Quality management during the developing and implementation of the project of integration of automated information systems

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Abstract. This article consider the activities of the company engaged in the extraction and transportation of natural gas, in which, today, there is a large fleet of automobile and special equipment and departmental gas stations. The activity of the enterprise is successfully implemented through its existing technical infrastructure. However, during a pre-project survey, the customer identified business processes that need automation, namely, the transfer of information about refueling to waybills. This solution will reduce the waybills processing time and eliminate the inconsistencies about refueling with the data of the existing AIS. This article considers the implementation of only one task: the development of an algorithm for transmitting data on gas stations. The project successfully passed all the necessary tests, after which an act of acceptance of integrated systems into operation was drawn up.

1. Introduction

Quality of the ready IT project – success of the customer and developer. Important criteria for evaluation of results of development and implementation of automated information systems are assessment of quality and management of them [10].

Quality of the software - ability of the software product to confirm the specification provided that the specification is oriented to characteristics which the customer wishes to receive. Technical requirements of the customer are a guarantor of quality of the implementable IT order where the customer signs the agreement with the projecting organization and participates at all stages of the project. The systems analyst should make and approve competently and effectively technical requirements of the customer before development of the specification. And only after that to start the main development stages of AIS [3,8].

At quality management of the performed works as the IT specialist, the IT project should answer certain quality indicators. In the international and domestic practice certain standards for quality management and assessment of its indicators are used: TQM technique, standards ITIL/ITSM, ISO 9001, ISO 9002, ISO 9003, COBIT, GOST 34, 12207, instructions of ITSEC, TCSEC, SPICE and others.

Competent application of standards, instructions, techniques by developers and mutual participation of the customer in the project and also use of modern software products in the field of IT it is also quality management. In detail theoretical and practical material is presented in grants of the author Novikova T.B., namely: "Project management in social and economic systems", "Workshop on development of
AIS (GOST 34.601-90): predesign inspection" (Nazarova O.B. coauthor), "Workshop on standardization of software", etc. [1-2]

The article addresses the issues of some activities automating of services in a gas producing enterprise. An example of development of technical requirements of the customer of the IT project on development and implementation of integration of two automated systems on the example of the gas enterprise is in detail reviewed. And also implementation of the project which successfully underwent operation. For presentation convenience purposes and because of the law on trade secrets, we will use the fictitious name of the organization – «Enterprise A», as well as automated systems – «AIS1» and «AIS2» when describing the implementation of the task [4,9].

1.1. Relevance
For many years, Russian gas companies have been among the leaders in the natural gas extraction and supply. According to experts, more than a third of the world's natural gas reserves are located on the territory of Russia, which guarantees future supplies to the world market and the further development of this industry. Russian gas companies have been developing dynamically for over forty years. Using the latest technologies, machinery and equipment allows maintaining a high production level and having a 50% share in the total energy balance of the country. However, it should be noted that these results were achieved not only by using the latest technologies and equipment, but also with various automated information and control systems.

The following Russian and foreign scientists made great contribution to the advancing of the theory and practice of the development and use of databases, applications, etc.: Meldman M., Arif N., Basyrov R., Borovsky A., Zharkov V. A., Kyte T., Kretschmer R., Magda Yu. S., Mayer R., Markin A. V., Novikov B., Radchenko M. G., Rizzo T., Rudikova L., Rybalka V., Summerfield M., Ulman J., Hubbard J., Khomonenko A., Schlee M., Goloshchapov A., Darcy L., Dronov V. A., Staker M. A., Stephen D. S., Noyes B. Privat M., Pugachev S., Rybalka V., Esposito D. and others.

2. Problem statement
«Enterprise X» is a 100% subsidiary that provides gas supplies to consumers in 13 regions of Russia. More than 9 thousand kilometer of main oil and gas pipelines (GP) are operated in the areas of production activity. «Enterprise X» is implemented on the basis of the following principles:

- maximum consumer requirements satisfaction for gas and oil transportation, maintenance and repair of gas transportation infrastructure and pipelines, production and sale of compressed gas, implementation of investment projects;
- continuous improvement of the production process management system, the introduction of advanced technologies, new forms and methods of production and business management;
- maintenance and development of an enterprise quality management system that meets the requirements of current versions of ISO 9001, GOST ISO 9001, etc.;
- continuous improvement of the effectiveness of the quality management system, etc.

