



On-line data gathering using GSM short messages

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Abstract

Nowadays, decision-making is close related to the quality and freshness of the data handled by the analyst. In railway management, many decisions could be made simply by centralising information related to the trains running on the network, thus improving service quality. The Asturian regional service of the Spanish Railway Company, RENFE, has started a new procedure for automatically gathering and processing relevant on-line information, through the use of the SMS (Short Message Service, the integrated paging service that allows GSM cellular subscribers to send and receive data right on their cellular phone's LED display). All the ticket collectors carry their company GSM cell phone used for sending predefined short messages that are processed by a central computer, discriminating between regular messages (for statistical purposes such as number of passengers, cleanliness of the coaches, etc), and urgent messages that should be answered by the person responsible at headquarters. In this paper, we present the computer system designed, together with the experience that the managers of the company have experienced with the new system.

1 Introduction

Client satisfaction is the aim of current quality systems based on the EFQM Excellence Model [1]. In the provision of services, rapid response to (potential or real) problems is essential; this calls for the aid of the new information and communications technologies.

An essential element is the existence of rapid, reliable communication between inspection points and service points. For this reason, systems based on e-mail and other types of electronic data exchange are being used more and more,



thus avoiding the use of telephonic communication which implies manual intervention of the information to be processed or paper forms, which do not allow rapid response, as well as being prone to errors.

The reduction in the cost of mobile telecommunications and its spread in recent years means that this is an option to be taken into consideration by companies when creating solutions adapted to their communications needs. Digital GSM mobile telephony, due to its characteristics, offers the possibility of sending and receiving short, alphanumerical messages (at present, up to 160 characters). These are known by the name of SMS (Short Message Service) messages. The cost of sending said messages is low, and the delivery time between cell phones is usually almost immediate. Moreover, the SMS message is stored in the cell phone and may be read at any time, which means that the receiver is not obliged to pay it immediate attention, as would be the case when dealing with a telephone call.

These characteristics have made SMS a communications tool that is being widely used by both private individuals as well as firms of all kinds: some television channels send their subscribers SMS messages containing information related to the subscriber's preferences (sports results, share prices, news headlines, etc.); universities send their students their exam marks via this service; delivery services use it to send orders to their employees, etc. Other reported comparative applications are related to Corporate Email, Mobile Banking, Electronic Commerce, Customer Service, Vehicle Positioning and Job Dispatching.

In 1999, more than a thousand million SMS messages were transmitted between terminals, this figure being doubled in 6 months. However, among all the messaging applications based on SMS, corporate applications making use of this technology are in a minority, the majority of the messages being generated by private consumer applications [2].

Within the railway world, a number of experiences using GSM have been reported, including some using SMS messages [3], basically for operating all their communications (train control, locomotive diagnostics, railway signaling or station video monitoring) on a single platform in an attempt to reduce operating cost (in the first case), or in order to offer information to passengers about the services offered (in the case of SMS).

The problem with the existing SMS technologies in first generation GSM is their lack of interactivity, which is solved by the second generation technologies (WAP). However, there exist cases where the simple, bi-directional transmission of small messages is sufficient. An obvious case is the use of the SMS messages sent by ticket inspectors located in remote places as a simple, cheap means of communicating incidents.

This article presents an application of the use of SMS technology that centralizes the incident reports supplied by ticket inspectors, allowing all this information to be automatically centralized as well as permitting a rapid response to different types of incidents. Section 2 describes the Regional Railway Network of RENFE-Asturias and the system currently used for communicating incidents,



indicating the problems and points that may be improved on. Section 3 presents a detailed description of the architecture developed. Finally, a number of conclusions and the advantages of the new system are expounded in Section 4.

2 The regional Railways Network of Renfe-Asturias and its operations control

RENFE-Cercanías de Asturias, the Regional Railways Network of RENFE in Asturias, currently has three passenger transport lines in the region (in the North of Spain), offering to its clients a daily service of 180 trains, which transport some 25,000 passengers (approximately 8 million passengers per year).

