

## THE DEMAND FORECASTING PROCESS IN CZECH CHEMICAL COMPANIES

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### Abstract

An accurate and timely demand forecast represents the key input information for most decisions made within a company. It can only be obtained through a systematically managed process of demand forecasting. However, what still has not been researched sufficiently is how to manage this process in the right way in chemical companies that are characterized by implementation of a make-to-stock strategy based on demand forecasting. Therefore, the given area became the subject of a quantitative primary research conducted at 58 Czech manufacturing chemical companies. It aimed to identify the way of organization of the demand forecasting process, the way of developing demand forecasts, and the way of assessment of the accuracy of created forecasts. The research conclusions and their subsequent comparison with modern theoretical approaches made it possible to identify the main directions in improvement of the process of demand forecasting in chemical companies.

### Introduction

Each managerial decision in the company is more or less based on the estimate of the future, while most of these decisions are based on the future demand forecast. Therefore, demand forecasting represents an important corporate management tool, which makes it possible for the managers not only to make rational decisions, but also to manage the other corporate processes effectively. Chemical companies in the Czech Republic are characterized by mass-produced or off-the-shelf products with low flexibility, and so make-to-stock strategy represents the main method of production they apply. In such cases, timely and reliable estimate of future sales is crucial for planning sales, manufacturing, purchase, as well as other subsequent corporate processes. Such a forecast can only be obtained through a systematically managed process of demand forecasting, involving representatives of all the corporate departments.

There are a few foreign studies dealing with the forecasting technique familiarity, satisfaction, usage, and application, as well as with the way of organization of the demand forecasting process in practice (see e.g. the researches<sup>1,2</sup>). However, quantitative surveys of this type do not enjoy enough attention in the Czech environment. Therefore, this paper aims, on the basis of quantitative research, to identify the way of organization of the demand forecasting process, the way of developing demand forecasts, and the way of assessment of the accuracy of created forecasts in Czech chemical companies.

### Demand forecasting management

Management of the demand forecasting function within an organization can be divided into three basic areas:

- demand forecasting organization,
- demand forecasting process, and
- demand forecasting controlling.

The demand forecasting organization is concerned with how the company organizes development and application of demand forecasts. Mentzer and Moon<sup>3</sup> have found that companies typically organize their demand forecasting function in one of four ways: an independent approach, a concentrated approach, a negotiated approach, or a consensus approach to demand forecasting management. The *independent* approach means that each functional department in the company develops a demand forecast geared to its specific requirements. The absence of coordination and collaboration among the departments developing separate forecasts hinders the departmental sales forecasts from being used as a contribution to the planning functions in various departments and as an aid to corporate-level planning. The *concentrated* form of demand forecasting organization assigns forecasting responsibility to one department. The orientation of the demand forecasts tends to ignore information from and the requirements of other departments. A company that uses a

*negotiated* approach to manage its demand forecasting process develops demand forecasts in each functional department and then assembles representatives from each department during each forecasting interval to negotiate an official demand forecast for each forecasting level and horizon. In the *consensus* approach to demand forecasting organization, a committee consisting of representatives from each functional department is responsible for developing demand forecasts using input from each department. A genuine consensus forecasting approach incorporates high levels of functional collaboration. The benefit of cross-functional integration between marketing and production departments, for instance, is already apparent due to increased flexibility, product quality, etc.<sup>4</sup>. Hence, interdepartmental integration becomes even more important while supply chain partners collaborate in relation to promotional or new products<sup>5</sup>.

The next area of the demand forecasting management refers to design the process of demand forecasting. A typical demand forecasting process that is used in many industries (including chemical industry) consists of multiple phases<sup>6</sup>:

- collection of input data like forecast data from former planning runs, historical customer orders, shipments, etc., and correction of historical data;
- computation of further data (e.g. statistical forecasting);
- judgmental forecasting by the forecasters, who review the market situation and give their own input;
- consensus forecasting, consolidating different views of the forecasters or dealing with exceptions;
- release of a forecast to further planning and execution process.

