Determinants of Sales Forecasting Performance in Retail Chains: An Empirical Study from Central-Eastern Europe

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Abstract. Sales forecasting plays crucial role in management of distribution systems, especially in retail chains based on integrated supply chain. Yet although many papers were introduced on various forecasting aspects, predominantly regarding situational and methodological parameters, evidence giving a comprehensive picture of a forecasting system is still rather sparse. In this paper, effect of selected factors on indicator of sales forecasting performance is evaluated: first open research interviews were conducted to identify a total of 15 potential factors, then significance tests with correlation analysis were applied to determine their effect on forecasting performance. The results show that a comprehensive approach to forecasting management is vital, stressing the importance of performance evaluation and information systems. Social-morale factors, formal education and domain work experience, on the other hand, were found to be of much less importance. Empirical evidence was provided by an extensive survey that involved 148 forecasters from 7 multinational companies operating in the Central European region.

Key words: Sales forecasting, Retail chains, Forecasting performance, Organizational behaviour, Supply chain management.
JEL classification: M12, M50, M54

1 Introduction

Sales forecasting is an essential element in all supply chain and distribution systems involving the future. The accuracy of sales forecasts critically determines the validity, credibility and effectiveness of inventory management (Mentzer & Moon, 2005), as well as sales and manufacturing decisions (Moon et al., 2003). This importance is even multiplied in case of integrated supply chains, typical for most of the major retailers (Merrilees & Fam, 2011; Ali & Boylan, 2010). Because of this, managers and companies strive for the highest forecasting performance, which can represent the edge necessary for business success in this era of heightened competition and economic turmoil (Zhao et al., 2002). Historically, however, separate attention was given to the various components of forecasting. While there was significant empirical research conducted concerning forecasting methods and their fit to given marketplace conditions, evidence relating to the organizational factors of forecasting is rather sparse (Fildes et al., 2008; Winklhofer, 1996; Fildes & Hastings, 1994; Makridakis & Wheelwright, 1977) and mostly descriptive, without causal insight (Fildes et al., 2003; Winklhofer, 1996; Mentzer & Moon, 2005). Also, it is rather exceptional to find research evaluating and comparing factors from different forecasting spheres, including methodology, situational parameters and organizational factors. According to Wiklhofer´s (1996) review, only about 17% of papers from 1973 to 1996 investigated more than one such forecasting aspect.

However, both approaches offer substantial opportunities for performance improvements. In some cases, a certain quality of organizational factors is instrumental in gaining and retaining an advantage from partial innovation; be it for instance the effect of domain knowledge (Armstrong, 2001a), rewarding schemes (Moon & Mentzer, 1999), or information sharing (Ali & Boylan, 2010). When properly implemented, complex research on a factor based performance model could even multiply partial improvements, as proposed by Orrel & McSharry (2009) and exhibited by Mentzer & Davis (2007) or Mentzer et al. (1999). A quantitative comparison of a forecasting system´s various components, currently

unavailable, would be a significant boost for determining relationships between basic factors and the magnitude of their effect. This would help in prioritizing management goals and determining precise strategies for their achievement. This long-standing research requirement has already been emphasized by Armstrong (1988) and Fildes & Hastings (1994).

In this paper, I seek to fill this gap by simultaneously analyzing all the most vital aspects of forecasting, with special regard to organizational factors. Such an ambition puts significant pressure on the validity of the research framework, which has to integrate evaluation of radically different functional areas. However, I believe that by using an appropriate research method and data source, this survey is possible, and would bring valuable results. My work is inspired mainly by the semi-complex study of Davis & Mentzer (2007), which proposed a Sales Forecasting Management framework of four components as a robust performance management tool. While taking a more open approach than the dominantly quantitative analysis used by Mentzer & Davis, and also a different analytical method, their paper provided great inspiration in terms of factor dissemination and research framework. My paper is also related to Mentzer´s older papers (Mentzer & Cox, 1984; Mentzer et al., 1999), in terms of the ambition to integrate and evaluate factors from all spheres in one research case. Both sources are, among other studies, discussed in the results and conclusions phase. My contribution is to link fragmented knowledge about forecasting performance in one comprehensive analysis. The final ambition is to create a factor based model of forecasting performance that would integrate and evaluate significant effects from all forecasting spheres.

In order to derive such a complex system picture, comprehensive research in three stages was conducted. In the first stage, paper focused on both sides of the equation: definition of performance indicator and selection of potential factors that can significantly affect forecasting performance. The second stage was all about quantitative evaluation and description of selected factors. Finally, the third stage concentrated on quantitative testing of the significance and effect they have on forecasting performance. I next present data and the specific methods used in this analysis.

