Information Technologies in Managerial Data Analyzing, Processing and Synthesizing

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ABSTRACT

It is presented the Information System developed to fulfill the rules of registration and roadworthiness tests for vehicles and trailers. The system is an adaptive one with distributed database. Oracle Database 11g Express Edition as distributed databases and Oracle Application Express were selected as development tools for the technical platform. The aim of the Information System is automating the process of annual technical testing of vehicles and it has been implemented at the national level.

Keywords: automatic, test, system, information, process, adaptive, database, distributed, data

1. INTRODUCTION

The main goal was to develop a national information system AutoTest (IS AutoTEST) for National Agency Transport Auto (ANTA), allowing experts to operate, maintain, adjust and develop at national level in accordance with the respective requirements legislation. The system has been implemented at 83 technical testing stations and ANTA [2].

The main objectives that led to creation of IS AutoTEST were to allow independent users to build, according to their professional interests, original versions of software called computer decision support systems (DSS) without the required assistance of IT specialists.

Management is defined as *"application of scientific method in analyzing and solving problems of managerial decision making"* and has following main characteristics [1]:

- systemic approach to decision-making situations;
- focus on adopting managerial decisions;
- decision-making on the basis of scientific methods;
- use of formal mathematical models;
- use knowledge and methods from various disciplines;
- use of ICT on a large scale.

As the IS AutoTEST platform, Oracle Database Express Edition 11g and Oracle Application Express were chosen as a development tool.

Application domains of IS AutoTEST are the support of the following processes:

a) registration;
b) technical testing;
c) on-demand search of motor vehicles and trailers, of car owners, in the field of evolutionary activity field;
d) generation of statistical reports for the governing bodies of the Republic of Moldova.

2. METHODOLOGY

2.1 Life Cycle - as a method of analyzing and designing computer data processing systems

Nowadays, elaboration of an IS of medium or large complexity can no longer be conceived without the use of analysis and design methods. *Methods of analysis and design* mean a lot of methods, techniques and recommendations used in the early stages of the life cycle of an IS, having as a final aim creation of an application model to be built.

The lifecycle of an IS represents all the steps that are taken in the development prose of the respective IS [3, p.16]. The most important stages are:

- ✓ *Collection of specifications (functional analysis)* - involves defining the problem; detailed specification of the functionality that must be supported by the application;
- ✓ *Analysis* - where the essential characteristics of all possible correct solutions are identified;
- ✓ *The design* – that adds to analyzed models new elements which define a particular solution based on certain optimizing criteria;
- ✓ *Implementation* - in which the realization of a particular solution of the executable project modeled in the design phase, takes place;
- ✓ *Testing* – where the result of implementation is verified and compared with model initially designed, and validates the fact that implementation meets the accuracy criteria identified in the analysis phase.

Each stage of the life cycle is characterized by specific activities and products resulting from the respective activities.

Adaptive methods are focused on rapid adaptation to changes. It is not exactly what will happen in the future. An adaptive team can report exactly what tasks will be performed next week and what is planned for the next month.

Predictive methods are focused on detailed planning activities over time. A predictive team can report exactly what is planned for the entire development process. The predictive team has difficulty changing the direction. The plan is optimized for the original destination and changing direction can require giving up current results and rescheduling activities. Only the changes considered important are taken into account.

The structure of the life cycle of adaptive applications is shown in Figure 1. From the figure it can be seen that the development of adaptive applications is as original life cycle, which combines the advantages of the life cycle of the *"cascade"* with type *"agile"*. Steps 1-7 correspond to the life cycle of *the cascade,* and 8-10 correspond to stages of the life cycle *"agile"*.