Today, the gas producing «Enterprise X» has its own fleet of automotive and special equipment, which, in turn, needs accounting and control of spare parts. A car park is a complex farm with a diverse production activity, which has an extensive fleet of special-purpose vehicles. For the automated accounting of the working activities of vehicle fleets, the specialized software system «AIS_X1» is used. It allows you to create a single centralized system of vehicle management and is designed to automate management and operational accounting in road transport enterprises and organizations [5]. The program «AIS_X1» is networked, and will allow you to work with a common database simultaneously from several workplaces: operator, dispatcher, accountant, manager.

Following business processes are automated by means of the «AIS_X1» system:
- long-term and short-term vehicles planning;
- waybills building, printing and processing;
- accounting and control of fuel consumption using GLONASS/GPS systems;
- transportation costs distribution by location (cost centers);
• maintenance schedules building and control;
• repair of motor vehicles;
• mileage control of spare parts and units;
• batteries issue and write-off accounting;
• tires mileage control and accounting;
• OSAGO, KASKO accounting, rotational transport.

In addition to the fleet, the gas production «Enterprises A» includes departmental filling stations, which have a comprehensive automated management system for petroleum products («AIS_X2»). The system is designed to automate the process of receiving, dispensing and accounting of petroleum products, as well as monitoring the presence of petroleum products at departmental automobile filling stations [7].

The «AIS_X2» system allows round-the-clock petroleum products issue and accounting without operator involvement on departmental gas stations. Drivers (or vehicles) authorization at the non-operator sale terminals occurs by means of electronic identification cards or electronic keys. Optionally, a waybill identification can be made. Non-operator sale is implemented using non-operator sale terminals KAZS-ASI-2.0 «Stream», integrated with fuel filling stations dispensers. The terminal connects to the corporate data network and uses the reference information of the upper level system. The terminal can be connected to the TCP/IP enterprise network either directly or through hardware and software gateways via GSM, radio or satellite communications. The system eliminates the turnover of cash when refueling departmental transport, allows you to keep accurate records of petroleum products reception and issue at gas stations, allows you to set fuel supply limits with reference to vehicles or drivers, eliminates unauthorized fuel issue from the gas station, allows for daily and twenty-four-hour fuel issue without operator involvement [6].

With all the existing optimization of the business processes of «Enterprise X», there are some operations that are performed inefficiently. One of these processes is the registration of waybills. The company is developing, the fleet of motor vehicles is increasing accordingly, which complicates the process of travel tickets issuing, recording and closing. After analyzing the «bottlenecks» in existing business processes in an enterprise, the following shortcomings were identified:

• the calculation of residual petrol, oil and lubricants by way of travel lists, the re-taxing and the compilation of reports require a lot of labor and concentration;
• a large number of documents is maintained in paper form;
• it is impossible to provide operational reports to management within the time-frame;
• possible dispatcher errors when registering the amount of fuel filled by the driver (for example, without analyzing the driver’s handwriting, registering other quantitative indicators, which may lead to inconsistency of reports and distortion of information) and others.

As a result of the analysis of the «bottlenecks» at the gas producing «Enterprise X», a management decision on the integration of the existing software «AIS_X1» and «AIS_X2» was proposed and accepted by the customer. The practical relevance of this solution will reduce the time of trip tickets processing and eliminate inconsistencies in refueling with «AIS_X2» data. The solution will be implemented through the organization of data exchange between the «AIS_X1» IAS and the «AIS_X2» system through the SQL Server Task Scheduler (Job). The relevance significance of this work will allow us to apply the developed algorithm to solve similar problems in other areas of the national economy.

3. Customer specifications

Purpose: the integration of data on refills from the «AIS_X2» module waybills.

Description: A view “dbo.AIS_X2 WU” is situated in the integration center (IC for short). The description of the fields is presented in table 1.
Table 1. Description of the fields for refueling the vehicle system in «AIS_X2»

| Filed   | Type   | Description                                      |
|---------|--------|--------------------------------------------------|
| Key     | int    | Refueling ID (counter)                           |
| Auto    | int    | Reference to the field in the table              |
| Date    | datetime | Refueling date                        |
| Cut     | float  | Fuel quantity                                    |
| Top     | int    | Reference to the field in the table              |
| Accep   | datetime | Accreditation date (refueling verification and acceptance) |
| Putlist | int    | Reference to the field in the table              |
| Zapravka | Int | Reference to the field in the table              |

Only those records are allowed for integration, in which waybill, the amount and type of fuel and the vehicle are indicated, and the fact of refueling is confidential. This table is updated at least once per hour. Description: A view "dbo.AIS_X2_ZapravkaWU " is situated in the IC (table 2).