2 Method and Data

For each stages of the analysis process, different methods and principles were used. The purpose of the first stage was to reduce the vast amount of potential variables affecting a forecast into a comprehensive set of factors for further testing. For this purpose, a qualitative research method, semi-structured research interview, was used. This method is well suited to exploratory, open ended research1 (Denzin, 2009), such as the projected identification of performance factors. A typical interview began with probing questions about the interviewee's formal position and role in the forecasting process; after that meritory questions were gradually and informally introduced. In order to determine which factors potentially play a significant part in forecasting process, research questions from the following scopes were developed:

- What forecasting methods do you regularly use for sales forecasting? For which variables?
- What are the performance indicators of the methods you or your company regularly monitor?
- What is the most important performance indicator of those monitored? Why?
- What factors affect those performance indicators, considering individual forecasting methods? How?
- Are there any differences between the factors in terms of significance? Do you consider some factors to be more significant and effective than others?

[1] Because of this "open-beginning" conception, where research variables were derived as late as during the first research stage, the bulk of theory overview was postponed until the final discussion, where the model gained its definite outline.

- What kind of relationship exists between significant factors and vital performance indicators? Is it constant, linear, non-linear?

Follow-up questions were asked in relation to important topics, but still in a relaxed manner – the aim was more to regulate forecasters' testimony than to strictly structure it. Most of the interviews lasted about 30 – 40 min and were conducted with just the subject and researcher present. In the majority of cases permission to record the interview was obtained. Otherwise they were recorded using author´s personal notes with a pre-prepared protocol. Respondents were notified about purpose of the interview and surveyed topics in advance, but were not given any concrete questions.

After initial 10 interviews, second phase of the interview was added: the other 10 respondents were confronted with previous findings, in terms of factor choice and presumed effect, but only after they independently made their testimonies like in previous cases. Purpose of this was to gain more detailed insight into forecasters´ perception of potential factors. Following completion of the interviews, all of the testimonies were rewritten and their analysis began. The author and three research assistants went independently through the transcription and made their notes about potential factors mentioned by interviewees. Then, a research meeting was held, where all of the notes were compared and list of all detected factors was written down. In order to qualify into this list, a factor must have been recorded by at least one evaluator – all of the factors were, however, detected by two or more reviewers independently. The key principle here was union of individual notes, not their intersection. After completing the final list of factors, their definitions were also précised, utilizing information provided by the interviewees and know-how established by forecasting literature (Mentzer et al., 1999 paper was found particularly useful).

Table 1: Surveyed companies

Company	Position	Area of operations	Yearly turnover/ market share (Czech. Rep., 2011)[a]	Respondents in the first stage (interviews)	Respondents in the second stage (questionnaire)
Comp. A	Major retailer	Pan-European	47.5 bln. CZK 14.05%	4	21
Comp. B	Major retailer	Pan-European	44 bln. CZK 13.02%	6	33
Comp. C	Major retailer	Pan-European	42 bln. CZK 12.43%	1	42
Comp. D	Major retailer	Pan-European	14.1 bln. CZK 4.17%	2	12
Comp. E	Major retailer	Czech Rep.	25.9 bln. CZK 7.66%	2	9
Comp. F	Major retailer	Pan-European	22.2 bln. CZK 6.57%	0	7
Comp. G	Major supplier of consumer goods	Worldwide	4.4 bln. CZK -	5	24
TOTAL			**200.1 bln. CZK 57.90%[b]**	**20**	**148**
[a]Source: Incoma GfK (2011).					
[b] Excluding Company G, which acts in a different market role.					

Interviewees for the first stage were selected from different positions of the analyzed industry – retail chains. The interviews itself took place in seven companies, which included global pan-

European firms as well as local companies (see Table no. 1 for details). In every company a contact person was appointed and acted as a liaison throughout the whole data collection process. With this liaison officer and managers of the involved departments, a list of potential respondents for contacting was drawn up. The sample was constructed to be both "broad" and "deep" as recommended by Moon et al. (2003), involving people from different company functions as well as from every vertical level of management. A total of 20 respondents participated in the interviews, ranging from executive forecasters/planners and team leaders to department directors – details of the sample are outlined in Table no. 2. An initial group of 3 forecasters was used as a pretesting sample. Their interviews were followed by a feedback discussion based on which the research questions were calibrated in terms of understandability and criterial validity. Afterwards, the bulk of questioning was carried out.