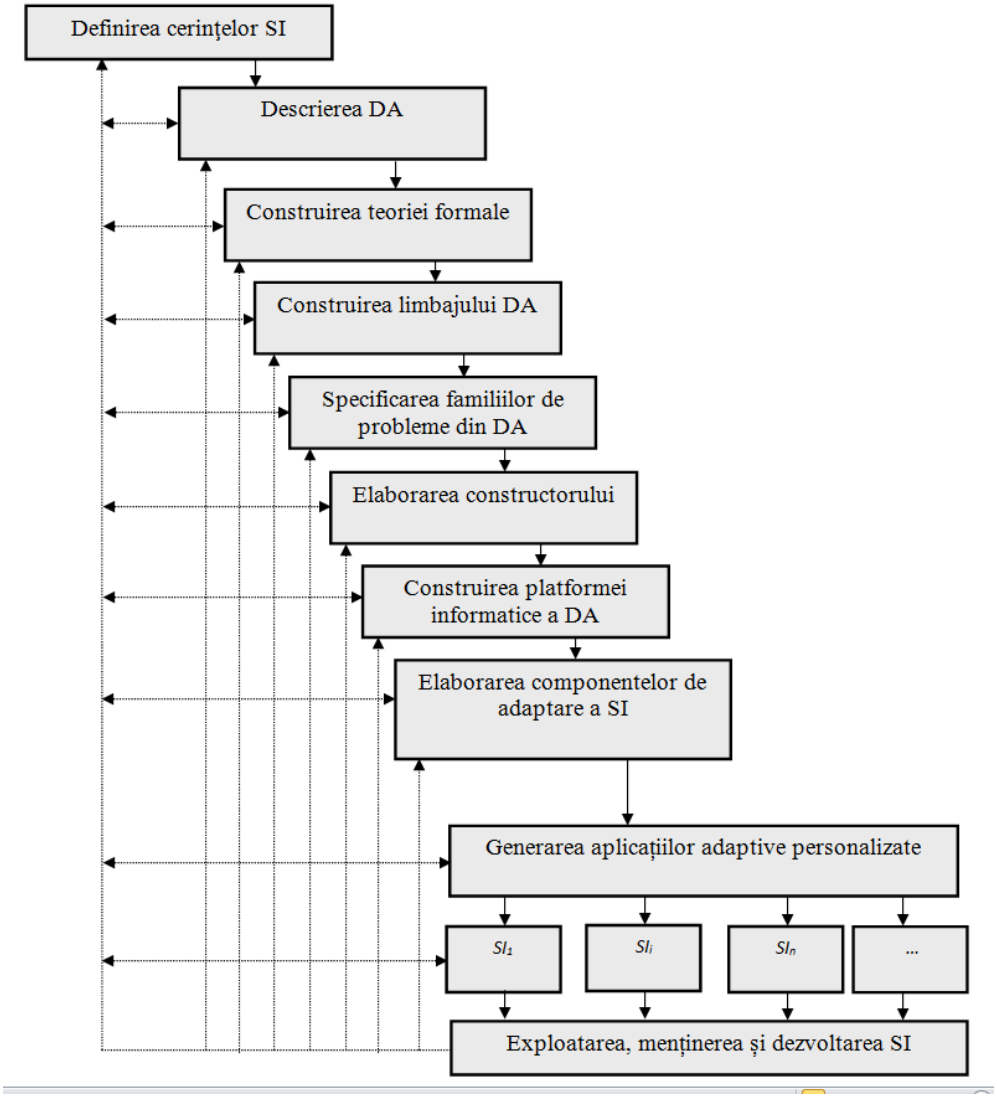

Fig. 1. Cycle of computer systems life.

3. DESCRIPTION OF IS AUTOTEST

3.1 Functional description of IS AutoTEST

Testing of transport units and trailers shall be carried out during the calendar year. For public passenger transport units and transport units of dangerous goods, mandatory technical testing is carried

out every six months. For other types of transport units, mandatory technical testing shall be carried out once every 12 months.

The applicant (the individual accompanying the transport unit (TU)) addresses any technical testing station in order to perform the technical test of TU.

The following actors participate in the technical test (see Table 1):

Table 1. The actors of the technical testing process of TU

Nr. d/o	Actor's name	Description
1	Applicant	Initiates TU testing; Accompanies TU; Holds the entry documents.
2	Registrar	Records the applicant's request; Identifies TU and TU owner; Ensures data entry.
3	Tester	Accompanies the TU at the test station; Provides the collection of technical test parameters.
4	Expert	Takes the decision on the technical state of the TU; Releases the technical verification report of TU and the technical verification hologram.
5	Statistician	Generates current, analytical and statistical reports.