At present, 55 ticket inspectors work for the company. Each of these is the sole representative of the company on each train dealing with the public and is the person who is closest to the perception that the clients have of the service that they are receiving. For this reason, the company has entrusted these inspectors, amongst others, with the task of verifying *in situ* certain quality parameters, which will then be reported to head office so as to correct any anomalies noticed.

2.1 The present system of reports

In the Regional Railways Network of RENFE in Asturias, as in the other national lines belonging to the company RENFE, the method traditionally used to conduct this monitoring of parameters is the so called "system of reports". This system, of a manual kind using paper, consists in whenever ticket inspectors observe any sort of abnormality on the train on which they are on duty, they fill out a form that they deposit at the end of their shift in a box made available for this purpose by the company.

The report is itself a list of the most common anomalies on board a train, so that the inspectors only have to mark with a cross the points in which they have noticed anomalies (it is a kind of "Inspection Points Program"). The subjects referred to on the report are of the most varied kind: from damaged seats or doors to dirty floors or windows.

Each day, the person in charge of the ticket inspectors collects the reports that have been deposited by these from the box. On the basis of said reports, this person gets in contact with the persons or departments responsible for resolving the problem reflected in the report. Thus, in the case of a report concerning a door that does not function properly, he or she would inform the workshop, indicating the number of the train to be checked. This communication is currently carried out via e-mail in a more or less informal manner.

Once the department or person responsible resolves the problem, this is communicated to the person in charge of the ticket inspectors, who in turn notifies the inspector who gave rise to the report. This notification is deposited in the corresponding pigeon hole of said inspector, who is made aware of the fact

that the problem he or she reported has been resolved. Feedback is thus given to the information circuit, and so the inspectors are given an incentive to carry on using a system that they feel to be efficient. The flow of information is represented in Figure 1.

Once they have been used, the reports are filed for three years. During this time, it is not envisaged that anyone uses any of them; they are only kept to comply with the quality norm in force in the company (*RENFE-Cercanías de Asturias* is in possession of the ISO-9000 certificate).

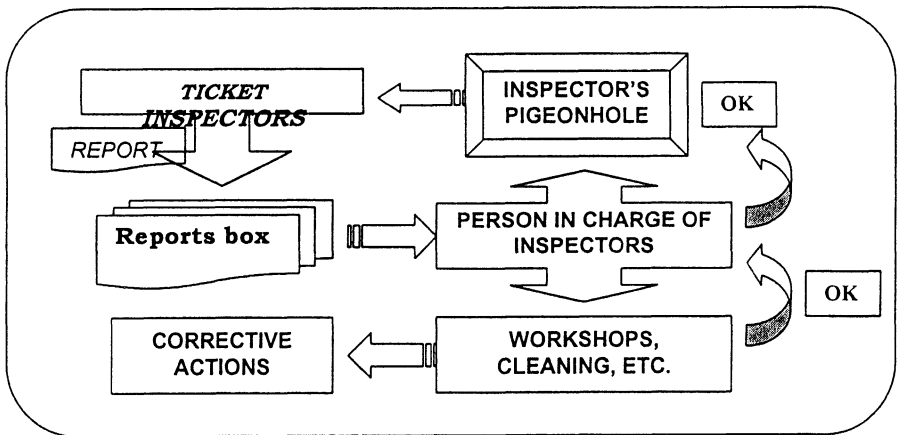


Figure 1. Information flow of the traditional system of reports

2.2 Weak points of the system of reports

The description of the system of reports brings some of its weak points to light:

- There is an important time difference between the moment at which the inspector detects the problem, the moment at which the problem comes to the notice of the person in charge of the inspectors and the moment at which it is communicated to the department responsible for resolving the problem. As the reports are handed in and collected only once a day, it is not unusual for 24 hours to pass between the beginning and end of the process.
- The report reaches the workshop practically at the same time as the train. Therefore, the workshop simultaneously finds itself faced with a list of problems to schedule and with the problems themselves. It is very useful (from the point of view of the scheduling of maintenance activities, the preparation of spare parts, the search for another train to substitute the one



that is broken down, etc.) to know of the existence of such problems a certain time in advance.

