multiple units of analysis is due to the combination of high variety and a high depth of added value especially applicable for the development of an approach to assessing material flows with a special focus on the consideration of logistical characteristic values. A high number of in-house production parts (IHP) (IH-parts>15,000) and purchase parts (PP) (PP-parts>5,000), in combination with a high degree of variety and customer-specific delivery dates of single orders, leads to relatively low lot sizes at the subassembly and part levels. This results in a hardly manageable degree of complexity as well as in the need for the assessment of logistical material flows to apply optimization and target-oriented investments along the value chain. Nowadays, it is quite common to analyze a part only during its first launch and therefore the process steps of the concerned material flow are defined only once. In the subsequent run, the parts are not evaluated repeatedly in relation to potential improvements. Especially in cases when parts are classified as B- or C-components, there is no further analysis. For economic reasons, most companies concentrate on A-parts which are often reassessed carefully and go through a range of improvement procedures in their life cycle. As a result of the Pareto principle [7], this handling is a common basic rule in companies to recognize potentials of improvement, to focus management activities on the vital parts of the production. However, a considerable number of defects appear during the successive process operation, also caused by B- or C-components. This circumstance is also traceable with the help of the missing parts analysis. Therefore, the objective of this paper is to illustrate an approach for a systematic assessment of material flows with a special look at parameters, showing the actual logistical effort with the result of identified critical in-house production parts. In general, an in-house production part can be classified as critical, if this IH-part determines at least one performance criterion (quality, quantity, time, price, etc.) for an entire segment of the supply network [8]. For a detailed discussion of the term logistical criticality, see [9] who developed a 25-point scale item to determine logistical criticality within his thesis.

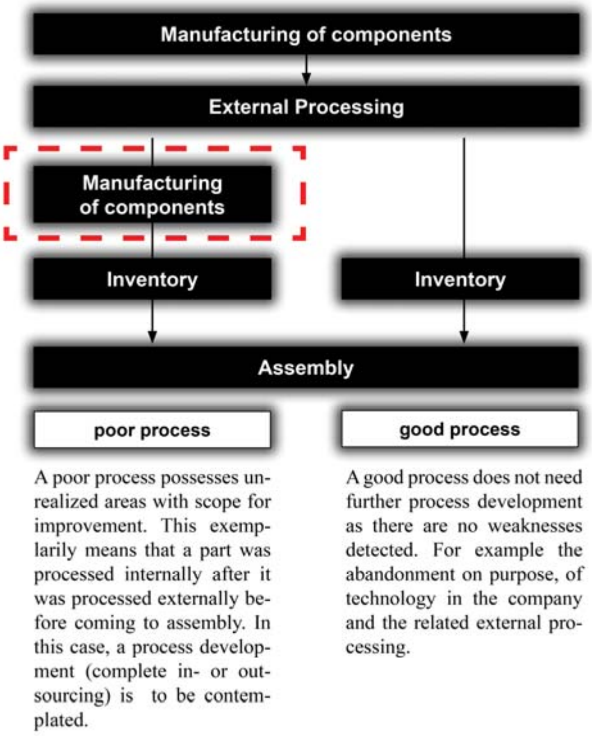
2. Deduction of the relevant logistical drivers

One possibility to identify relevant logistical drivers is to assign all in-house production parts to a process and afterwards to classify them as 'good' and 'poor' parts. Since this process would be too complex, the project team asked themselves a counter question: What makes a process 'good' or 'poor'?

In the following step, the processes of the in-house production parts were classified within a series of expert workshops. They consciously chose a high level of abstraction and came to the following classification:

- good processes (perform well and do not

require further analysis)
- average processes (are kept under observation)
- poor processes (are in need of improvement)



A poor process possesses unrealized areas with scope for improvement. This exemplarily means that a part was processed internally after it was processed externally before coming to assembly. In this case, a process development (complete in- or outsourcing) is to be contemplated.

A good process does not need further process development as there are no weaknesses detected. For example the abandonment on purpose, of technology in the company and the related external processing.

Figure 1: Process classification

The repetitive comparison of good and poor processes in expert workshops enables the stepwise identification of logistical drivers, which are seen as the root of the differences between the mentioned process categories. The revealed drivers are supposed to have a significant impact on the classification of good and poor processes. Based on the resulting list of influencing drivers, expert workshops were held once more to identify those drivers which are of certain importance to the company's performance. This phase is the first step for companies trying to classify their processes: depending on the product, type of business or customer base, the logistical drivers will differ in each company or supply network and therefore have to be defined individually. In the considered company, for example, the number of plants involved in the production has a strong impact on the logistical costs. In contrast, for other companies, customized engineering effort or the number of companies involved in the supply network are more important. The accurate identification of the appropriate criteria is the key success factor for such a project.

