LogDynamics
International Graduate School

Delivery Time Uncertainty in Dynamic Supply Networks

Today, value chains within the manufacturing in industry are implemented in supply networks. In general, a supply network is considered as the cooperation between suppliers and a manufacturer with the objective to realize a product.

In those industries, where batch sizes are high (series production), the supply networks usually are stable in terms of involved companies and the related processes. Under stable conditions, the planning and controlling of the processes to reach reliable deliveries is based on experience and continuous improvement.

Due to the fact that market opportunities are more and more short term and customer expectations are dynamic, supply networks in many cases need to be designed according to a specific market opportunity. In consequence, the configuration of supply networks becomes dynamic.

The objective of these dynamic supply networks is to realize individual demands in a reliable way with short reaction times to the market need. In comparison to stable supply networks, the planning and controlling of the processes can't be based on its history.

To ensure reliable deliveries of a supply network, a method to identify and to control potential uncertainties regarding the delivery is needed. An important issue to reach reliable deliveries is the consideration of delivery time uncertainties due to the fact that a predictable reaction time is a main success factor in the global competition.

Specific problem definition

Delivery time uncertainty within a supply network can be understood as the ability of the network to guarantee a certain percentage of deliveries within a defined time frame. In Figure 1, the delivery uncertainty is presented in a qualitative way.

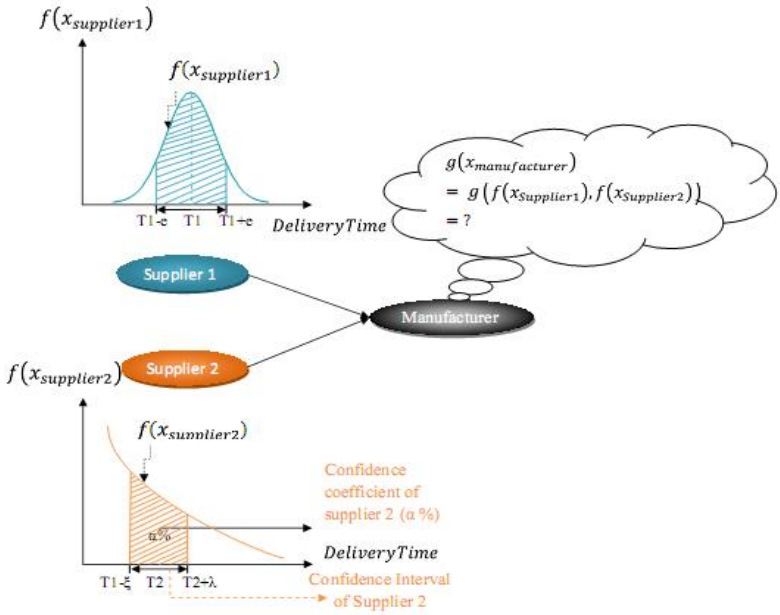

Figure 1: Delivery time uncertainty

The *confidence interval* is the time frame, a supply network is able to deliver a certain percentage of orders in. The *confidence coefficient* represents the percentage of orders which are delivered within the confidence interval.

The time related objective of planning and controlling strategies in supply networks is to reach a low level of delivery time uncertainty of the entire network – in other words, to reach a low confidence interval in combination with a high confidence coefficient.

Agility and accuracy in delivery time, product final cost and quality are the fundamental characteristics of competitiveness. The enterprises have to be able to provide consumer demand just in time, with desired quality and at a reasonable price.

Backlogs, delay in demand delivery, demurrages and product total prices increase as a result of higher uncertainty in delivery time. The way in which enterprises interact with their supply network partners and type of relations has a large impact on uncertainty in delivery time. Design

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and organizing appropriate relations in the network in order to reduce delivery time uncertainty can be assessed from the position of the network configuration that has to identify and build utilitarian relations in the network.

The development of an approach to estimate the delivery time uncertainty in dynamic supply networks is the purpose of the proposed research.

The delivery time uncertainty of a supply network is caused by the individual delivery time uncertainties of the members of the network. To be able to estimate the delivery time uncertainty of the entire supply network, the impact of these individual uncertainties on the total uncertainty level has to be understood. The way in which the individual uncertainties need to be accumulated depends on the network type.

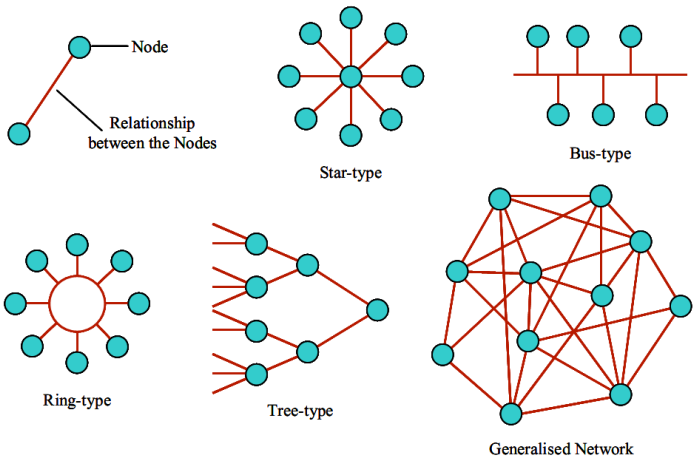

Figure 2: Basic network types

Formally, a supply network can be described by nodes representing the companies and the links (relationships) between these nodes. From this perspective, a network type is defined as the structure in which the different nodes are linked with each other. Figure 2 depicts the possible basic types of a network. Generalized networks can be described as a combination of these basic types.

The research problems are:

- To identify how the individual delivery time uncertainties of the members in a supply network need to be accumulated to the total delivery time uncertainty for different network types.
- To understand how the individual uncertainties influence the total uncertainty of the network.
- To identify those parts of the network which have the highest potential for improving the total delivery time uncertainty

Objective and Expected Result

The objective of this work is to develop mathematical models to calculate the delivery time uncertainty of supply networks considering different types of networks. Superposition rules for the different basic network types will enable an estimation of the delivery time uncertainty also for more general network types. To achieve this objective, the following aspects should be solved:

- Identification of effects of each node in a supply network on the final uncertainty in delivery time dependent on the network type and derivation of mathematical rules to describe these effects.
- Calculation of the interval confidence and confidence coefficient for delivery time uncertainty for each supplier in network (local uncertainty) and its accumulation to the total uncertainty level.

The further contribution of the study is the development of a new methodology based on the previously developed mathematical models to identify those parts of a network where local improvements have the largest effect on the total uncertainty level.

Methodology

The procedure of the research will be done in well defined steps. First, the causes and effects of ‘time uncertainty‘ in supply networks will be studied. Second, introducing the distribution functions definitions, interval confidence and confidence coefficient of delivery time for each supplier of the network, with paying attention to the past information. Third, identifying the shape of curve for each statistical distribution functions of each supplier in the supply network. After that, mathematical models for the different network types could be developed. The evaluation of the models will be based on a case study (example) in which the models will be applied.

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