A critical step in the demand planning process is selection of an appropriate forecasting method that has many consequences. Statistical forecasting methods based on time series analysis are more and more applied in practice thanks to a quick development of information technologies. Their indisputable advantage is the capability of unbiased processing of a large amount of data<sup>7</sup>. However, unexpected changes in the development of the demand that are not considered in the forecasting model frequently result in creation of inaccurate forecasts<sup>8</sup>. Judgmental forecasting methods are based on the knowledge, experience, and intuition of human forecasters. They play a significant role in forecasting the demand for new products<sup>9</sup>, in the case of radical changes in the market, or in forecasting the impact of promotions on the demand<sup>10</sup>. Within judgmental forecasting, forecasts might be distorted as a result of subjective opinions, wishes, or due to different interests of the forecasters, which can be considered as one of the main disadvantages of these methods<sup>11</sup>. Combination of statistical and judgmental methods can make corporate forecasts significantly more accurate<sup>12</sup>. There are a number of ways that a judgmental forecast can be combined with statistical forecasts. One of the oldest approaches to combined forecasting refers to individual forecasts and joins them by taking weighted averages<sup>11</sup>. Another approach (called model building) addresses judgments to choose variables, structure a model, and then define parameters for generation of statistical forecasts<sup>13</sup>. Nevertheless, judgmental forecasting is most often used to making adjustments of statistical forecasts<sup>6</sup>.

In order to achieve high forecast accuracy, it is necessary to implement appropriate demand forecasting controlling mechanisms<sup>14</sup>. The first step in setting up demand planning controlling is to define the basic forecast accuracy metric<sup>15</sup>. Calculation of the forecast error must be supplemented with analysis of the causes of its potential change. It may be application of an unsuitable method, unexpected customer behaviour, but also an unsuitable way of demand forecasting organization in the company. Ideally, the forecast quality is also quantified as a loss resulting from wrong estimation of the future. The thing is that overestimated forecasts result in unsold goods, which stays in stock, has to be sold for lower prices, etc. On the other hand, underestimated forecasts result in loss of sales, or the necessity of purchasing the missing products, usually for higher prices<sup>16</sup>.

## **Research Methodology**

The primary quantitative research was conducted using the method of on-line questioning through a structured questionnaire. The research involved 100 companies randomly selected from the database of Czech chemical companies (CZ-NACE 10 Manufacturing of chemical substances and chemical preparations), whose annual turnover exceeds EUR2 million and/or who have more than 10 employees. The selection was made with the support of the commercial database of the Czech Economic Subject Rating. Within the survey, we got back 58 filled in questionnaires, which corresponds to the response rate of 58%. The selected sample of companies included 35% of small companies (the annual turnover of up to EUR10M and/or up to 50 employees), 41% of medium-sized companies (the annual turnover of up to EUR50M and/or up to 250 employees), and 24% large companies (the annual turnover exceeding EUR50M and/or more than 250 employees).

To meet the research targets, the data obtained from eight semi-open questions were analyzed. These questions aimed to identify in the company: the form of demand forecasting organization, the considered factors affecting the demand in the monitored markets, the used sources of data and information for forecasting, the applied forecasting methods, the software or information system used for demand, whether and how the companies analyze the forecasting accuracy. The data were processed by frequencies and multiple response analysis using the statistical software package IBM SPSS Statistics (v. 24).

## Results and discussion

The first part of the outcomes describes the way of demand forecasting organization through analysis of the frequency of application of the four basic approaches described in the literature<sup>3</sup>: the independent approach, the concentrated approach, the negotiated approach, and the consensus approach (see outcomes in Table I).

Table I  
Demand Forecasting Organization by Company Size Crosstab

Demand Forecasting Organization	Company Size			
	Small	Medium	Large	Total
Independent Approach	7%	24%	25%	18%
Concentrated Approach	7%	35%	13%	21%
Negotiated Approach	71%	18%	50%	44%
Consensus Approach	14%	24%	3%	18%
<i>Total</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>

A positive finding of the research is the fact that almost two thirds of the respondents (62%) create the final demand forecast on the level of the entire company, which is a necessary prerequisite for integrated management of corporate processes based on a single forecast. However, the negotiated approach is the most frequently applied form of demand forecasting organization that can bias the final forecasts (political pressures among departments resulting from separate goals, information, and requirements of each individual department). A more suitable solution in the form of consensus forecasting is only applied in one fifth of the cases (18%). Table I also shows that the rate of application of the consensus approach does not significantly depend on the company size. This implies that an obstacle to consensus forecasting obviously cannot be found in the complexity of the organizational structure of the researched companies, but rather in the low level of collaboration among departments and in the reluctance to push changes in organization of the demand forecasting process.