Table 2: Structure of respondents

	Executive Forecaster[c] *(Forecasting specialist, Demand planner, Supply chain planner, Stock controller etc.)*	Team Manager[c] *(Project manager, Team-leader, Unit manager etc.)*	Head of the Department[c] *(Replenishment director, Inventory manager, Sales manager etc.)*	**Total**
First research stage (interviews)	12	6	2	**20**
Second research stage (questionnaire)	119	21	8	**148**

[c] Job titles may differ, but their actual agenda must in all cases have passed the relevancy check - participation in the forecasting process.

The second research stage was aimed mainly at obtaining data describing factors in different forecasting environments. Based on the previous interviews, questionnaire was chosen as the main survey tool, along with the Likert-scale as its main technique. Because the same respondents would provide data both on factor rating and accuracy, the risk of harmful subjectivity (self-evaluation) had to be taken seriously. In order to mitigate this, a diverse and firmly separated approach was adopted. At first, respondents were asked to evaluate all of the factors in their forecasting environment; for this part, scales were set to 5 points from, generally, extremely poor (-2) to extremely good (2). Evaluation of forecasting accuracy was then tailored separately, in two dimensions: respondents were asked to evaluate the accuracy of forecasting methods identified in the first stage, in different time horizons and for different forecast variables. They were also asked to indicate the most prominent (frequent) method in their forecasting environment. Data of the most frequent method would then be used as a pilot performance indicator for the final statistical stage. The scale of this accuracy evaluation was based on MAPE metrics and calibrated on the basis of mean average percentage error with 5 points from very inaccurate (-2) to very accurate (+2). By building a "Chinese wall" between factors and performance and by diverting respondents´ attention towards evaluation of forecasting methods instead of evaluation of their own performance, the risk of subjective self-evaluation was principally avoided. This separation was further strengthened by the accompanying text and guide offered to respondents prior to questioning. On the other hand it enabled the important causal linkage to be preserved between factor and accuracy

evaluation, which is ensured by a single respondent providing both of them.

Respondents in the second stage came from the same company pool as the previous one (yet they were of course different persons). Again, they were all suggested by the department managers, who were asked to submit relevant candidates from their team, in terms of their work qualification (must have been based on sales forecasting) – no other criteria was enforced. After gaining list of all relevant candidates, random choice was applied in terms of final respondents' choice. The questionnaire was submitted either in person (by author or research assistants) or electronically, via a specialized website. In order to ensure proper sample-penetration and satisfy the assumptions of the statistical procedures used (mainly regarding theoretical frequencies), three waves of questioning were employed, spanning from early 2010 to early 2012. During the three waves, relevant personnel from all involved companies were addressed, constituting a survey sample of 148 respondents (n= 148). The sample structure is also outlined in Table no. 1. Again, their working positions varied from managers and supply chain planners to almost pure forecasters, complying with the "broad" and "deep" principle mentioned earlier (see Table no. 2). It needs to be noted that as the estimated number of forecasters in Czech retailers is in the hundreds at most, this sample offers a very substantial representation.

The objective of the third stage was simple and dominated the entire way in which the research was devised: to obtain quantitative evidence of existing relationships between identified factors and the indicator of forecasting performance, i.e. forecasting accuracy. For this purpose, two statistical steps were calculated. To determine the relationship between factors and achieved accuracy in the first step, a battery of two tests (Pearson test, and M-V X2 test) was used, in order to separate significant and insignificant factors. With respect to low theoretical frequencies, a common problem with smaller samples with tight distribution, Cochran´s (1950) rule of thumb was adopted, meaning that no theoretical frequency can drop below 1. Only factors deemed significant were then admitted into the second step, where on the basis of three correlation coefficients (Spearman, Gama and Kendall tau) the tightness of the dependency was evaluated. The significance of the correlation coefficient was also tested (both on $p = 0.05$). The choice of statistical method was determined by the data type (qualitative variables, ordinal) and conducted to achieve maximum provability. For this reason consecutive positive results in both sub-phases (significance tests pass, significance of correlation coefficients) were required to prove the overall significance of the factor. Mutual correlation of individual factors was also examined, to disprove their functional overlaps.

3 Results and Discussion

First the performance indicator that would constitute the dependent side of the research equation was defined. On the basis of testimonies put forward by the vast majority of responding forecasters, sales forecast accuracy in non-financial form was selected. This indicator was determined as the primary parameter of the whole distribution planning process that affects all the manufacturing and inventory decisions. From a research point of view, "pure" accuracy offers additional advantages: it allows the identification of fundamental linkages and relationships on a non-individualized, yet unified scale (Goodwin, 2009) and it is much easier to obtain and measure, in terms of data (Kahn, 2003). On the basis of the interviews and the forecasting conduct they described, Mean Average Percentage Error (MAPE) was chosen as the measurement method for forecasting accuracy.
During the first interview stage, a total of 15 factors were identified. Details of the set and corresponding evidence are outlined in Appendix no. 1. For all of the factors, research metrics (scales) were added and calibrated on the basis of evidence arising from the interviews. This was primarily with respect to situational and personal variables. In some of the organizational factors, individual scales had to be developed to better represent the surveyed

environment – the papers Mentzer et al. (1999) and Mentzer & Cox (1984) were found to be particularly useful here. Table no. 3 outlines results of the final quantitative analysis.

