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DEPENDABILITY STUDY OF THE ERP SYSTEM

Abstract

The paper present the various aspects of the process of testing of the ERP system's dependability .This process has been systematized using the procedures taken from the Polish Standards and adopted for purposes of the ERP system. Thanks to an introduction of same normalization and the unification of terminology, the testing of the systems dependability under different conditions, as well as for different systems, will be possible.

A review of MS Axapta system in relation to the dependability of the functioning of its particular elements, has also been carried out. This was based on previously presented instructions of the dependability test.

1. INTRODUCTION

The ERP system dependability is vital for the functioning of the whole enterprise. As all elements of an enterprise are integrated with the ERP system, the system's correct functioning seams to be of vital importance in the context of its wide implementation across a variety of enterprises.

The ERP systems are characterized by modular structure or there are several modules in every single system. Modules can co-operate in different configurations, witch means that a firm does not have to buy the whole system, it is enough to buy chosen modules which can co-operate and transmit loaded data.

The whole system works on the basis of a data base. The MS Axapta system version 2.4+ based on MS SQL data base will be tested for dependability of dependability test on the ERP systems. This method can also be used on other systems of the same family, built on other databases.

2. BASIC DEPENDABILITY CHARACTERISTICS

To analyse the parameters of the ERP systems dependability, the notion of dependability in the context of those systems, must be defined.

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It can therefore be started, that dependability means the extent to which the system can be relied upon to perform a particular task correctly, under the given conditions or within a given time scope, with the required external resources supplied [5].

Every component characteristic of dependability depends on the structure of the ERP system modules and on the dependability characteristics of those modules. Every component characteristic on the system's level can depend on several components on the module's level [6].

The ERP system's dependability cannot be described by one single number. Some of the characteristics can be expressed by probability, others are deterministic; some elements can be presented quantitatively, other aspects can be described only qualitatively.

Here is an example of the analysis of the ERP systems on the module level, where [6]:

- the system's structure contains surplus elements and the availability of the system depends on the characteristics of the surplus modules;
- if the system's structure contains the mechanisms of system protection, this protection depends on the availability characteristic of the modules which provide this protection;
- if the structure contains modules which control the internal information transfer between different parts of the system then availability of the system depends on the safety characteristics of those modules.

On the Fig. 1 Elements of dependability:

- availability;
  - failures' intensity;
  - attendance;
- credibility;
  - inviolableness;
  - protections.

Availability which consists of failures' intensity and attendance is qualified as an element of the ERP system's dependability, the element is connected with applications which forms the system and also with applications which are created to the needs of individual customers and are part of the system's customization.

Credibility consists of inviolableness and protections and was assigned to functions of data bases of the ERP system.

Dependability consists of availability which depends on the system's failure rate (failures' intensity) and the time which is necessary to system's repair (attendance).

However, if the system is prepared for fulfilling its functions, it does not mean that it for sure fulfills those functions correctly.

It is the matter of credibility that depends on:

- system's ability to alarm call if it turns into the state when it is able to correct fulfill some (or all) of its functions (inviolableness) credibility with reference to the MS SQL base that is connected with ability to projecting messages which inform about incorrect working of data base, possibly with tools that monitor data base functioning and project messages in case of possible problems;
- system's ability to reject every incorrect input or unauthorized access (protections), in this case the SQL data base is equipped with many protections and accessories that enable control and system's inputs and outputs monitoring. The logged on users can also be monitored. Fig. 2 presents the logging window in the MS Axapta system.

In order to test the ERP system dependability it is necessary to define and estimate the contents that determine the system's dependability.

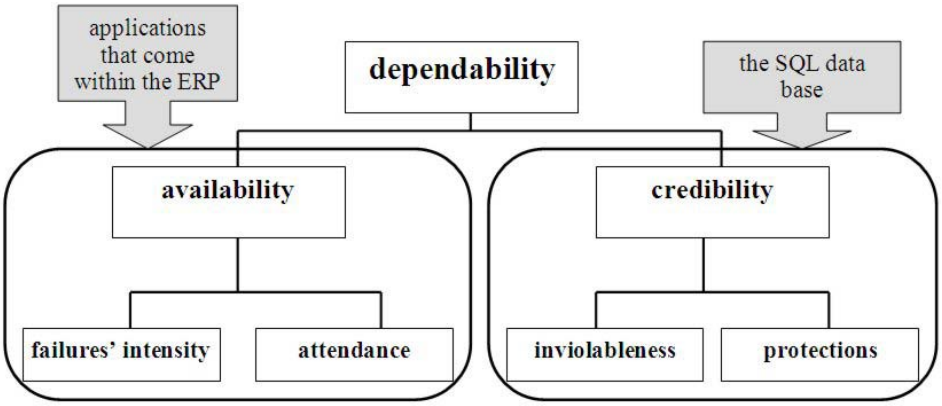

Fig. 1. Hierarchy of dependability contents with distinctions of data bases (SQL) functions and programs that come within the ERP system.