The second part of the outcomes aims to identify the demand forecasting process itself with the focus on the considered factors affecting the demand in the markets with chemical products, the information sources used for forecasting, the applied forecasting methods, and the software used for creation of statistical forecasts.

Table II contains the frequency distribution of the considered factors (Responses) and the frequency of companies where the given factor was identified (% of Cases). Chemical companies mostly consider, when forecasting the demand, the impacts of product prices and seasonality of sales (roughly two thirds of the cases). They are factors whose influence on the demand cannot be studied effectively without using adequate sources of data (particularly historical sales) and forecasting methods (causal methods, time series analysis). Almost a half of the cases also consider the customer habits and traditions, technological design, and qualitative parameters of products. They are factors whose influence can rather be included in the final forecasts through judgmental adjustment of statistical forecasts. Therefore, a suitable combination of judgmental and statistical methods is crucial for creation of accurate forecasts in chemical companies.

Table III shows frequency distribution of information sources used for forecasting (Responses) and frequency of companies where the given information source was identified (% of Cases). The analysis outcomes imply that chemical companies have the use of a high quality portfolio of data and information for forecasting. An absolute majority of respondents use historical sales data, and in two thirds of the cases forecasts are based on the experience of the sellers, or information provided by the customers. However, it is obviously information of the qualitative character, as hard data from the point of sale (e.g. volume of sales to final consumers) are used marginally (9% of cases). This finding corresponds to the low willingness of the customers to share the data concerning the demand in these markets<sup>17</sup>.

Table II  
Frequencies of considered factors

Factor	Responses		% of Cases
	N	%	
Product prices and their modifications	32	12.0	70
Seasonality of sales	31	11.6	67
Consumer habits, traditions	23	8.6	50
Technological design of products	21	7.9	46
Qualitative product parameters	21	7.9	46
Macroeconomic environment	19	7.1	41
Intensity of competition	19	7.1	41
Level of logistics services	15	5.6	33
Way of product distribution to final customers	14	5.2	30
Weather	13	4.9	28
Product life cycle	11	4.1	24
Advertising	11	4.1	24
Other (different) marketing communication tools	11	4.1	24
Range of the product line	9	3.4	20
Sales support for distribution intermediaries	9	3.4	20
Sales support in the place of sale	8	3.0	17
<i>Total</i>	<i>267</i>	<i>100.0</i>	<i>x</i>

Table III  
Frequencies of information sources used for forecasting

Source of Information	Responses		% of Cases
	N	%	
Historical sales data	39	29.3	85
Sellers' experience with the services market	31	23.3	67
Information obtained from customers	31	23.3	67
Information obtained from suppliers	10	7.5	22
Primary research	9	6.8	20
Secondary research	6	4.5	13
POS data	4	3.0	9
Information from media	3	2.3	7
<i>Total</i>	<i>133</i>	<i>100.0</i>	<i>x</i>

Table IV shows frequency distribution of applied forecasting methods (Responses) and frequency of companies where the given forecasting method was identified (% of Cases). An unequivocally prevailing forecasting method applied by chemical companies is the Sales Force Composite (86% of cases), as the sellers and sales representatives have most information about behaviour of the company's customers and, at the same time, they have the use of effective tools affecting the volume of future corporate sales. The Sales Force Composite Method is most often combined with research into the customers' purchase intentions (Customer Expectations), and/or with the knowledge of the sales value generated by the customers within the immediately preceding period (Naïve Method). This combination was mentioned by roughly a half of the addressed respondents. What is a negative finding of the research is a very low level of application of statistical methods, which make it possible to analyze the demand in the context of the influence of the main factors affecting the demand in the monitored markets (product prices and their modification, seasonality of sales). Less than a half of the respondents make use of time series analysis when forecasting the demand. Regression models, exponential smoothing methods, and other advanced forecasting methods were mentioned within the research in less than 5% of the cases. In view of the fact that forecasters do not necessarily know the titles or principles of some statistical methods, the respondents could mark them, providing they are implemented in their forecasting software, as "Unknown Methods Implemented in Software". However, this possibility was used by 12% of the addressed respondents only, which confirms the conclusion that statistical methods still have not been significantly applied in practice by Czech chemical companies.