When addressing, *the applicant* shall submit testing station set of documents:

$$D_{Inpu} = \{D_{input\ 1,inpu} D_{2,input} D_3 D_{inpu\ 4,secto} D_5 D_{input\ 6}\} \quad (1)$$

where

- $D_{input\ 1}$ - identity card (for individuals);
- $D_{input\ 2}$ - copy of registration certificate of the company (for legal entities);
- $D_{input\ 3}$ - registration document transport unit;
- $D_{input\ 4}$ - delegation or other document certifying the rights conferred on the transport unit;
- $D_{input\ 5}$ - certificate on compulsory insurance of civil liability;
- $D_{input,\ 6}$ - a receipt confirming payment of the amount of testing and road tax.

IS assists the *registrar* to enter personal data about the owner of TU, data of the TU responsible person and information about TU. The introduction of these data can be both manual and automated by online extraction of data from State Registers. The Registrar of the State Register of Population (RSP), the State Register of Law Units (SRLU) and the State Transport Register (STR) is the state enterprise

"State Information Resources Center" REGISTRU"". At the automatic extraction, *the registrar* compares the data extracted with one from presented documents.

The procedure of extracting data from the State Registers must comply with the Personal Data Protection Legislation.

Tester places TU on the test platform and initiates the procedure of testing the technical condition of TU. At the same time, it ensures the automatic input of the data obtained from the platform in the information system. If the test platform is unable to transmit data automatically, *testator* manually enters this data in IS. During TU's positioning on the test platform, the automatically processed picture of TU is taken.

Expert analyzes the documents D_{input} and data about testing the technical and decides whether the TU can be safely operated on the public roads. This decision is introduced in IS Astfel, that is de facto a decision support system (DSS). Based on positive decision, the *Report of technical verification* with a *badge hologram* is issued for *the applicant* under the strict registration.

However, the printed number of the report is introduces into the system and is associated with all the documents of $D_{input.}$ The technical report after the stamp is applied is given to the *applicant* and *the* hologram badge shall be sticked in right bottom corner of the inside of the TU windshield from the inside part or for new registration plates – at the established place on the panel. In case of identifying technical defects *expert* cancels previous decisions on the UT and prohibits its operation thereof or indicates a period of 30 days to liquidate defects.

The functional model of the actor IS "AutoTEST" is shown graphically in Figure 2.

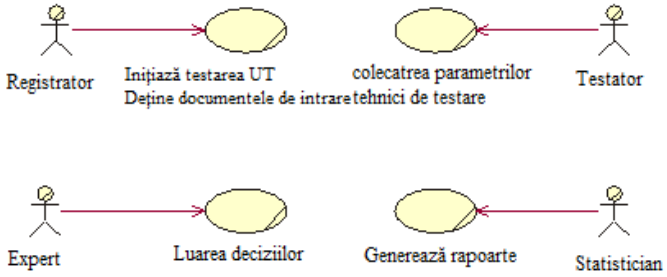

Fig. 2. The functional IS "AutoTEST"

3.2 Functional diagrams IS "AutoTEST"

IS "AutoTEST" has been designed according to the combined methodology of lifecycle methods of *"Cascade"* and *"agile" types* and technical regulation "Lifecycle processes of software" [4] taking into account the information flow analysis.

IS is characterized by the ability to compensate structural changes of the driven object. This is due to designed on-line management strategy that is based on a mathematical model or the most complete information about the process [5].

Strictly important is not to introduce into the system structure limitations that will not allow for an on-line change of leadership strategy. IS integrates a family of processes organized on hierarchical

levels that actualizes on a computer the whole range of documents related to these processes (see Table 2).