Table 3: Final results

	Significance Tests		Correlation Measurement		
	Pearson χ^2 (p)	M-V χ^2	Spearman	Gama	Kendall tau
Forecasting Method	0.000	0.000	0.181[d]		
Human Judgment	0.007	0.044	-0.185	-0.219	-0.158
Forecasting Horizon	0.000	0.000	-0.460	-0.594	-0.410
Forecast Variable	0.168	0.138	-	-	-
Communication from Superiors	0.039	0.006	0.197	0.221	0.168
Communication Upward	0.000	0.000	0.246	0.286	0.214
Communication from Peers	0.475	0.446	-	-	-
Information System and Technology	0.001	0.001	0.291	0.368	0.255
Team Morale	0.534	0.398	-	-	-
Decentralization of Forecasting Process	0.211	0.152	-	-	-
Management Approach	0.007	0.001	0.177	0.204	0.154
Performance Evaluation	0.005	0.010	0.272	0.292	0.228
Formal Education Level	0.108	0.091	-	-	-
Domain Work Experience	0.295	0.234	-	-	-
Forecasting Work Experience	0.034	0.028	0.300	0.342	0.252

[d] In this case (nominal variable), single Cramer V coefficient was used.

First of all, mutual correlation of performance factors was investigated, using overall correlation matrix. Only few of the dependencies between them overcame correlation coefficient of 0.5: Communication from Superiors x Communication Upward, Management Approach x Communication from Superiors and Management Approach x Performance Evaluation. These are close organizational attributes and certain level of dependence between them is logical and even viable; their introduction into analysis after exploratory research phase indicates that organizational phenomenas they represent are required to be inquired from different perspectives. None of them, however, surpassed 0.7 strength of mutual dependence, preserving them as independent and self-standing performance factors.

A total of six factors were not proven significant during the second stage: Forecast Variable, Communication from Peers, Decentralization of Forecasting Process, Team Morale, Formal Education Level and Domain Work Experience. The omission of Forecasting Variable is definitely the most surprising as it was considered to be a "hard factor"; heterogeneous predictability of different variables was observed regularly, e.g. by Kolassa (2009) or Jain & Malehorn (2006). There can be two explanations for their perceived insignificance here: regional difference, as the survey data originate from the specific Central-Eastern European environment, or immunity of the surveyed forecasting method to different variables.

The significant factors all passed the required conditions of consecutive positive result in both tests (Pearson X2, M-V X2 and significance test of correlation coefficient). The acquired correlation coefficients range from 0.154 to 0.594, reaching a low to moderate dependency strength (Cohen, 1988). However, considering mutual relationships and proportions is from author´s perspective more important than their absolute value; it is also essential to note that the investigated system is of a composite structure and consists of multiple

complementary factors. This is why a complex picture of "small effects" is vital.

The final stage revealed definitive relationships between factors and forecasting performance, supplied by forecasting accuracy. The initial factor, Forecasting Method, precedes the others in an important way: it determines to which method´s accuracy, or data, further results will be tied. It is widely accepted as almost forecasting common sense that forecasting methods have a substantial effect on forecasting performance (Makridakis & Wheelwright, 1982; Armstrong, 1985; Armstrong, 2001b). In this study, Forecasting Method, as a performance factor, was found to be significant with a low, yet undisputable level of dependency (0.181). This sets up the first important pillar of criterial validity of the research concept, as it generally confirms the importance of the literature-heavy, prominent factor with strong theoretical expectations.

The next factor, Human Judgment, is without doubt one of the single most discussed elements of the forecasting world. Originally, many authors (Landa, 1989; Šulc, 1989, but also partially Hanke & Wichern, 2005) presumed that subjective human judgment can in longer time horizons outperform objective (quantitative) methods, which retrospectively excel in the shorter time horizon. Armstrong (1985) and others (Ord et al., 2000; Makridakis et al., 1993) have gradually rejected this widespread theorem and proved that only under very specific conditions can subjective methods match the objective ones. Consequently, the perceived role of human judgment in the forecasting procedure has been degraded, with current practice agreeing on its usefulness only as an adjusting element (Fildes & Goodwin, 2007; Armstrong 2005; Goodwin, 2005; Fildes et al., 2009). In light of this unfavorable development, acquired negative values of association (-0.158 to -0.219) are not surprising. It supports the theses of Goodwin and Armstrong, making Human Judgment minor negative agent of forecasting performance – much weaker than the potent Forecasting Horizon, but still capable of producing negative effects.