- As it is a written report, it is filed and its usefulness ends there; it is not used to extract information (statistical data analysis, etc.).

3 Architecture of the newly developed system

Continuing along the line mentioned above of integrating SMS technology into on-line communication of quality information, the management of *RENFE-Cercanías de Asturias* decided to design a computerized system, a pioneer project within the country, that makes use of this technology to obviate the aforementioned problems of manual reports.

3.1 The new information circuit

Figure 2 is a representation of the new information flow using SMS messages and the SMS-Manager software developed for this project. With this new system, the ticket inspectors communicate *on-line* the incidents (previously codified so as to speed up the preparation of the message) appreciated in the units on which they are on duty, by means of the SMS. It is worth noting that the cost of the service is practically null thanks to the agreements signed between the railway and telephone company, by means of which they both share part of their respective transmissions networks.

The message is received by a computer located in the head office of the company (which is connected via a RS232 serial port to a cell phone, which acts as a modem), and is analyzed and processed by the SMS-Manager program. If the message is urgent or requires manual intervention, acoustic signals are emitted on reception so as to call the attention of the person in charge of the service. There also exists the possibility of automatically sending messages from head office to the inspectors en route, in order to convey instructions.

3.2 Structure of the SMS Manager program

SMS Manager is a management program for short, cell phone messages designed for the firm of *RENFE-Cercanías de Asturias*. Among the functions it includes, the following are worth highlighting:

- *Reception of messages.*

The program checks whether the message comes from one of the numbers included in the table of inspectors; interferences caused by persons from outside of the system are thus avoided. In the case of it being a codified message, it is decoded following the pattern established in the code table. Once the message has been decoded, it is added (already translated) to the database of incoming messages. The non codified messages are added as they stand to the list of incoming messages.

- *Sending of messages*

SMS Manager offers a very intuitive interface for facilitating the sending of messages (either using the telephone directory of the inspectors or directly keying in the telephone number to which the message is to be sent). It is possible to send to groups of telephones simultaneously. A register is kept of all messages sent. Figure 3 presents the screen that registers the incoming and outgoing messages.

- *Filtering of messages*

One of the aims of the SMS Manager is to make use of the fact that the information received in the messages is structured homogeneously, so that it may be used by other departments. It is therefore possible to filter the messages in a totally visual, simple way on the basis of several parameters: subject (those which have been defined in the code table), source telephone, source train, date and time, messages that have generated an alarm. Once said filters have been applied, the resulting messages may be extracted to a MS Access file, graphics and reports may be generated, or the message may be eliminated and sent to a historic file.

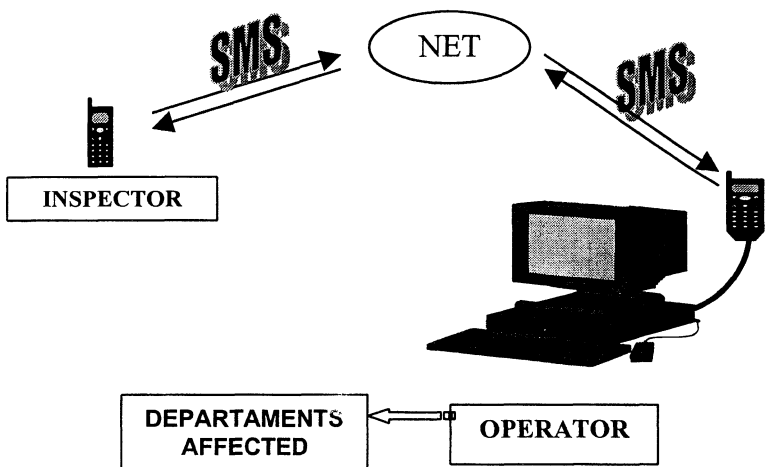


Figure 2. Information flow with the new system

- *Data analysis and graphical representation*

In order to visualize data (frequencies with regards to types of messages, etc.), the messages must be filtered with respect to a particular subject.