3. Definition of reasonable bounds (crash barriers) for the relevant logistical drivers

Fig. 2 is an illustration of the identified logistical crash barriers in the given company, including the determined reasonable bounds. The project team decided in favor of the term 'crash barrier', as it demonstrates that a predetermined range of values is better than fixed values. Naturally, the determined range has to undergo regular adjustment to maintain a reliable tolerance range.

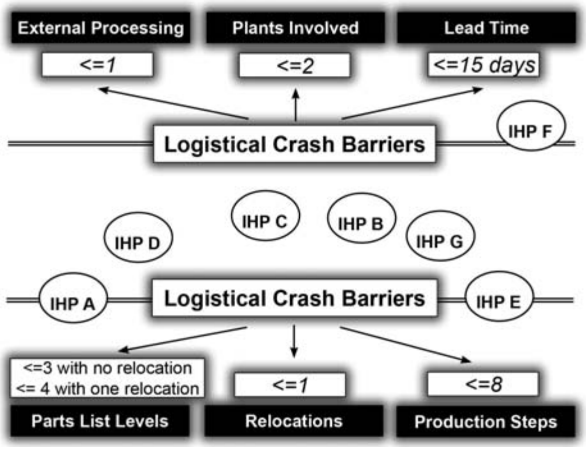


Figure 2: Survey of logistical crash barriers and their reasonable bounds

The following paragraphs explain the identified logistical crash barriers in detail.

External Processing

The term 'External Processing' means that process steps are carried out externally to benefit from technologies which are not available internally or to cover peak loads. The motive behind setting a reasonable bound is the idea of checking products that exceed them and deciding whether outsourcing the whole product or the acquisition of the relevant technology is favorable or not. Fig. 3 illustrates the basic idea of this specific logistical crash barrier.

For each in-house production part, violating the reasonable bound (<=1), it becomes essential to weigh the logistical consequences of external processing with the feasibility and economic efficiency of in-house production.

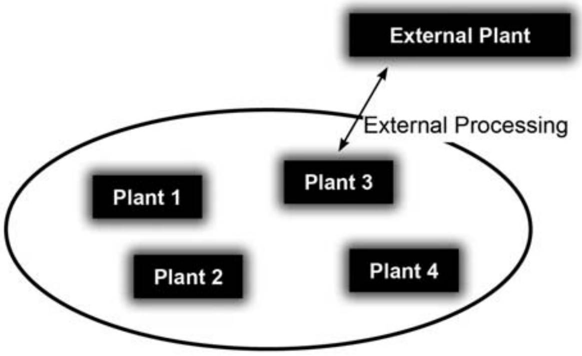


Figure 3: Illustration of External Processing

Plants Involved

Due to the processing in several plants, a lot of non-value-adding process steps (e.g. quality check, relocation of unfinished goods) will lead to significant cost and cycle time increases. As the aim is to achieve a high capacity utilization, to reduce cycle times and to benefit optimally from technology development in the company’s plants, the logistical crash barrier ‘Plants Involved’ was introduced.

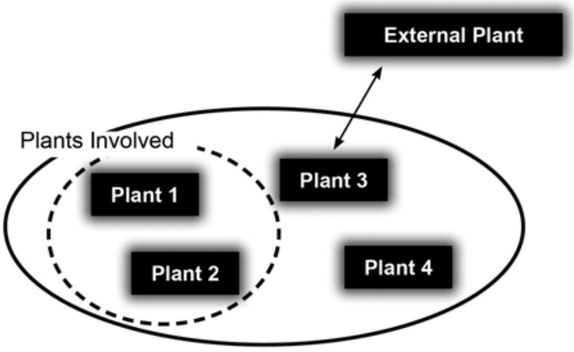


Figure 4: Illustration of Plants Involved

Lead Time

The third logistical crash barrier provides an identification of suboptimally coordinated manufacturing processes, which have high lead times. Implying the intention to reduce lead times to increase performance and to realize room for improvement, this logistical crash barrier was initiated.

The adequate average lead time of an in-house production part is in our case, 15 days. This barrier allows a synchronization with the production program, which can finally be fixed and thereby guarantee a lead time within 15 days. This kind of pulsing enables an exact master production schedule within the planning time frame.