Table IV  
Frequencies of applied forecasting methods

Forecasting Method	Responses		% of Cases
	N	%	
Sales Force Composite	43	22.1	86
Customer Expectations	29	14.9	58
Naïve Method	28	14.4	56
Time Series Decomposition	23	11.8	46
(Moving) Average	21	10.8	42
Panel Discussion	18	9.2	36
Market Test in Point of Sale	13	6.7	26
Analogy Method	6	3.1	12
Unknown Methods Implemented in Software	6	3.1	12
Delphi Method	3	1.5	6
Exponential Smoothing	2	1.0	4
Regression	2	1.0	4
Advanced Methods (Neural Networks, ARIMA Models, Simulation, etc.)	1	0.5	2
<i>Total</i>	<i>195</i>	<i>100.0</i>	<i>x</i>

The above outcomes also closely correspond to the low frequency of utilization of specialized demand forecasting software. Although some software is used by two thirds of the addressed respondents within forecasting, it is usually only a spreadsheet processor of the Excel type (30% of the respondents), and only 37% of the respondents prefer specialized software. The low availability of specialized software may thus represent one of significant barriers to implementation of statistical methods into the demand forecasting process.

The last part of the outcomes shows the most significant shortcomings of the demand forecasting process in Czech chemical companies, which are in the area of assessment of the accuracy of corporate forecasts. Table V shows frequency of answers to the question whether the company assesses the forecast accuracy and how the accuracy assessment is approached.

Table V  
Assessment of corporate forecast accuracy

Forecast assessment	%	Assessment methods	%
Yes	67	Only a comparison between forecast and actual figures	78
		Statistical analysis of the forecast error	3
		Comprehensive assessment of the forecast error	16
		Another method	3
		<i>Total</i>	<i>100</i>
No	33		
<i>Total</i>	<i>100</i>		

What is alarming is the fact that an entire third of the addressed companies do not check the corporate forecast accuracy at all. In an overwhelming majority of the other cases, companies only compare the forecast sales values with the actual sales values. However, such a way of analysis of the forecast accuracy is insufficient for assessment of the effectiveness of the demand forecasting process. Unless the checking process makes it possible to analyze what economic impacts the current of demand forecasting method has on the company, it is not possible to make rational decisions when proposing and accepting suitable remedial measures in the entire demand forecasting process or in its partial sections. Comprehensive assessment of the error, including analysis of its impacts on the company's ancillary expenses, loss of sales, etc., was identified in 11% of the respondents only.

## Conclusion

The primary research outcomes indicate a low level of demand forecasting in Czech chemical companies. Low level of collaboration among departments results in creation of independent forecasts in individual functional departments of the company. In the better case, the forecasts created this way are at least harmonized (adjusted) on the level of the company's top management. However, the consensus approach to demand forecasting organization still has not found significant application in practice of chemical companies. The most frequently considered factors affecting the demand on the monitored markets include the product price, its modification, and the seasonality of sales. Although the researched companies have suitable data and information available for demand forecasting, they do not apply adequate forecasting methods. One of the possible causes is insufficient utilization of specialized software, which represents a necessary prerequisite for application of most statistical forecasting methods. The most significant drawbacks of demand forecasting management can be found in the absence of effective controlling mechanisms, which would enable rational management of the demand forecasting process.

On the basis of comparison of the research outcomes with modern theoretical approaches, it is possible to propose the main trends in improvement of the demand forecasting process in Czech chemical companies:

- Higher intensity of cooperation between functional departments in the company, which would ensure creation of single consensus forecasts (e.g. through creation of a committee consisting of representatives from each functional department, which would be responsible for developing demand forecasts).
- Implementation of statistical methods into the demand forecasting process, which would be supported by a higher availability of specialized software and training of forecasters in the principles and possibilities of application of advanced statistical methods within demand forecasting.
- Introduction of the system of measuring demand forecasting performance, which would make it possible to analyze and evaluate the corporate forecast accuracy, including its economic impact on the other corporate processes, and thus created the environment for rational management of the demand forecasting process.

The research outcomes reliability might be affected by a lower questionnaire response rate, which is however comparable to the other surveys conducted in this research area. Nevertheless, we believe that the analyzed respondent sample can be considered as sufficient with respect to the paper targets and the applied statistical analysis methods.

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