- *Security*

SMS Manager directly accesses the database that contains the ticket inspectors' codes and data, thus allowing said data to be modified, added to or deleted by means of this program. As these are operations that could negatively affect both the running of the program as well as the integrity of



said data, two modes of accessing the program have been established: as an Operator and as an Administrator.

Mensajes entrantes

Nº	Fecha	Hora	Telefono	Tiempo	Alarma	Mensaje
4	2/11/99	11:38:00	600324577	111	SI	Seguridad - Impagos: SI ## Seguridad: A ## Vandalismo: SI ##
3	2/11/99	11:18:00	636900898	120		Limpieza - Asientos: 12 ## Baños: A ## Cristales: C ## Olores: A ## Suelos: A ##
2	2/11/99	10:11:00	600253125	110		Confort - Asientos: A ## Cierres: D ## Temperatura: A ##
1	2/11/99	10:05:00	600324577	100	SI	Seguridad - Impagos: SI ## Seguridad: C ## Vandalismo: NO
5	28/10/99	11:05:00	600253124	110		Limpieza - Asientos: 15 ## Baños: B ## Cristales: A ## Olores: C ## Suelos: A ##
4	28/10/99	10:40:00	600346580	120		Limpieza - Asientos: 20 ## Baños: A ## Cristales: C ## Olores: A ## Suelos: B ##
3	28/10/99	10:35:00	600260869	100		Confort - Asientos: D ## Cierres: D ## Temperatura: A ##
2	28/10/99	10:22:00	600213536	110		Confort - Asientos: D ## Cierres: D ## Temperatura: A ##
1	28/10/99	10:05:00	600253125	120		Confort - Asientos: C ## Cierres: A ## Temperatura: A ##
7	27/10/99	18:40:00	600325460	111		Confort - Asientos: B ## Cierres: B ## Temperatura: C ##
6	27/10/99	18:35:00	600324577	100		Confort - Asientos: A ## Cierres: C ## Temperatura: A ##
5	27/10/99	18:25:00	600253125	111		Confort - Asientos: B ## Cierres: B ## Temperatura: B ##
4	27/10/99	18:20:00	600213536	100		Confort - Asientos: A ## Cierres: A ## Temperatura: C ##
3	27/10/99	18:18:00	600332211	125		Confort - Asientos: A ## Cierres: C ## Temperatura: B ##
2	27/10/99	18:12:00	600253125	120		Limpieza - Asientos: 10 ## Baños: B ## Cristales: B ## Olores: A ## Suelos: B ##

Mensajes salientes

Nº	Estado	Fecha	Hora	Telefono	Tiempo del mensaje	Mensaje
1	E	23/05/99	12:33:00	600312159		Se ha solucionado el problema de los asientos de la unidad 112
2	E	10/01/99	15:15:00	636900898		Problema en limpieza solucionado.
3	E	11/11/99	11:11:00	600260869		Recibida información sobre tren 100
4	E	18/03/99	12:13:00	600324577		Paseo por central a recoger nuevas telas
5	E	22/03/00	17:28:46	600253125		Se le envia gracias de seguridad
6	E	24/03/00	22:35:45	600325460		Gracias por su informe, se ha dado aviso al taller
7	E	25/03/00	11:53:02	600253125		Advertida cuadrilla de limpieza, gracias por su informe
8	E	26/03/00	11:53:25	600213536		Recoge nuevas telas en central el finicar el turno

Numero de mensajes entrantes: 27

Figure 3. Incoming and outgoing messages screen

3.3 Codification of the messages

In order to process the information received, the SMS-Manager program maintains a database containing information relative to the different elements that intervene in this new process: principally, inspectors (name, their cell phone number for ID, etc.) and the message codes. Said codification fulfils a double purpose:

- To summarize the information to be sent, so that the information sent is maximized while minimizing the number of keys the inspector has to press.
- To rationalize the sending of messages, thus facilitating their subsequent treatment. Imposing a common pattern for the messages leads to a structuring of the information received.

A codified message will have the following structure:

NUM#M#C1#C2#C3#C4#C5

NUM: three digits that indicate the train from which the message originates.