Forecasting Horizon is one of the key forecasting parameters and almost part of professional "common sense". There is a strong presumption of an interconnection between time horizon, uncertainty and accuracy, assuming that lengthening of the forecasting horizon will generally result in a decrease in accuracy (Mentzer & Cox, 1984; Granger & Jeon, 2007). With significant, yet negative correlation (-0.410 to -0.594), this presumption was fully verified, constituting the second pillar of the criterial validity.

Both the Communication Line based performance factors, as the information backbone of forecasting, are generally viewed as vital, by some even as critical (Porter et al., 2011; Davis and Mentzer, 2007). On the other hand, some studies virtually dispute such critical position of communication lines, yet still consider it necessary to a certain extent (Moon et al., 1998). Quantitative evidence of its effect is, however, still rather lacking. Even Davis and Mentzer´s (2007) detailed paper does not explicitly cover vertical communication lines, and focuses more on "cross functional communication". Consequently, we could have hardly accepted a higher correlation than exhibited by the hard factors (e.g. time horizon). The vertical communication lines, Communication from Superiors and Communication Upward, both exhibited a similar level of positive association (0.168 to 0.221 and 0.214 to 0.286 respectively), which seems appropriate in light of available expectations and other results.

An information and communication system forms the backbone of a commercial company and its forecasting subsystem alike. Mentzer and Cox (1984) were one of the first to describe this dependence. Numerous other studies soon followed examining various system aspects or software solutions (Kahn and Adams, 2000; Goodwin et al., 2007; Ferrer, 2008). Among the more specific outputs, Mentzer et al. (1999) defined "systems" as one of the four dimensions

that determine the forecasting process and observed four stages of its development, stressing its importance in the sales forecasting process. Davis & Mentzer (2007) paid considerable attention to different aspects of information systems, including information technology and information processes, making meta-factor information logistics by far the most frequent in their content analysis. The results produced by presented survey largely support this thesis. ICT was found to be the second most effective factor among the examined set, with association ranging from 0.255 to 0.368, which sometimes exceeded weaker factors by 0.1. Considering that the association level among organizational factors averages around a value of 0.23, this makes ICT one of the main factors of forecasting performance.

Management Approach completed the triangle of three factors with strong mutual interconnections. Contrary to vertical communication Management Approach is considered to be more "executive sponsorship" of senior management than pure technical communication (Moon, 2008). Generally, and not only in forecasting, management approach is one of the key pillars of organizational effectiveness (Jain & Malehorn, 2006; Watson-Jones, 2008; Wader & Moon, 2008). Therefore, this factor was expected to achieve at least an above-average correlation rating. With results ranging from 0.154 to 0.204, this presumption was not confirmed. Management Approach was identified as a minor agent of forecasting performance, with the weakest – positive – effect of all the surveyed factors. This supports Davis and Mentzer´s (2007) quantitative results on coincident "leadership support", which was rated as rather mediocre and counted as sixth out of ten surveyed factors (5.5% of total content units).

Performance Evaluation and remuneration procedures enjoy an important position in every management system and there is abundant evidence that the situation in forecasting follows the same line (Moon & Mentzer, 1999; Dhuyvetter, 2005; Moon et al., 2003 or Goodwin, 2007). Performance Evaluation is assumed to be a particularly important part of these procedures. In Davis and Mentzer's (2007) study, the factors of Reward Alignment and Performance Measurement accounted for a combined score of 18.08%, pushing this meta-factor into third place in terms of importance. In presented research, Performance Evaluation was rated as the second most effective factor of the organizational sphere with association measures from 0.228 to 0.292. With regards to theoretical expectations, this result is a bit of a contradiction. On one hand, it puts Performance Evaluation on top of the organizational factors. But the difference between them, with the exception of Management Approach, is very small, and furthermore, the survey failed to promote Performance Evaluation to any position distinctively higher than other organizational factors. It does not reach anywhere near the presumed effect of the "hardest" factor, Forecasting Horizon.

