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Transparency of Risk for Global and Complex Network Decisions in the Automotive Industry

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Abstract:

This paper presents a multi-period, multi-objective optimization model that enables robust production network and location planning during times of increased market uncertainty and risk exposure in environmental factors. The planning model focuses primarily on integrating the quantitative and qualitative risk factors associated with strategic production network planning. Integration was realized by linking a robust programming model with aspects of multi-target optimization using an EPSILON-constraint approach. This allows quantitative risks such as fluctuations in demand, exchange rates, and transportation costs to be factored into a common mixed-integer optimization model as discrete scenarios, with qualitative risks, e.g., security risks, accounted for as part of a points-based evaluation approach. The developed model minimizes the firm's expected downside risk exposure while meeting a pre-selected threshold level for environmental risks. The trade-off between risk and profit is depicted and interpreted using a Pareto analysis. The developed model makes it possible to characterize a variety of risks that are very difficult to manage when carrying out strategic planning of production networks in practice.

1. INTRODUCTION

Due to the dynamics of customer expectations, the competitive playing field, and technological advancement, companies must respond ever more quickly to changes in the corporate world while remaining agile when it comes to procurement, production, and sales trends. In the past few years, many companies have pursued outsourcing these three activities to foreign locations to profit from the lower operating costs there and to maintain or improve their competitive edge. Manufacturers such as BMW, Daimler, and Toyota, for example, have spread their value-added activities around the world to create a global production network comprising international suppliers, production facilities in multiple countries, and worldwide sales markets. Enterprising on a global level, however, means that automotive manufacturers must deal with increasing risks, such as fluctuations in demand in different countries, exchange rate issues and the costs and decline in earnings associated with them, as well as changes in transportation costs due to rising oil prices. Key factors that make or break the competitive process of a company therefore surround decisions regarding production quantities, capacity utilization and expansion of existing locations, and control of global procurement and distribution flows. These long-term decisions affect a complex international network and are thus intertwined with the significant uncertainty of economic and sales data (Kauder 2008, p. 4). Changes of parameters that are used for long-term planning of production networks