Table 2. Description of the fields for gas stations in «AIS_X2»

| Filed   | Type     | Description       |
|---------|----------|-------------------|
| ZapravkaID | int     | Gas station ID    |
| Zapravka | Nvarchar (200) | Gas station name |

This table stores information on the gas stations from which the fuel for the vehicle is supplied. It is updated on demand (when putting a gas station into operation).

Task

It is necessary to import the data on filling stations into «AIS_X1» IAS by collecting information on filling stations from the IC. Import must occur no later than 30 minutes after data changing in the IC. It is also necessary to add a field in the table with the list of filling stations in the «AIS_X1» IAS, which allows determining the fact that this filling station was imported from IC.

It is necessary to import data on the facts of fuel issue to the module of waybills of the «AIS_X1» IAS by collecting information on the facts of refueling in the IC. Data import should occur no later than 10 minutes after updating the information in the IC. Data transfer (transmission and acceptance of information) to the branch (through replication) must be carried out no later than 20 minutes after updating the information in the IC. Data in the IC can change: the fact of refueling can be transferred from one waybill to another, etc. Only the «ID» field remains unchanged.

In case when fuel was issued at the «AIS_X2» filling station, editing form of this record should be disabled (as well as the ability to delete this record).

If an identical refueling record is already present in the waybill (the fuel brand, its quantity and the refueling date are the same), then this record should be replaced with data from the IC. It is necessary to store information about the user who closed the waybill.

3.1 Conflict resolution

It is necessary to add general settings to the Administration module with the name «AIS_X2. Automatic rerate» and «AIS_X2. E-mail notification» (may contain several e-mail addresses).

If the waybill for which the data is imported has already been processed, then it is necessary:

1. If "AIS_X2. Auto rerate" setting is ON then it is necessary to:
   - add information about fuel issue from "AIS_X2";
1. Rerate the waybill;
   • if some value in the waybill has changed after rerate (the final amount of fuel, etc.), then the
     person who closed this waybill should be notified via e-mail that a rerating has occurred and the
     values have changed.

2. If "AIS_X2. Auto rerate" setting is ON then it is necessary to:
   • add information about fuel issue from "AIS_X2";
   • remove the "Closed" mark from the waybill;
   • notify the person, who closed this waybill, via e-mail that there has been a change in the
     information on the issued fuel.

3. If there is no waybill at the branch or wrong fuel brand is indicated for this vehicle or there are
   other conflicts, then it is necessary to: send the notification to the e-mail address, specified in the
   "AIS_X2. E-mail informing" settings.

   If the waybill for which the data is being imported does not exist in the Administration database,
   anyway it is necessary to transfer this data to the branch and check the availability of the waybill in
   the branch (the branch can be determined by the car specified in the IC) [2].

4. Development and implementation of an algorithm for accounting and data transmission
   optimizing on the example of a gas producing enterprise

   In order to visualize the integration process of IAS systems «AIS_X1» and «AIS_X2», consider the data
   exchange model between the systems shown in figure 1.

   ![Figure 1. General scheme of data exchange between the AIS "AIS_X1" and the "AIS_X2" systems.](image-url)
Let us consider the proposed model in detail. Data on waybills and cars reference will be transmitted to the integration center (hereinafter IC). For import of waybills data and cars reference from IC to «AIS_X2», the developed algorithms will be used.

Data on the facts of refueling will be downloaded to the IC from the «AIS_X2» system in the table «Refueling facts». In the same way, data on filling stations will be downloaded from the «AIS_X2» system to the IC, into the table «Filling stations».

The main constant field in the «Refueling facts» table will be the «ID» (Refueling ID, counter) field. The «ID» field is the identifier of data belonging to a specific branch, according to which the AIS developer will subsequently distribute records to a specific branch. The «AutomobID» field is an auxiliary field for checking the belonging of a car that completed refueling to the waybill for which refueling was made, and is checked for compliance before transferring to IC from «AIS_X2».

The main unchangeable field of the «Gas stations» table will be the «Zapravka (ID)» field (Gas station ID, counter).