Forecasting Work Experience is the sole representative of the personal sphere among the significant factors. As opposed to the related factor, Domain Work Experience, which resembles domain knowledge as defined by Armstrong (1985), Forecasting Work Experience is more linked to professional experience in forecasting, potentially across different stages in a professional career. According to Roebber & Bosart (1996), forecasting skill is largely determined by past experience, at least in the context of weather forecasting, similar dependence was also reported by Cho & Hersch (1998). In general, Forecasting Work Experience itself is rarely covered by forecasting surveys, yet it integrates many vital outcomes to its bearer (Winklhofer, 1996; Fildes et al., 2008). Therefore, expectations for this factor were positive, with uncertain prediction of association level. However, the results acquired surpassed most of the other factors. With perceived association ranging from 0.300 to 0.342, Forecasting Work Experience is rated as one of three most influential factors, competing with ICT for second position. Such an outcome supports the thesis of Roebber and Bosart, making

Forecasting Work Experience one of the major factors in the set.

4 Conclusions

This paper analyzes the effect of different factors on sales forecasting accuracy in retail supply-chains. Using the individual assessment of forecasters, a set of factors was identified through a qualitative interview process, and these factors were subsequently tested (i) for their significance with respect to forecasting performance embodied by forecasting accuracy and (ii) to determine the magnitude and direction of the effect they have. Overall, the results only partially corroborate the conclusions of Davis & Mentzer´s (2007) study. While the importance of sales forecasting climate was disputed (in Davis & Mentzer´s design it comprises leadership and reward alignment, whose mirror factors in this research were found to be important, along with credibility of sales forecasting, which is closest to team morale, deemed unimportant), the significance of a shared interpretation of the sales forecasting information was not confirmed, and was in fact largely rejected by presented research. On the other hand, the prominence of performance measurement/evaluation was fully verified, supporting its firm position in the forecasting system. While this study and Davis & Mentzer´s research differ noticeably in their main modus operandi, i.e. analytical method, these differences provide an interesting perspective of factual or regional variance. The research implication of this schism will be discussed later in this chapter.

4.1 Implications for practitioners

As for practical implications, the research highlighted four main messages. First, in order to improve sales forecasting performance, managers should employ a comprehensive, integrated management system. The research confirmed that a forecasting system does comprise powerful performance agents, mainly in the situational sphere (forecasting time horizon); these are, however, largely set implicitly by the forecasting task and have to be accepted as they are. As for organizational and personal factors, the main variable basis of a management system, the findings of this study imply that none of them are dominant and they are all similar in effect. Such homogeneous association matrix, along with the data acquired through interviews, form the main argument for the thesis of a comprehensive management system. Focusing on excellence in a limited number of factors, while omitting the rest, would therefore meet with limited success. Some forecasters have even deemed this strategy potentially harmful and damaging in the long term. While it requires more sophisticated investigation and separate management research, it is highly advisable to ensure the proportional development of all aspects of a forecasting system.

Second, contrary to some previous beliefs, research has indicated that horizontal-social factors, such as Communication from Peers and Team Morale, are not critical factors within a forecasting system. Results imply that the "harder" of the organizational factors, such as formal vertical communication or Information Systems, were the major pillars of the performance asset. While author would definitely not recommend omitting social factors in any forecasting department, a more correct interpretation would be that these should be not considered among the primary drivers of forecasting performance – the set of crucial management tools, which constitute the core of the integrated system mentioned in the second paragraph. They should be maintained at an appropriate level, but not developed to a disproportionately high standard of excellence, as this will not result in performance improvement.

Third, as part of a comprehensive system, increased attention should be given to a pair of its components: Information System and Performance Evaluation. From a general, quantitative perspective, these factors retain an ordinary, slightly above-average position among the other factors. However, according to the forecasters´ testimonies from the interview

phase, these factors have strong negative potential in the event they are allowed to deteriorate below an admissible critical level. In the case of Information Systems, a failed implementation, disrupting the tried and tested forecasting routines, reportedly led to forecasting errors worth of millions of Czech crowns, creating important planning and manufacturing issues. Whole incorrectly planned shipments had to be dumped, resulting in substantial tension in the supply chain. Prolonged reliance on a low-level information system (most notably an ordinary desktop processor) was also reported to be a major deterrent to forecasting performance improvement, even though other factors were gradually improving. Performance Evaluation is also reported to be a notorious forecasting performance wrecker, which if mishandled, might lead to the effect of "sandbagging" or "over-confidence". All in all, these two factors deserve special attention – while they might be routinely utilized in a well-developed and stabilized system, if underdeveloped or mishandled, they can cause considerable damage to forecasting performance.