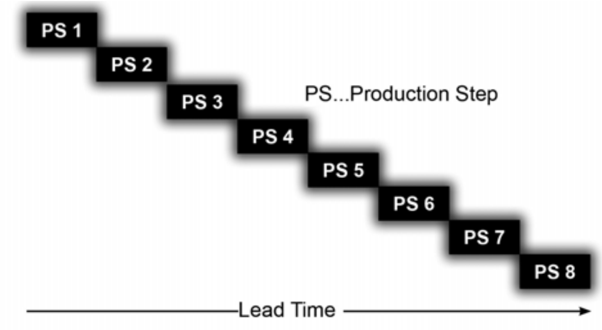


Figure 5: Illustration of Lead Time

The percentage of in-house production parts which violate the logistical crash barrier is relatively high compared to the previous evaluation. One example for this is the production process of one part in more than two different plants. This circumstance inevitably leads to a longer lead time. Other producing companies will also have a similar effect which has to be verified by a company specific analysis. The mentioned lead time and synchronous timing of the supply network stages are very sensitive subjects of supply chain management. One aim of the interpretation of the analyzed facts is to get an impression of their impact on the daily business, because lead time prolongations caused by process inefficiencies are not to be treated equally to long lead times caused by high utilization and respectively long waiting queues before real processing can take place. The overloading of bottleneck machines especially increases the overall production lead time even without a poor process. In that case, a company also has to take action, but might apply various measures (e.g. capacity extension, set-up and maintenance optimization or lot size and order sequence modifications) instead of process improvements or complexity reducing measures.

Parts List Levels

Due to the fact that the degree of complexity and a too wide range of product or part variety can be effectively avoided in the course of the product definition and construction phase, ‘Parts List Levels’ was chosen as a further relevant bound. This crash barrier was set at three levels within one bill of materials, respectively four levels if relocation between the different production plants was required, because in this case the system automatically created an additional virtual level for the relocation step.

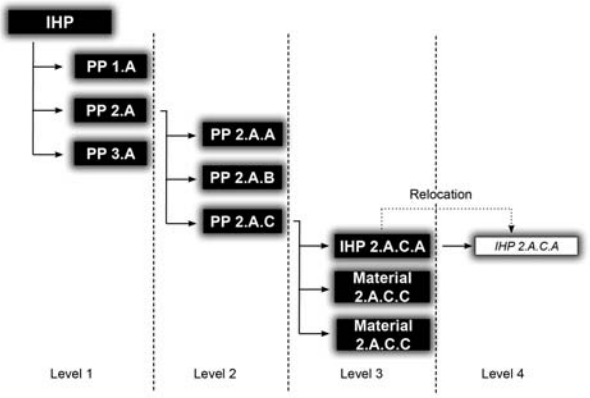


Figure 6: Illustration of Parts List Levels

This crash barrier, as well as the crash barrier ’Lead Time’, proved to be very important during the actual data analysis, noticeable in terms of the percentage of critical parts which were identified by these two crash barriers.

Relocations

‘Relocations’ are physical stock movements of assembly parts, prefabricated components and raw materials (e.g. material supply or transfer of unfinished goods to another production plant) and must be regarded as non-value-adding, but costly activities which should be reduced to a minimum. The maximum number of relocations of in-house production parts in this case study was set at one relocation per produced part.

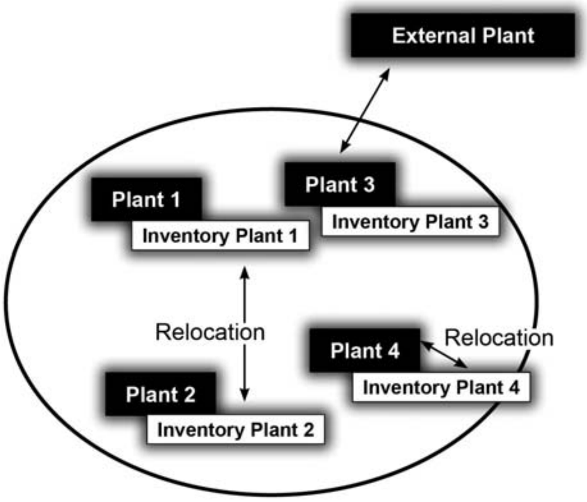


Figure 7: Illustration of Relocations

Production Steps

During process optimization, a company should keep the number of necessary production steps as low as possible. Therefore, the crash barrier ‘Production Steps’ was established with a defined maximum number of production steps including quality control, machine maintenance and material supply. Based on the specific needs of an individual company and the necessity of continuous improvement of the logistical crash barriers, the concrete target values must be steadily adjusted.

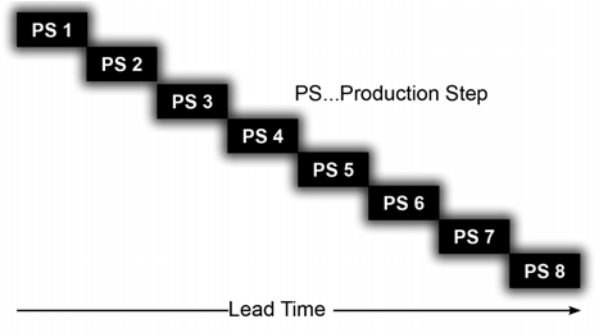
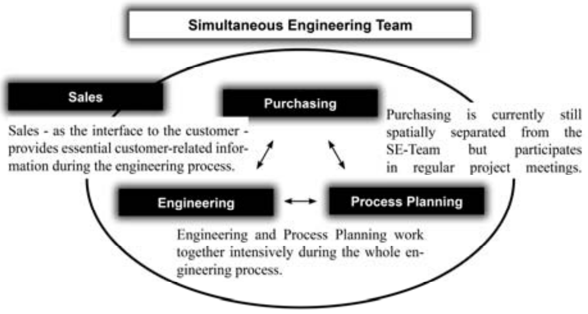


Figure 8: Illustration of Production Steps

Comparable to the analyzed process in the mentioned case study, a company has to first make assumptions regarding the selection of crash barriers and their adequate target values.

