Abstract

Punctuality is a key quality indicator for railway operators. The importance of punctuality will continue to increase while the general conditions for punctuality will become tougher [1]. For years, the French National Railway Company (SNCF) has proposed commercial compensations for delayed travelers. Recent evolutions of European regulations [3] set up compulsory such compensations for all operators.

Dealing with regularity, two caricatured approaches exist: "operator approach" and "customers approach". Whereas the first approach is used by all railway operators, the second one is more complex to implement because train delays are to be joined with commercial information. Moreover, in order to provide precise indicators to help management and efficiency, economical issues have to be addressed.

This research provides a new internal tool to analyze operational delays, including economic points of view. It is divided into two parts:

- The first part provides an internal tool to measure, analyze and to help management of operational delays, taking into account travelers and economical points of view.
- The second part develops an anticipation model, in order to optimize organization for processing the compensation demands.

In order to help management and adopt more actual indicators, this study make possible to systematically and automatically adopt and include travelers and economical points of view when dealing with punctuality.

To help economic management of punctuality

The objective of this work was to systematically include economic aspects in the management of punctuality. The economic consequences taken here into account are the compensation of customers (see below), but this approach can easily be extended to others economic aspects (e.g., passengers or operators).

This new approach allows changing from an "operator approach" considering delayed trains and delayed minutes to a "customers approach" considering delayed customers and economical impacts.

The Figure 1 shows the sequence of events:

- an incident occurs: this incident affects a specific resource (track, train, station team, etc.);
- this incident may cause delays to a first train (in some cases, incidents do not cause delays);
- delayed minutes may be also delayed indirectly if the train arrived with delay in their stop station or other trains in these trains may be also delayed if the train arrived with delay in their stop station (delay may concern only some stations deserved by the train);
- if compensation rules apply (taking into account the origin and the delay of [3]), customers may ask for an economic compensation.

In order to help management and adopt more actual indicators, this study make possible to systematically and automatically adopt and include travelers and economical points of view when dealing with punctuality.

Dealing with regularity, two caricatured approaches exist: "operator approach" and "customers approach". Whereas the first approach is used by all railway operators, the second one is more complex to implement because train delays are to be joined with commercial information. Moreover, in order to provide precise indicators to help management and efficiency, economical issues have to be addressed.

This research provides a new internal tool to analyze operational delays, including economical points of view. It is divided into two parts:

- The first part provides an internal tool to measure, analyze and to help management of operational delays, taking into account travelers and economical points of view.
- The second part develops an anticipation model, in order to optimize organization for processing the compensation demands.

In order to help management and adopt more actual indicators, this study make possible to systematically and automatically adopt and include travelers and economical points of view when dealing with punctuality.
The objective was to reverse this sequence such a way to be able, for each incident or type of resource to provide economic consequences (total euros involved and actually paid to the customers). With these indicators, the objective is to help to a better responsible and customer-oriented management of punctuality.

In order to compile these economic indicators for punctuality, we use several source of data, such as described in the Figure 2:
- incidents and trains delays are provided by operational supervision traffic systems
- number of people for each route in each train for all days are provided by reservation systems
- historical compensation data are provided from the compensation system
- more detailed information about incidents are provided by specific systems

Provided indicators combined three choices:
- the “spatial” dimension: a train, a specific line, group of lines, etc.
- the “temporal” dimension: a specific day, a month, a year
- the variable of interest: number of delayed customers, compensated euros, etc.

Others indicators are provided about incidents, stations, journeys, etc.

**PEPS : an intranet tool to help economic management of punctuality**

This new approach has been implemented in an operational intranet tool which allows all authenticated users to consult indicators. In this way, all indicators are automatically and daily computed and can be easily consulted. This new tool provide to all users to get the same information up to date. Same indicators are shared by all and for all the aggregate levels (spatial and temporal dimensions).
Challenge D: A world of services for passengers

**Figure 3:** Examples of screenshots of the PEPS intranet interface

Indicators are provided from several points of views:
- very synthetic such as monthly evolution,
- intermediate views such as consequence for a given incident
  or to a very detailed view: station stop for a specific train for a specific date.

The interface offers to easily navigate between these points of views from very synthetic view to very detailed one.