M: Characters that identify the subject to which the message refers (level of cleanliness, breakdowns, comfort...)

C1, C2, C3, C4 and C5: first, second, ... up to a maximum of five message fields. Each field refers to a particular aspect of the subject of the message; e.g. for the subject quality of cleaning, the five fields might refer to windows, floors, toilets, litter bins and the exterior of the train.

In some cases, it may be sufficient to use Yes/No type fields, which would be codified by the inspector as 1/0. However, in other cases it may be necessary to employ other types of data: an A, B, C, D classification; numbers; or even a short text.

The database code table (see Figure 4) defines the subjects (with the abbreviation that will identify each of these in the messages) and the fields (with the type of data they will contain). Whether this type of message will originate an alarm or not on reception at the central computer will also be indicated on this table. A delimiting separator (#) is introduced between each of the different fields.

In the case of a non codified message, it will only be necessary to include the field NUM, which allows the source of the message to be identified. The normal text of the message will come next. These messages are not automatically processed by the SMS-Manager, but rather are presented for the person in charge of managing the system to read.

The screenshot shows a window titled "Lista de Códigos" with a form for defining a new message. The form includes the following fields and controls:

- Tipo de mensaje:** A text box containing "Confort".
- Código:** A text box containing "C".
- Campo 1:** A text box containing "Asientos".
- Campo 2:** A text box containing "Cierres".
- Campo 3:** A text box containing "Temperatura".
- Campo 4:** An empty text box.
- Campo 5:** An empty text box.
- Tipo de dato:** A column of dropdown menus. The first three are set to "Rango", and the last two are set to "(Vacio)".
- Genera alarma:** A checkbox that is currently unchecked.
- Buttons:** "Añadir" (Add) and "Eliminar" (Delete) buttons.
- Footer:** A status bar showing "Registro 1 de 3" with navigation arrows.

Figure 4. Screen used to define the codification of a new message



4 Conclusions

This study presents a new system for the on-line management of the information of the regional railways service of the company *RENFE* in Asturias using SMS messages, which substitutes the traditional system of manual reports. The advantages that derive from the use of this new system are the following:

- The reports are received in real time: the ticket inspectors no longer need to wait until finishing their shift to hand in their reports; and the person in charge of the inspectors receives these reports as they are emitted, without having to collect them from a box.
- The reports can now be easily transmitted to the departments (maintenance workshops) affected. By applying the program database filter "cleaning", for example, the messages related to this concept are extracted. These are then sent to the department responsible for cleaning. The reports could arrive at the affected department a few seconds after the inspector had emitted the report.
- As a consequence of the above, organizational improvements are derived in other departments, thanks to a better scheduling of activities to be undertaken.
- The improved gathering of information gives rise to improvements in materials maintenance and hence in the image that the client perceives of the service received. Once more, the reduction of the delivery of reports allows the person in charge of the inspectors to make decisions on the spot: faced with a serious problem of quality, decision making is facilitated (to take the train out of circulation immediately, for instance), whereas previously, the train might have continued circulating several hours after detection of the fault until corrective action was taken.
- The possibility of generating graphics and statistical analysis leads to improved treatment of the information contained in the reports. Information may thus be extracted that may be of aid in the taking of management decisions.
- The new physical support of the reports (computer files instead of paper forms) leads to more efficient, less costly storage and classification.
- One of the keys to the success of this system is that of the correct codification of the messages. An inadequate codification, which makes its operation difficult (too much time spent keying in data, too many codes, etc.), can discourage the inspectors from using the system. Staff collaboration is essential and must be achieved by means of their appreciation that the system is more comfortable to use than the manual system.



References

- [1] European Foundation for Quality Management (1990) The EFQM Excellence Model – Companies Version.
- [2] GSMWORLD (2000) Corporate Applications Using SMS (see http://www.gsmworld.com/technology/sms_07.html)
- [3] Schlegel, M. (1998) GSMove: GSM-SMS to WWW Gateways as Intermodal Mobile Passenger Information Systems. Conference "Transport @ Internet", IBC, London, June 17, 1998 (see <http://gsmag.com/ezeitung.html>)