

Short and medium term forecasting of the temperature-controlled hauling activity

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Abstract. This article proposes an approach for the design, implementation, and full deployment of an activity forecasting system. These types of systems help to optimize human and material resource planning. A methodology to integrate, analyze, and forecast economic indicators is put forward. This methodology was successfully applied for an international temperature-controlled transport group.

1 Introduction

“Governing is foreseeing”, this maxim is also justified in economics. To adapt their strategy to economic crisis, businessmen try to anticipate the activity of their businesses. It has now become a strategic issue. To run a business, the managers need prospective information, such as growth, yield, and operational indicators. The objective of forecasting is to create a cost-management program through human and material resource control according to forecasted needs.

Forecasting is not a simple matter. To this, the crisis adds a lack of visibility, as well as economic and financial uncertainty, and causes economic players to be more cautious. Yet, when sharing the vision they have of the future, the directors also put their credibility at stake. However, forecasts are also of a reassuring nature which provide a vision through which action can be taken. If the forecasts give a pessimistic view, then they lead to a cost-cutting program, whereas if they give an optimistic view they lead to investments.

This article intends to study the design, development, and implementation of a forecasting system. Through the case of STEF-TFE (<http://www.stef-tfe.fr/index.en>), the French leader in cold logistics, the article puts forth a rigorous forecasting development process. The results obtained in this study have helped to validate this process.

2 Implications of Activity Forecasting

Fresh product retailing works on demand pull, (Spearman and Zazanis, 1992). Supply must reach the shelves without having to keep stock. Manufacturers answer the daily orders of supermarkets to supply their warehouses. The quantities of provisions fluctuate daily according to supermarket check-outs. To deal with this, major food industry companies set forth sales

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forecasts, on a monthly, as well as daily basis, (Russo and McLaughlin, 1992). The first chain in the logistic chain is sales forecasting. This forecasting must be as close to reality as possible. It gives a decisive competitive edge on the market where the keyword is “just-in-time”, (Zimmer, 2001). Thus, companies use sales forecasting as a tool for the just-in-time supply of distributors.

What should do the carrier? In the logistics chain, the carrier is between the manufacturer and the supplier. To satisfy the transport demand of goods between the various actors, the carrier must also forecast sales.

Due to the perishable nature of the goods, as well as the constraints linked to maintaining the cold chain, (Bogataj et al., 2005), a temperature-controlled goods carrier, is obliged, even more so than others, to forecast sales to limit losses. For STEF-TFE, activity is forecasted rather than sales as it is a consequence of sales. A brief description of how the carrier is organised will clarify activity forecasting issues:

- Shippers give their orders to a carrier every day for same-day transport.
- Transport orders come in by fax or EDI (Electronic Data Interchange) at 7 a.m. to be picked up from the shipper between 8 a.m. and 12 a.m. This is called collection round.
- The goods that have been picked up are unloaded on the hub of the STEF-TFE hub to be grouped together according to destination. This is called consolidation.
- The consolidated goods are dispatched between 6 p.m. and 10 p.m. over all of France.
- The network hub to whom the goods are dispatched and who deliver them to their final destinations are called deconsolidation agencies. Every day, around 7 p.m., through EDI, they receive the waybills to deliver.
- After deconsolidation, the delivery round takes place between 8 a.m. and 12 p.m., before the pick-up round.

Thus, in 90% of the cases, the hub receives the consignor’s transportation orders in less than 3 hours before the goods are picked up. It, therefore, has little time to get organised. To be constantly available for its clients, the hub offers a transportation plan which includes pick-up hours from the shippers and arrival hours in function to destinations. For STEF-TFE, the challenge is to sufficiently pre-determine:

- the number of trucks to schedule for the pick-up, dispatch, and delivery rounds,
- the number of warehousemen on the hub to handle the goods from the pick-up rounds or received from network dispatching.

Moreover, the quantities to be transported can vary between 1 and 10 from one day to another due to sales promotions which disorganise transportation scheduling. As clients do not share information on the promotional timeframe, the carrier must be able to forecast it. Furthermore, STEF-TFE uses temporary employment to meet activity variation which is quite costly, and therefore must be cut. To anticipate rather than undergo the activity, forecasting the **weight of the goods to be transported** and the **number of waybills to be fulfilled** is a decision-making tool that could be very useful. On the one hand, STEF-TFE would be able to determine the number of trucks to put on the road in function to the weight of the goods to be transported and the number of waybills to be fulfilled. And on the other hand, STEF-TFE would reduce the weight of the goods to be transported, the number of waybills to be fulfilled, and the number of **productive hours on the hub**. The project to implement a forecasting system for the STEF-TFE hubs is called “**Horizons**”.