4. Monitoring the compliance with logistical crash barriers

As a large percentage of the manufacturing costs are generated in the engineering stage and subsequent modifications are aligned with enormous follow-up costs, new assembly groups are continuously checked by a Simultaneous Engineering Team to limit complexity and variety. This SE-Team consists of staff members from the engineering, the process planning and the purchase department and is responsible for monitoring compliance with the logistical crash barriers.



Sales - as the interface to the customer - provides essential customer-related information during the engineering process.

Purchasing is currently still spatially separated from the SE-Team but participates in regular project meetings.

Engineering and Process Planning work together intensively during the whole engineering process.

Figure 9: Organizational Constitution of SE-Teams

If the adjustment of new parts falls outside the predetermined logistical crash barriers, the SC-manager in charge executes a respective check and initiates necessary modifications to be carried out by Process Planning, to guarantee compliance with logistical crash barriers.

5. Findings and Conclusion

In the course of an analysis of the material streams by means of the developed logistical crash barriers, 1,400 out of 15,000 in-house production parts which violated a logistical crash barrier and therefore required a subsequent analysis were identified. It is remarkable that only 350 parts of the identified 1,400 had previously been classified as A-parts. In other words 75 % of the identified parts had not appeared to be of main importance in an ABC-analysis. This finding, together with the previously described logistical crash barriers and the defined reasonable bounds, answers the first research question: ‘What are the relevant drivers of logistics performance? Are, for instance, A-components those parts, which cause problems in the material flow and accordingly a disproportionately intense logistical effort?’

The prototypic implementation of logistical crash barriers offers the first valuable clues to the potential of assessing material streams with the help of logistical parameters. In addition to this, the project team expects a particular leverage effect in the engineering of new in-house production parts.

The described course of action, including the deduction of criteria by the comparison of good and poor processes thus generating the described logistical crash barriers, provides the answer to the second research question, how a company can possibly identify the relevant logistical drivers within its specific context.

A further interesting aspect for future analysis is the comparison of those parts which go against more than one crash barrier to detect overlaps by more than one logistical crash barrier. The aim could be to reduce the number of logistical crash barriers as one or the other may not be necessary, being covered entirely by another one.

In summary, it can be stated that the identification and application of logistical crash barriers as a method to systematically assess logistical material flows, has proven to be effective and will be continuously developed further by the project team.

ogistical crash barriers are an effective tool to identify non-value-adding process steps and not optimally adjusted logistical processes.

However it is worth noting that the case study indicated that classical criteria of product and customer segmentation as well as purchase parts and supplier evaluation do not lose validity. However, some criteria of the logistical crash barriers can turn out to be less important in the overall view for some companies while others have to be extended by adding other or new, significant criteria. Especially this adequate and company-specific configuration of the applied collection of criteria for an integrative consideration of supply networks is the improvement of the proposed evaluation criteria: Based on the question, which logistical drivers exactly measurably disturb smooth process flows, the logistical crash barriers let those criteria in supply network systems which are actually relevant emerge. In contrast to analytical models, the heuristic approach ensures the feasibility of the analysis and likewise the validity of the results. In this regard, the proposed approach purposefully weights the universality of used criteria less pivotally (sometimes even detrimentally) in favor of external validity: due to its heuristic character, the method will result in the most distracting supply network issues ‘most probably’ and depending on the analysis data accuracy, not ‘by any means’. Due to the fact that criteria emerge from a company’s and its supply chain partners’ specific attributes, the method does not claim to provide objective or universally applicable criteria but rather to provide criteria for a holistic identification of what is critical for the investigated case. Thus, the procedural approach is universally applicable, but context specific criteria will emerge.

If the criteria described in this case are not applicable for another company, then a company-specific deduction (procedure see section ‘deduction of the relevant logistical drivers’) must occur.

Furthermore, it has to be considered that the applicability of the developed and described criteria in other companies is mainly dependent on the following factors: data availability, an integrated view, which consistently analyzes all major processes for disturbing factors and interdisciplinary teams during the data evaluation and criteria definition phases.

To sum up, especially under turbulent market conditions, the main focus of the project is to make the company more adaptive through a better capability to quickly identify the sources of performance limits.

6. Acknowledgment

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