All these indicators form an actual tool to help decision: specific context (spatial and/or temporal dimension) with bad results can be easily identified and analysed (with help to the resource aspect). The economical may also help to take decision for specific action or investment.

**An example to prove the interest of data visualization**

Taking benefit of the large database gathered for the previous work, the SNCF Innovation & Research department proposed an innovative interface to consult punctuality data. It can be quite difficult to have a synthetic view of the punctuality and economic impacts: because numerous data are involved and these data are quite complex to analyze under all their dimensions: time, space, economic, etc.

The Figure 4 shows a screenshot of the innovative interface: it provides a full interactive synthetic view of the 5 minutes punctuality for a two-year period for all the compulsory reservation trains (more than 100 millions customers per year). When the user scrolls over days, more detailed information are given: total number of customers, repartition into groups of lines, number of delayed customers, economic aspects and spatial repartition by station of the arrival of delayed customers is provided through a map.
Challenge D: A world of services for passengers

Figure 4: Screenshot of the innovative interface

Such a synthetic view demonstrates how to provide great amount of data in such a way to help decision:
- in a glance, bad/good lines or bad/good days can be identified,
- once interesting parts are identified, “zoom” into data allows to get more details when is needed.

To anticipate compensation demands

The last part of this research investigated elaboration of a practical anticipation model in order to help to process the compensation demands.

Figure 5: The process of customer compensation

As shown in the Figure 5, the process of delayed customer compensation has several steps:
1. When a delayed train is under compensation rules, envelopes are given to the delayed customers in the train or in the station, when they arrived.
2. Customers complete the form and send theirs original tickets (or ticket reference for e-ticket) with the furnished envelope.
3. Envelopes are received in the punctuality centers
4. Punctuality centers have 21 days to provide the right answer to the customer and compensate them if needed.
In order to better manage the punctuality centers, a key point is to anticipate the number of customer folders which will have to be treat in the next days or week. This number varies a lot because it is deeply connected with past delayed customers: some days very few demands are arriving while in other days, thousands of new folders came in.

In order to anticipate this number, we build a simulation model for the whole compensation process:

1) Thanks to the PEPS tool (see above), we know how many delayed customers can ask for compensation.

2) For each day, we estimate how many customers will ask for a compensation (not all customers do). The estimation is done thanks to historical data, we build a $F$ function as shown in Equation (1).

\[ \text{number of customers asking for a compensation} = F(\text{number of customers that can ask for a compensation}) \] (1)

3) For each estimated asking customer, we estimated an arrival date in the punctuality center. Once again, this estimation is done thanks historical data and taking into account non-working days for delivering post mail. Log-normal distribution is used to furnish the distribution model of time between the delayed train date and the arrival date in punctuality center.

4) Thanks to these previous steps, we estimate how many envelops are received each days in punctuality centers.

5) We now have to build a simulation model $G$ of the punctuality center, that is how many envelop are treated each day, depending on how many operators are working that the Equation (2).

\[ \text{number of treated envelops in the day} = G(\text{number of operators working in that day}) \] (2)

6) The last step is to simulate the whole process as stack management: the stack is growing by arriving folders and decreases each time a folder is treated by an operator.

With this simulation model, we can anticipate and adjust the good number of operators in order to satisfy the 21 days delay of answer. A more detailed presentation of statistical aspects of this model is given in [2].

**To simulate new scenarios**

This study provided a lot of quantitative elements and models. This precious material has been used to investigate and simulate new scenarios for the future of compensation process:

- new rules of compensation,
- electronic demand

These analyses aimed to both furnish economic evaluation and to better understand and get size organizational impact of these scenarios.

**Conclusions and perspectives**

This research allows the SNCF Voyages department (national lines with compulsory reservations) to add a “customers approach” to the more traditional “operator approach”. The intranet tool PEPS provides up to date indicators about delayed customers linked to original causes and economical consequences. Another part of the work allows to entirely model and simulate the process of compensation, in order to better manage punctuality centers and anticipate future changes.

This work succeed into providing a new systematically approach for SNCF Voyages, it relies on data provided by compulsory reservations. A first research perspective is to extend this approach when data about reservation is not available. Others large research perspectives are socio-economic evaluation of punctuality and new tools to help economic management based on data analysis.
References

[1] European Performance Regime