3 Forecasting Model

The first step was to create a mathematical model to integrate, analyse, and forecast economic indicators. This model was tested on a large scale. It was validated by the results obtained and it was reused to foresee other performance indicators.

The challenge of “Horizons” is to propose a statistics model for hub activity forecasting which is adapted to over 70 STEF-TFE hubs, and to implement the model through a computerised application to integrate it into the operational workflow. This is a step towards a concentrated approach, meaning that activity forecasts will be centralised in a single department. The activity of transportation hubs is depicted through the following daily reports:

- daily total number of waybills
- daily total weight of goods to be transported,
- daily number of waybills for a given distribution round,
- daily weight of goods to be transported for a given distribution round,
- daily number of waybills for a given shipping round,
- daily weight of goods to be transported for a shipping round.

To meet the scheduling expectations of the resources, the following must also be forecasted:

- daily total number of productive hours on the hub,
- daily number of productive hours on the hub to handle goods for distribution,
- daily number of productive hours on the hub to handle goods for shipping.

Implementing activity indicator forecasting in the STEF-TFE transportation hubs proved difficult. In fact, these indicators result from chronological events which not only have factors of a deterministic nature (bank holidays, school holidays, geographical zones), but also of a stochastic nature (weather, strikes, economic market, impact of the news on consumer behaviour). Forecasting also requires the use of statistical and probabilistic modelling. There is no ideal method for forecasting sales. Using the principle that two is better than one, two decomposition methods are used here to extract the better of two. The added value of this forecasting model is that it adapts to the specificities of each hub. It is implemented to be executed without human intervention. The model is based on advanced mathematical algorithms, the principle of which is to project past events onto the future. For more details on the forecasting mathematical model, see Despaigne (2010a).

4 Graphic Interface

The graphic interface developed in thin client is meant to reproduce forecasting results in a clear and useful manner. The reproduction environment must be user-friendly, simple, and clear. It must produce what the user is used to seeing. It should not seem complicated and repel the user. This is why the data which accompanies the forecast is displayed according to the level of understanding of each user.

The objective is to make this application a decision making tool. More than just a forecasting tool, it makes it possible to analyse a hub’s activity throughout time. These graphic options help one to see at a glance a typical data set, activity lows and highs. The management charts are made to be able to go into more detail. They give information on the accuracy of past forecasts. The tool contains a scheduling module. It gives the activity and the forecasting indicators schedule resources and the measure of profitability. The forecasting system’s graphic inter-

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face is a solution that is complete, powerful, and easy to interpret for predicting and scheduling the hub's activity. The “Horizons” tool should make work scheduling easier, quicker, and more reliable. The interface must be able to post, instantaneously, information extracted from tables which can have over 6 million records.



FIG. 1 – “Horizons” Homepage

Figure 1 shows the home page of the forecasting tool. A short test reminds the user of the objective of the tool and the information that he/she will find there. There are hyperlinks to online help. They answer the following questions: How did the project begin? What are the main properties of the forecasts? What mathematical and algorithmic methods were used? What computer tools were used? Which were the pilot hubs? How do you use forecasts?

The application is protected, that is to say to have access to real and forecasted data, the user must identify him/herself. Some information is subject to access rights. After authentication, the user chooses from a drop-down list box, the hub he/she wants to consult. The web page is divided into 3 different part (see figure 2). A column on the left gives the navigation menu. A graphic header gives an overall, rapid and synthetic view of the data listed below. The part which lists the data is under the graphic frame.

Each indicator (tonnage to be transported, shipped, distributed, number of waybills for transportation, shipping, distribution) is illustrated with three curves: real, model forecasting, and user forecasting. The graph is interactive. Once the user approaches a point (intersection between days on the abscissa and data value on the ordinate) using the mouse pointer, a rectangular box pops up to give details relative to this point: date, real datum, forecast, correction, difference in percentage according the real datum (see figure 2). The listed data are arranged in the tables. The user has the choice to show between 2, 5, and 10 weeks of data.