Finally, the research touched on the issue of personal settings of a forecasting system. Unfortunately, no decisive results on this matter were produced. While it was determined that Formal Education and Domain Work Experience do not significantly affect forecasting performance, only Forecasting Work Experience was found to have significant, effect, comparative with Information System and Technology or Performance Evaluation. However, the implication of this finding should not banish formal education and domain experience criteria from a company's recruiting and management scheme. The first factor is reportedly one of the main factors easing the adaptation to a new environment and technology, while the latter is a long-promoted agent of forecasting performance by many, putting the outcome here in a somewhat uncertain light. Overall, the most appropriate message here would be that Forecasting Work Experience, not education or domain experience, should be the main personal factor in structuring the forecasting team; putting people with substantial experience preferentially in senior positions, as long as other important criteria (such as communication, technical skills etc.) are met.

4.2 Directions for future research

The correlation analysis proved sufficient significance and association between the chosen measure of forecasting performance and the selected factors. However, it did so with two potential limitations: the analysis took place (i) with a strong regional focus and (ii) with a limited set of performance factors. The first point offers the most obvious and perhaps the most exploitable implication for future research. Presented study thoroughly investigated the situation in the Czech retailer sector and, to a certain degree, in the Central-Eastern European sector (although the majority of the surveyed companies have global reaches). While achieving a substantial level of detail and penetration, such regional focus creates a natural level of limitation. Future research is needed to verify results in different regions and to confirm their validity in a regional sense.

The second research limitation is related to a set of factors examined during the analytical phase. Although the research concept was constructed as fairly open, and great effort was put into openness in first research phase, where the potential factors were identified, inevitably some level of simplification took place. While we might consider this level to be totally appropriate, as confirmed by the overall criteria validity of the research, i.e. agreement between findings of concurrent studies and the derived set of factors, the obvious dynamics of management systems prompts us to undertake the iterative work of introducing and testing additional, new performance factors. In this sense, the paper offers a basic framework of findings on performance determination, which could structure future research and should be supported by continuous work in an extensive (verification of new possible factors) as well as intensive (re-evaluation of current factors) dimension.

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Appendix 1: Overview of research variables (performance factors)

	Measurement Method	Qualitative survey (interviews) reference	Theoretical reference	Hepothesed effect
Forecast Accuracy	5 point MAPE based scale • Very accurate (0 – 5% MAPE) • Accurate (5 – 10% MAPE) • Rather accurate (10 – 15% MAPE) • Inaccurate (15 – 20% MAPE) • Very inaccurate (20%+ MAPE)	-	-	-
Forecasting Method	Predetermined four options: (1) Time series method (2) Time series method adjusted by individual judgment (3) Time series method adjusted by group judgment (4) Pure individual judgment	Mentioned in 18 interviews in total (company A, B, C, D, E, G).	Makridakis & Wheelwright, 1982; Armstrong, 1985; Armstrong, 2001a; Makridakis & Hibon, 2000	Forecasting method is a significant factor with moderate association strength.
Human Judgment	5 point Likert scale • Very small (0 – 10% adjustment) • Small (10 – 20% adjustment) • Limited (20 – 30% adjustment) • High (30 – 40% adjustment) • Very High (40% + adjustment)	Mentioned in 15 interviews in total (company A, B, D, G).	Ord (2000) ; Makridakis et al. (1993) ; Fildes & Goodwin (2007); Armstrong (2005); Fildes et al. (2009)	The level of human judgment is negatively associated with forecasting accuracy.
Forecasting Horizon	Predetermined 3 options: (1) Short (< 6 months) (2) Medium (6-12 months) (3) Long (> 12 months)	Mentioned in 19 interviews in total (company A, B, C, D, E, G).	Armstrong (1983); Mentzer & Cox (1984); Granger & Jeon (2007); Armstrong (2006)	The length of forecasting horizon is negatively associated with forecasting accuracy.
Forecast Variable	Predetermined 3 options: (1) Fresh meat products (2) Fresh fruit and vegetables (3) Non-fresh food and beverages	Mentioned in 16 interviews in total (company A, B, D, G).	Wertheim (1989); Kolassa (2009); Jain & Malehorn (2006); Catt (2009)	Fresh component in forecasting variable is negatively associated with forecasting accuracy.
Communication from Superiors	5 point Likert scale • Extremely poor (-2) • Poor (-1) • Average (0) • Good (+1) • Extremely good (+2)	Mentioned in 13 interviews in total (company A, B, G).	Davis & Mentzer (2007); Gilliland (2005); Sanders (2005); Fildes & Hastings (1994); Mentzer & Moon, (2005)	The level of communication from superiors is positively associated with forecasting accuracy.
Communication Upwards	5 point Likert scale Extremely poor (-2) – Extremely good (+2)	Mentioned in 11 interviews in total (company A, B, G).	Davis & Mentzer (2007); Gilliland (2005); Sanders (2005); Fildes & Hastings	The level of communication upwards is positively associated with forecasting