Further uploading of data about refueling from IC to the central enterprise database will be organized to implement data exchange between IAS «AIS_X1» and «AIS_X2» systems by setting up the task (job) in the SQL Server Task Scheduler, which runs the SQL procedure with a periodicity of no more than 10 minutes. Data on filling stations will be unloaded in the same way, but with a frequency of no more than 30 minutes. To store the data on the facts of refueling in database, a table will be created that is identical to the table «Refueling facts». The existing reference table "Gas stations" will be used to store the data about the filling stations. Further, the data will be transmitted to the enterprises branches through file replication via corporate network. When data in the branches changes, it will be rerated and e-mail notifications will be sent to the users, which will allow to response in time and review previously created reports.

Because of accepted management decision, the following project tasks were developed: a private technical task for the algorithm for transmitting data about gas stations and a private technical task for the algorithm data transfer on the facts of refuelling. This article will discuss the implementation of only one task: the development of an algorithm for transmitting data about gas stations.

5. Algorithm implementation

The algorithm is a finite set of rules that determines the sequence of operations for solving a specific set of problems and has five important features: finiteness, definiteness, input, output, effectiveness (D.E. Knuth).

The algorithm is designed to transmit data about gas stations from the Integration center into the "AIS_X1" system. The algorithm must be implemented as a stored procedure that will be run using job, with a frequency of no more than 30 minutes.

If (ZpID code in IC is not equal to ZpID code in DB 01 or ZpID code in IC is equal to ZpID in DB 01) OR (ZpID code in IC is not equal to ZpID code in DB 01 or Date in IC is greater than Date in DB 01) then Record is marked for processing: field DoIT is set to 1. Otherwise Record is marked for deletion: field DoIT is set to 0.

In the resulting temporary table, all records with the value of the DoIT field equal to 1 are processed according to the following algorithm:

Step 1: If Tp_Int in IC is equal to «I», then if ZpID code in IC is equal to ZpID in DB 01, then Set Tp_Int field equal to «U» value; move to step 2.

Else add record to resulting table, identical to record in IC, containing script to add record (for all added records HD_INT is set to 'F')

If it is the last record in temporary table, then run the scripts from resulting table, delete temporary and resulting table and finish the procedure.

Else move to step 1.

Step 2: If Tp_Int in IC is equal to «U», then
If ZpID code in IC is equal to ZpID in DB 01, then
add record to resulting table, containing script to update record in DB 01 according to data in IC (for all updated records HD_INT is set to 'F')
If it is the last record in temporary table, then run the scripts from resulting table, delete temporary and resulting table and finish the procedure.
Else move to step 1.
Else set Tp_Int field equal to «I» value; move to step 1.

Step 3: If Tp_Int in IC is equal to «D», then
add record to resulting table, identical to record in IC, containing script to add record (for all added records HD_INT is set to 'T')
If it is the last record in temporary table, then run the scripts from resulting table, delete temporary and resulting table and finish the procedure.
Else move to step 1.

6. Result
The data in the «AIS_X1» system in the «Refill» table become identical to the data in the «Refill» table from the IC. Information on filling stations is stored in table in stored in table 3.

| Filed type in DB | Filed name in DB | Filed name in SIKE Table SpZapravka | Filed type in DB | Filed name in DB |
|------------------|------------------|-------------------------------------|------------------|------------------|
| Int              | ZapravkaID       | Identification number               | Int              | ZapravkaID       |
| Nvarchar(200)    | Zapravka         | Filling station name                | type_str         | Zapravka         |
| Datetime         | RC_Date          | Record update date                  | type_date        | RC_Date          |
| Varchar(1)       | Tp_Int           | Record change type                  | Varchar(1)       | Tp_Int           |

At the start of the procedure, records are made into a temporary table about the gas stations, which are stored in the IC. An additional DoIT field is added to this temporary table. DoIT field type: Integer.
Also, when starting the procedure, a result table is created in which scripts are created.
The DoIT field is filled in the temporary table using the algorithm described above.

7. Conclusion
The developed and implemented project for the integration of the «AIS_X1» and «AIS_X2» IAS is one of the connecting elements in the infrastructure of «Enterprise X». This project allows automating the process of waybills registration and oil and lubricants at any enterprise that has its own fleet of vehicles.
The project was developed on developers own initiative with a view to its subsequent implementation, with the help of which the developer company can occupy a clear gap in the software market, attract new customers, strengthen the relationships with existing customers, as well as improve work efficiency and profitableness of the company itself.
The developed project successfully passed all the necessary tests, after which an act of acceptance of the integrated systems into operation was drawn up.

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