The tables of detailed data provide, for each day of the week, the result of the previous year at the same time period. This information is very important. Not only does it enable the user to compare the current information to the information of the previous year, but it is also a referent to validate the forecast. Indeed, the calculation engine is still mechanical, it can get jammed. This is why the user must validate the forecasts or give an ajustement of it (see section 5).

Despaigne W.

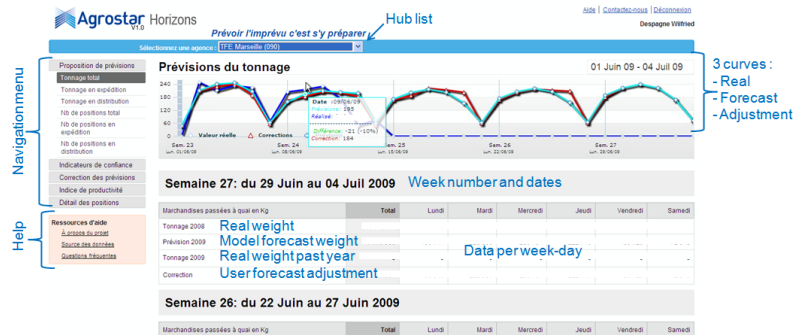


FIG. 2 – “Horizons” forecasting tool’s daily forecasting proposition

Maintaining a goal of transparency, the graphic interface of the “Horizons” tool gives all of the statistics to describe the performance of past forecasts (voir figure 3). Forecasts always have uncertainty and inaccuracy. It is important to evaluate the rough estimate and to communicate it to the users, (Forslund and Jonsson, 2007). The performance statistics are available for any of the set sizes and for any time range.

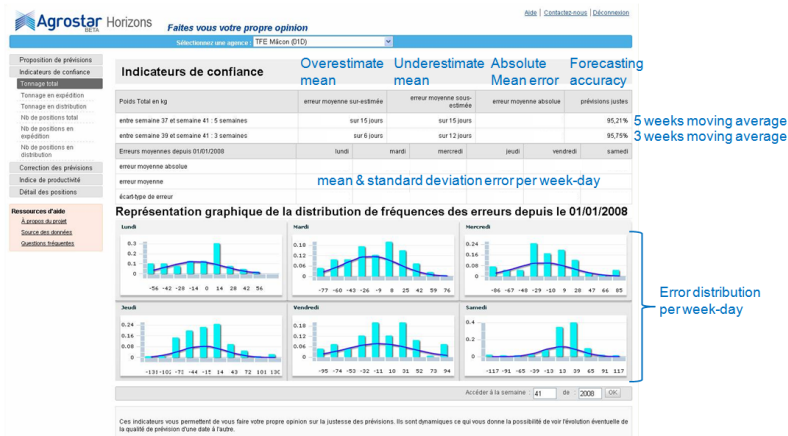


FIG. 3 – Accuracy indicators of the “Horizons” forecasting tool

The “Horizons” graphic interface proposes a collaborative forecasting window. It can help to fit and validate each of the forecasts proposed over a week. A pattern should appear for each adjustment. The adjustment patterns are chosen from a list: earnings portfolio, losses portfolio, commercial event, holiday, beginning of the month, end of the month, seasonal op-

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eration ... After a year of gathering information, the forecaster can perfect the forecasts. For example, knowing that at the same time period the previous year a sales promotion took place, the system should send a warning message to ask if this promotion will happen again. If such is the case, it takes it into account in the forecasting calculation.

After presentation of the interface at the pilot hubs, the ergonomics of the site was not an issue, on the contrary, it seemed to please a large number of the users. However, one question constantly came up: what is the source of the data? As long as the users do not understand how the data is calculated and how it is linked to the numerous indicators already in place in the information system, they will not use the forecasting tool. In fact, to make it easier for them to accept the tool, it is crucial that the data posted is reliable, homogeneous, and of controlled quality. Having access to a forecast is not enough, the interpretation and use of the forecast depends on the quality of information given Forslund and Jonsson (2007). Two new pages have been created to get the user to accept the presented information. A help page gives the definition of the information, its calculation rule, and its sources. Another page lists all of the waybills taken into account in the provided indicators. The user can, therefore, verify all of the posted data himself. This will make it easier for him/her to accept the given data.

5 Instructions

A forecasting system is not only a computer tool or just a mathematical model. It is all a complete method of organization and a group of procedures that are to be implemented in a business, (Moon, 2006). The quality of a forecasting system is first of all a question of management. A procedure must be defined, through which the forecasts will be read, interpreted, and used.