Table 2. The functional and adaptation levels of IS AutoTEST

	Documents	**Processes**
Central level, *conducted by ANTA*	- classifiers - authorizations (stations, experts) - document types - normative parameters - etc.	- the accumulation of data from the entire adaptive information system; - interconnection with other institutions; - adding and removing nodes; - initiating the deployment of new modules; - generating different statistical reports
Local aggregate level, *carried out by the aggregate test station*	Documents Processed / issued by All Subordinate Stations: - technical status report; - certificates (CEMT, INTERBUS, ADR, CEMT); - technical parameters of vehicle; - picture	- data accumulation from subordinate stations; - interaction with subordinate stations; - initiating the right timing of the synchronization act; - deploying new versions
Local level, *carried out by the Ordinary Testing Station*	Processed/Issued Documents Only by Current Ordinary Station: -the technical verification report; - certificates (CEMT, INTERBUS, ADR, CEMT); - technical parameters of vehicle; - picture	- obtaining technical test and vehicle photo data; - input and accumulation of data from current ordinary stations; - interaction with other institutions on the territory of the station (commercial banks and insurers); - initiating the right timing of the synchronization act; - deploying new versions

At the central level, data exchange with external institutions is achieved through *technology web-service,* the protocol SOAP (see Figure 3).

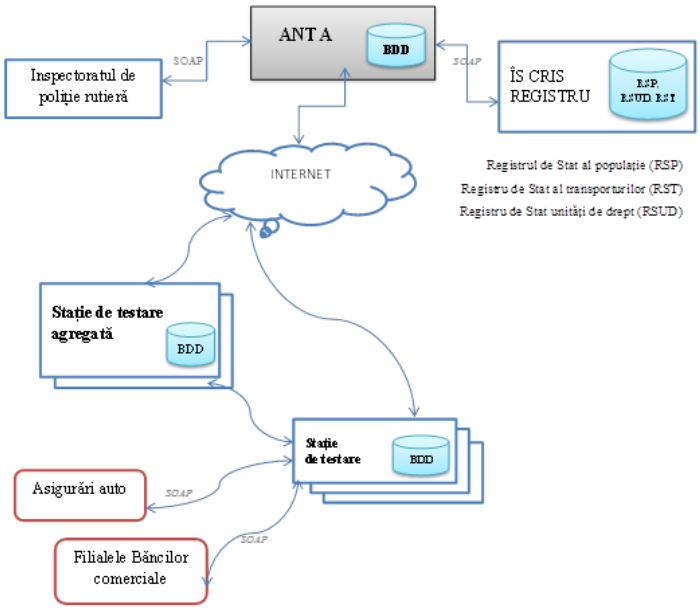

Fig. 3 Fig. 3. Diagram of information flows IS AutoTEST.

For the local level of IS AutoTEST, the flow of information is shown on the figure below.

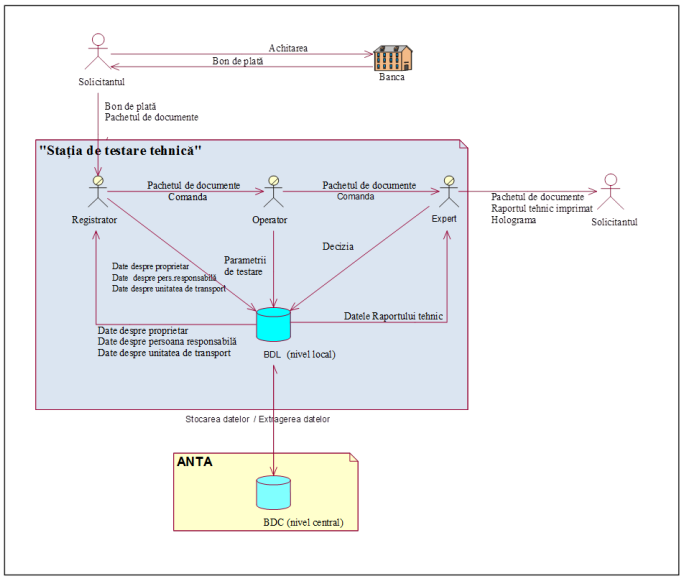

Fig. 4. Chart information flows at the local level (at the test station).

