Conversion Factory

TRANSPORTATION ORDER FORECASTING FOR BULK GOODS.

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Introduction

This report describes a tool that can be used to forecast the number of truck transportation orders to be received in specific periods, for trucking companies serving the international bulk goods transportation market. The tool has been developed for a company in the bulk transport sector, serving supply to manufacturing companies in the food and non-food sector. The company faced high uncertainty with respect to demand for transportation and small profit margins, and has restructured its transportation resources to flexibility in available capacity. However, the use of flexible capacity requires knowledge of future orders. Therefore the company developed a transportation order forecasting system.

The forecast is generated by a tool that analyses the data about orders in the past, to find correlations between demand in successive weeks and between weekly demand and exogenous factors such as holidays.

During holidays, production in manufacturing companies is limited or even zero, as is supply of materials to these companies. Different countries have different holiday periods and different incidental holidays. As a result, the demand for transport on a certain day on a certain lane (origin to destination) will depend on whether or not the day is a holiday in the region of origin or the region of destination. Thus, knowledge about the holidays in a region can be used to forecast the demand for transport on lanes that require loading or unloading in this region.

Scope

International transportation of liquid and dry bulk goods, such as fats, cereals, and chemicals, is a business with ever increasing competition and small margins. As a result, transportation companies in this field seek opportunities to reduce their cost. The dominant cost factor is the cost of trucks and truck drivers. Most companies in this business use flexible labor contracts to be able to cope with the varying demand for transportation, while avoiding excess capacity in periods of low demand. However, flexible capacity cannot be made available instantaneously; the need for capacity must be made known to the capacity provider a number of days in advance of its use. Thus, a company that uses flexible labor contracts must forecast its demand for transportation at least this number of days ahead. Moreover, the forecast needs to be specific in terms of the transportation resources needed since the product that must be transported may need a specific type of truck and may need a specific type of truck driver may for loading, transporting, and unloading the kind of product. Moreover, as input for the transportation planning, the lanes for which transportation is demanded must be known a number of days in advance, since different lanes requires different driving times and have different opportunities for return load. The tool therefore must forecast the demand for lanes and resources needed; this is the unit of forecasting.

Description of the approach

Aggregation and categorization

Within the geographical region covered by a transportation company, many different potential lane-resource combinations (transport order from a specific origin to a specific destination requiring a specific resource) can be distinguished. Many of these potential lane-resource combinations will not be served, other will be served occasionally, and some will be served frequently. The tool takes all lane-resource combinations served over a past period, ranks them according to number of orders

placed, and selects the most demanded lane-resource combinations that account for X% of total demand (a Pareto analysis).
The selected lane-resource combinations (referred to as lrc's from now on) are categorized according to weekly demand pattern. For characterizing demand patterns, two aspects of the weekly demand per lrc are measured. First, the average number of weeks between weeks with non-zero demand; and second, the squared coefficient of variation of demand per week with non-zero demand. Lrc's with few weeks with zero demand and low variation in non-zero demand are categorized as **smooth** lrc's. Lrc's with few weeks with zero demand and high variation in non-zero demand are categorized as **erratic** lrc's. Lrc's with many weeks with zero demand and low variation in non-zero demand are categorized as **intermittent** lrc's. Lrc's with many weeks with zero demand and high variation in non-zero demand are categorized as **lumpy** lrc's.
The tool allows for forecasting at various levels of aggregation.
At the highest level, all demand per week is added up, disregarding origin-destination and resource. The resulting weekly demand series are input to the forecasting module.
At the second level, all demand per week belonging to the Pareto group is added, disregarding origin-destination and resource. The same is done for all demand per week belonging to the non-Pareto group. The resulting two demand series are input to the forecasting module.
At the third level, first the smooth lrc's with an average weekly demand larger then 4, called regular demand lrc's, are selected. For each of these lrc's, the resulting weekly demand series are input to the forecasting module. For smooth lrc's with average weekly demand lower than 4, and lanes with erratic, intermittent, and lumpy, geographical regions are defined. For each resource, each of these lrc's are allocated to one of these regions, and the demand is added up per region to produce the total non-regular demand per resource per region. Note that regions are aggregations of lanes which have both origins and destinations close to each other. The resulting time series are input to the forecasting module.
Some lrc's may not be possible to allocate to one of the regions. These will be considered manually.
At the third level each individual lrc is considered. At this level, no aggregation takes place. The resulting time series are input the forecasting module

Forecasting

The tool provides two different forecasting methods.
First, for the weekly demand time series at the total demand level, at the Pareto level, at the non-Pareto level, for the regular demand lrc's, and for the regional demand lrc's, a multiple regression technique can be used to identify whether certain factors affect the demand in a week
The following factors are used as independent inputs for explaining the demand in a specific week:

- Expected peak: this is the input of a human planner
- Nr. of contract customers
- Demand one week earlier
- Demand two weeks earlier
- Demand three weeks earlier
- Demand four weeks earlier
- Is New Year in this week
- Is Christmas in this week
- Is Eastern in this week
- Is King's Day in this week
- Is Dutch Liberation Day in this week
- Is Ascension Day in this week
- Is Whit Monday in this week
- Is Dutch "Bouwvak" in this week
- Is Carnival in this week
- Is Labor Day in this week
- Is Belgian National Day in this week
- Is Assumption of Mary in this week
- Is All Saints in this week
- Is Armistice Day in this week
- Is Early May Bank Holiday in this week
- Is Spring Bank Holiday in this week
- Is Battle of the Boyne in this week
- Is Summer Bank holiday in this week
- Is National Bay Austria in this week
- Is National Uprising Day in this week
- Is Constitution Day of Slovakia in this week
- Is The Day of the Virgin Mary of the seven Sorrows in this week.

Based on the past demand data in each of the time series, a regression analysis is performed, the significant factors are identified and for the significant factors the regression coefficients are determined. These regression coefficients are used to forecast the future demand in the time series. Second, for the individual lrc's, the Syntetos&Boylan forecasting method is available. This method can deal with time series containing many zero demand occurrences. It separately forecasts the length of the interval between two non-zero demand events, and the magnitude of the non-zero demand, and combines these separate forecasts to obtain a forecast per period.