Forecasts are used for different purposes. Department heads use them to make scheduling more effective, hub heads use them to draw up a budget and set objectives, marketing people use them for follow-up with customers. Users will understand forecasts differently according to the use he/she has for them. He/she will prefer the monthly forecast for the medium-term to the daily forecast for the short-term, or vice versa. That is why "Horizons" proposes monthly forecasts over 24 months and daily forecasts over 70 days.

The reliability of the forecasts depends among other things on the mathematical model, and on the reliability and volatility of the input data. Therefore, the forecast figures should not be taken at face value. They are a base that is to be discussed and adjusted during review board meetings, the objective of which is to consolidate the forecasts for the hubs. As noted by Fildes et al. (2006), statistical forecasts, in an operating environment, should be adjusted and confirmed by experts in the trade.

Figure 4 shows the sequence of operations which is group of necessary steps to make an accurate forecast that is acceptable for all of the players. The series history to be forecasted is extracted from the databases. The forecast processor is based on the hypothesis that the activity of the transport hubs, as well as their environment, are stable. In other words, that the future will most likely unfold similar to the past, taking a progressive evolution of the phenomena studied into account. The forecasting algorithm does not take into account the internal structural modifications of the hubs or the company, nor short-term market changes linked to hauling. Forecasting methods are unfortunately not perfect and are not meant to be purely mathematical exercises without economic content, (Gordon, 2010).

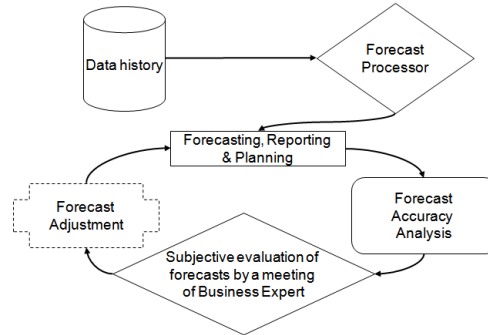


FIG. 4 – “Horizons” forecasting system: method of use

To compensate for the absence of qualitative data, transport hubs are advised to place activity forecasts on the agenda of weekly meetings. The weekly meetings are usually organised to deal with past, present, and future problems. The heads of the commercial, management, hub, and operating services are present; they make up the review board. No one can claim to have better knowledge of the the transport hub activity than each of the heads of services. Thus, the experts use their judgement to validate or adjust the proposed forecasts. The “Horizons” application also gives them reports which help them to make a carefully thought-out decision. The quantitative reports along with the exchange of qualitative information from the various services of the hub should make it possible to get as close as possible to the real future value.

Moreover, like the forecasting timespan, the forecasting error is not seen in the same way by all of the forecast users. First of all, for the forecaster, a +5% error is the same as a -5% error. Error distribution is around 0 and that is what matters. However, the operator will care more about one or the other, according to the human and material means he has available to handle the forecasted activity. A positive error (the forecast is higher than the realized activity, see figure 3 - over and underestimated error) costs the hub money, because too many workers would have been scheduled to come in, but it would have been able to answer the demand, which is essential for its reputation. An error inferior to zero makes the hub push the activity of one day forward to the next, due to lack of means. Too few workers would have been scheduled to handle the real activity.

Then, transport hubs are advised to set an average error tolerance in function to the productive hours it has. For example, a forecasting error of 10% is less than 8 productive hours, which is acceptable because the head of scheduling does not have to call in one more or one less person for the given period.

6 Conclusion

The design, development, implementation and deployment of the forecasting system was done within the framework of a PhD research, (Despaigne, 2010b). The “Horizons” forecasting system is, still today, used in all of the STEF-TFE transport hubs. It is also used in production

meetings and budget presentations. User feedback is very positive, they see the productivity gain that the tool can bring.

Beyond the precise context of the STEF-TFE group, the produced methodology was also generalized. This methodology is useable in various industrial sectors and notably, those which are part of a logistic chain. The forecasting mathematical model needs to be adapted, but the environment analysis, organisation choices, project management, computer development, personnel training, and communication are exportable.

Although a forecasting system gives a competitive edge, it is essential to remember that forecasting in a business is neither a decision made by a manager, nor a number that comes from a blackbox, but a group of tools, of procedures, of organisation which make it possible to come to a reliable forecasting result.

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Summary

Donner la traduction anglaise du résumé dans le préambule avec la commande `\summary{Your abstract ...}`