Viewed from the perspective of mathematical logic DA "AutoTEST" represents a formal (axiomatic) theory in the sense of Mendelson. The finite alphabet of DA's formal theory "AutoTEST" represents the basic concepts of this field.

Recall that a formal theory (axiomatized) of an activity is defined by the following components: *alphabet finite set of expressions* - the set of words finished over this alphabet, *the set of formulas* - a subset of the set phrases and *set of axioms* - a subset of the set of formulas, *set of inference rules.*

<formal (axiomated) theory of DA "AutoTEST"> :: = (1)
< DA alphabet "AutoTest">
<the set of finite words over the DA alphabet "AutoTEST"> |
<set of DA formulas "AutoTEST"> |
<set of axioms YES "AutoTEST">
<set of inference rules YES "Autotest">

1) *<alphabet DA "AutoTEST">*
::= (2)
{<ST>
<ANTA>
<ST associations>
<input frames>,
<technical test reports>,
<statistical reports>}

2) Many words finished over alphabet specified in (2) represents universal sets of RS, frame inputs of technical and statistical reports. These sets can represent, for example, adaptations of IS (Generic) Auto Testing in different countries.

3) *<the set of formulas over the DA alphabet "AutoTEST"> :: =* (3)
<universal RS set>
<universal set of input frames of AutoTEST>,
<universal set of AutoTEST output documents>
IS "AutoTEST" is adapted to the conditions of the Republic of Moldova.

4) The set of axioms:
RS "AutoTEST" is a dynamic object, the structure of which evolves over time.
So,
$RS=\{ RS^{(1)}, RS^{(2)}, ...,R^{(k)}, ...\}$ (4)
where
$RS^{(i)} = RS(t)$ and $t^{(i)} \le t \le t_{inc}^{(i)}{}_{fine}$
In the set of axioms, the set of valid registered documents is also included.

5) The set of inference rules is performed on the computer by the IS AutoTEST modules.

6) In the context of the formal theory described in the test reports and statistical reports obtained using inference rules, they can be seen as theorems of the formal theory of DA "AutoTEST".

Based on the formal theory described, IS AutoTEST was developed.

The IS AutoTEST database

Referring to the adaptive IS database it is a strictly necessary condition to maintain as much flexibility as possible of the chosen architecture. When the organization is geographically dispersed, there are two options of database selection: *one centralized database* or *a distributed database.*

A *centralized database (CDB)* is a collection of data on a single node of a computer network. A *distributed database (BDD)* is a distributed shared database that is physically distanced on the nodes of a computer network.

Generally, it is possible to develop an adaptive information system with both a centralized database and a distributed database. But, if the deployment objects are geographically dispersed, an adaptive IS with the BDD is more appropriate due to the fact that information objects are provided, even in the case of computer network interruptions. A distributed database management is performed by a *management system of a distributed database* (DBMS), which is able to operate the database with a DBMS centralized similar to [6].

BDD are divided into two classes: *BDD homogeneous,* in which all nodes have a soft, a structure of the interface and of an identical database; *BDD heterogeneous,* which can have different DBMS models and database structures, interfaces and different software.

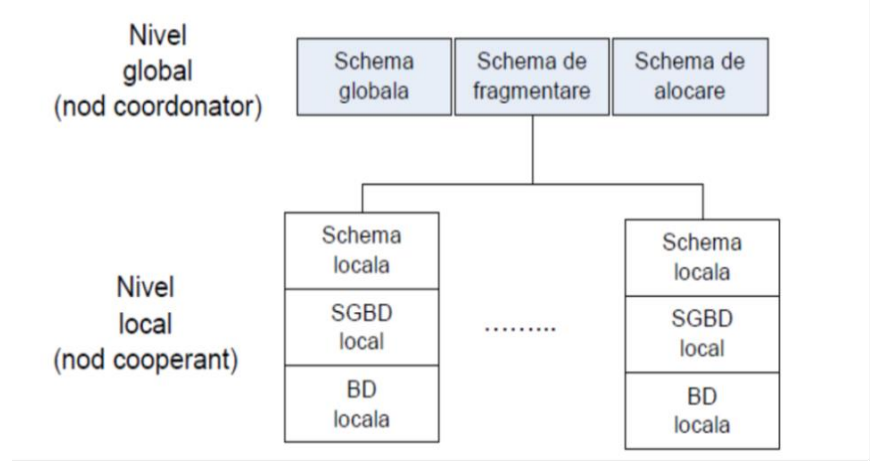

Fig. 5. Architecture reference for homogeneously distributed DBMS.