			(1994); Mentzer & Moon, (2005)	accuracy.
Communication from Peers	5 point Likert scale Extremely poor (-2) – Extremely good (+2)	Mentioned in 11 interviews in total (company A, B, E, G).	Wheelwright & Clarke (1976); Sanders (1995); Moon et al., (2003); Koster (2005); Lapide (2003)	The level of communication with peers is positively associated with forecasting accuracy.
Information System and Technology	5 point Likert scale • No distinct forecasting software, only common office SW • Basic forecasting software, not connected to MIS and other corporate IS • Basic forecasting system connected to MIS and other corporate IS • Advanced forecasting system not connected to MIS and other corporate IS • Advanced forecasting system connected to MIS and other corporate IS	Mentioned in 14 interviews in total (company A, B, C, G).	Kahn and Adams (2000); Goodwin et al. (2007); Ferrer (2008); Smith (2009)	The level of information system and technology is positively associated with forecasting accuracy.
Team Morale	5 point Likert scale Extremely poor (-2) – Extremely good (+2)	Mentioned in 13 interviews in total (company A, B, E, G).	Jain (2005a); Mello (2005); Davis & Mentzer (2007)	The level of team morale is positively associated with forecasting accuracy.
Decentralization of Forecasting Process	5 point scale • Solo forecast preparation (-2) • Is recommended and used to consult with other forecasters (-1) • Is obliged to consult other forecasters, but retains decision about final forecast (0) • Installed formal mechanism to involve other departments, forecaster retains strong influence on final forecast (+1) • Installed formal mechanism to involve other departments, final forecast developed jointly (+2)	Mentioned in 11 interviews in total (company A, B, D, G).	White (1986); Moon et al. (1998); Sanders and Manrodt, (1994); McGill, Slocum, & Lei (1992)	The level of decentralization of forecasting process is positively associated with forecasting accuracy.
Management Approach	5 point Likert scale • Very low level of support, no recognition of forecasting among other business procedures (-2) • Low level of support, but forecasting is recognized as self-standing special business procedure (-1) • Mediocre level of support, forecasting is recognized and managed as a separate function, but within common management system (0) • Good level of support, forecasting is managed as a separate function and within common management system, but with distinctive deviations (+1) • Very good level of support, forecasting enjoys attention of top-management and is managed via special designed management system (+2)	Mentioned in 9 interviews in total (company A, B, G).	Sanders (1995);Wader & Moon (2008);Jain & Malehorn (2006); Watson-Jones (2008)	The level of management approach is positively associated with forecasting accuracy.

Performance Evaluation	5 point scale (inspired by Mentzer et al.,1999) • Forecasting accuracy not measured, evaluation based on non-accuracy criteria (-2) • Forecasting accuracy measured, yet evaluation based primarily on non-accuracy criteria (-1) • Forecasting accuracy measured, evaluation based on accuracy without further implications (0) • Forecasting accuracy measured, evaluation based on accuracy with recognition of further implications (inventory level, financial and marketing plans) (+1) • Evaluation based on multidimensional metrics of performance, i.e. impact of accuracy on business goals (+ 2)	Mentioned in 15 interviews in total (company A, B, D, E, G).	Sanders (1995);Moon & Mentzer (1999); Dhuyvetter (2005); Goodwin (2007)	The level of understandability of evaluation is positively associated with forecasting accuracy.
Formal Education Level	Four options (undergraduate, professional college, university, postgraduate)	Mentioned in 11 interviews in total (company A, B, D, G).	Cerullo & Avila (1975); Mentzer and Cox (1984); Davidson (1987); Sanders (1995); Lapide (2003)	The level of formal education is positively associated with forecasting accuracy.
Domain Work Experience	Four options: (1) 0 – 4 years (2) 5 – 9 years (3) 10 – 14 years (4) 15- 19 years (5) 20 + years	Mentioned in 9 interviews in total (company A, B, G).	Avila (1975); Davidson (1987); Jain (2005); Jain (2006)	The length of domain work experience is positively associated with forecasting accuracy.
Forecasting Work Experience	Four options: (1) 0 – 4 years (2) 5 – 9 years (3) 10 – 14 years (4) 15- 19 years (5) 20 + years	Mentioned in 10 interviews in total (company A, B, G).	Adya et. al. (2000);Armstrong and Collopy (1992); Sanders & Ritzman (2001); Armstrong & Cuzán (2006)	The length of forecasting work experience is positively associated with forecasting accuracy.