As a BDD the BBD homogeneous was selected (see Figure 5). The reason is that the developed information system must be robust to possible problems with the network, effort and, finally, the cost of development and implementation must be optimal. We note that each implementation object is a

separate private institution with its own computer technology and with a degree of decisional autonomy.

In homogeneous BDD *data dictionary* and *objects structure* are identical for all nodes and data are fragmented by the adaptive copy. This adaptive process of copying data is called *actualization (copying in one direction)* or *synchronization (copying in both directions)* of the data.

Information flows within the information system are carried out by the mechanisms developed to synchronize the BDD.

The IS AutoTEST database, ANTA level, consists of 57 tables and 9 representations. Local database consists of 47 tables and a representation.

According to the functions fulfilled, the tables can be divided into three families:

- Factual tables;
- Classifiers;
- Service tables.

BDL has relational architecture and was designed in the third normal form.

Oracle database contains a procedural language that allows modern and execution algorithms needed within the database as *procedures, functions, packages* and *triggers.*

Below we explain the most relevant modules of IS AutoTEST.

4. RESULTS

4.1 Web applications of IS AutoTEST

Web application is a collection of Web pages in a single security designed to solve a problem.

It would be natural for each employee to have a single web application to perform the job duties.

To find out which Web applications we need, we build the process-to-table table (after the organization's generic structure) with the framework processes of the information system (see Table 1). *The applicant* is not an actor of the information system, because he is a recipient of the service test. For other information systems, especially for on-line services, the beneficiary may be a system actor.

The organizational structure of both large stations and small stations was studied at the design stage. Some stations observed a merging of functions of the *Registrar* and *Tester* players in a certain role actor. Therefore, it was decided to create actors *Registrar* and *Tester* one Web application that finally was called by beneficiary *"AutoTest"* with internal ID 162.

Expert's web application actor system due to the management functionality and decision making at the local level was named *"Administrator"* with internal ID 164.

Web application for actor *Statistician due to its* functionalities to generate statistical and analytical reports on a local level, was named *"Reports"* with internal ID 163.

This application is also used for the central ANTA level with internal ID 100. The difference is the data source, centrally operated with data from all stations.

The algorithm validation is a logical expression linked to a web page that is checked after filling the fields on the page by the final user. This algorithm is associated with a final-user error message that is displayed on the Web page.

Next, the main adaptive decision elements on the web interface of each of these three applications will be displayed.

Table 3. Relationship between IS "AutoTEST" actors

Actors **Processes**	**Registrar**	**Tester**	**Expert**	**Statistician**
P_1 - registration of the test order	✔			
P_2 - testing technical condition of UT		✔		
P_3 - extraction data from State Registers	✔			
P_4 – TU photographing		✔		
P_5 - verification and validation of data			✔	
P_6 - print the Report of technical verification of the TU			✔	
P_7 - saving data in BDL			✔	
P_8 - cancellation, doubling of Report of technical verification of TU			✔	
P_9 - managing final users (see (3.2))			✔	
P_{10} - System configuration			✔	
P_{11} - manually synchronization of BD			✔	
P_{12} – installation of new versions			✔	
P_{13} – generation of reports				✔

5. CONCLUSION

IS AutoTEST was designed and conducted to ensure the principle of *data mining as the* examined information must be *complete, current* and *accurate.*

Complete and current qualities of information are accomplished through online communication and pooling of data from the central node of ANTA. Transactional *consistency* mechanism is performed on each document, provided by Oracle DBMS.

Veracity of information is ensured by the multiple conditions of validating forms of information entry with the extensive use of classifiers.

It is required in the perspective of implementing predictive forms with cognitive validation methods.

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