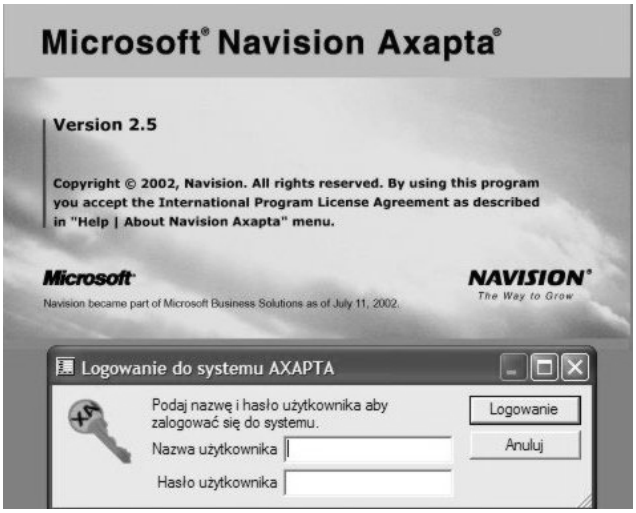

Fig. 2. The logging window in the MS Axapta system

One of two basic elements of system's dependability is its availability that depends on availability of every single system's modules and on those modules co-operation in fulfilling of the task of the system. The way of the modules' co-operation can include:

- functional surplus's (homogeneous or diversified);
- emergency surplus's;
- functional degradation.

2.1. Functional qualities of the system's availability

In practice, availability depends on applied procedures and supplies accessible to system's service, it concerns applications that are parts of the system. The system's availability is different for different tasks.

The system's availability that is ascribed to each task can be quantitatively expressed in two ways:

To predict the system's availability it can be calculated in the following way:

$$\text{availability} = \frac{\text{average time till damage}}{\text{average time till damage} + \text{average time of repair}} \quad (1)$$

where:

- "availability" is the system's availability ascribed to given task;
- "average time till damage" – in regard to the ERP systems it is necessary to admit that it is the time from system's repair (removing applications' incompatibilities) to given tasks' performing till the moment of another system's damage (that is till the moment of another damage report or another incompatibility);
- "average time of repair" is average of total times needed to remove a failure or an incompatibility in the system.

The value which is describe above refers to applications created during the process of customization. The firm which implements the ERP system should present such availability factor in order to increase implementation's dependability.

In case of a functioning system, availability can be calculated as follow:

$$\text{availability} = \frac{\text{total time in which the system was ready to fulfill the task}}{\text{total time in which the system was expected to fulfill the task}} \quad (2)$$

One of two elements that are part of system's availability to realize appointed functions is failures' intensity that depends on failures' intensity of every single module of the ERP system and on the way of those modules co-operating while fulfilling the system's tasks. The system's failures' intensity can be different for different tasks. The failures' intensity of each particular system's modules can be predicted using partial analysis. The system's failures' intensity can be then predicted by synthesis. It is important that in case of system's modules there are no methods of failures' intensity prediction that give a high level of confidence.

Another element of system's availability is attendance of the system that depends on attendance of each particular system's modules and on its physical and functional structure. The physical structure has its influence on ease of access, substitution etc. The functional structure influences on ease of diagnostic etc. Tools, used to create programmes, which are part of the system, and I particular their unification which allows for its functioning in the same environment in different ERP platforms, and of particular unimportance within the system attendance.

It is recommended, that all actions required to repair the system and to bring it to full capacity, are included in the quantitative expression of attendance. They should contain time needed to detect defects, service informing, diagnosing and removing causes, adapting and control etc. It is recommended that quantitative attendance expression is enlarged by qualitative statements on the following:

- **report** about failures: alarm announcements, light signaling etc.;
- **access**: easy access for staff (possibility of defect's repair and compilation of amended script), modularity etc.

- **diagnostic**: direct defects' identification, diagnostic tools that do not influence the system, tools to remote control by service helping, statistic errors control;
- **reparability / substitutivity**: modularity, synonymous identification of modules and elements, minimum of needed special tools, minimum repercussions caused by other elements and modules when they are replaced;
- **final control**: Easy procedures of service, minimum requirements referring to final control.

2.2. Functional qualities of the system's credibility

The ERP system's credibility depends on inviolableness and protection mechanisms implemented as functions that are performed by the system's elements. While testing credibility, also data base's credibility (which is the main source of problems in the ERP systems) is being tested, taking into consideration inviolableness and protections.

The inviolableness mechanism is implemented using the element that controls outputs from other elements.

The protection mechanism is implemented using the element that controls inputs to system, data base and all system's modules, besides the user who logs onto the system can have different authorizations for using system and its modules.

Credibility mechanisms include [6]:

1. checking:
   - if functions work correctly (e.g. using alarm program, using known data);
   - if data is correct;
2. actions, e.g.:
   - autocorrection;
   - information about acting.

Mechanisms which are presented above can be used to ensure inviolableness and protections. Credibility is a deterministic feature and some aspects can be expressed quantitatively.

One of the system's credibility elements is its protection that depends on mechanisms which are implemented on its limits in order to detect incorrect inputs, unauthorized access and preventing them. The safety element is one of the most essential points in the ERP system functioning, to a large degree the correct work of the enterprise depends on its working.

Another element of the system's credibility is its inviolableness that depends on mechanisms implemented in output elements in order to control the correctness of outputs. It also depends on mechanisms implemented in the system that are used to detect and prevent incorrect data transfer among system's modules. These inner mechanisms are mechanisms of inviolableness or protection of the system's modules which can be treated as systems themselves.

3. PROCEDURES OF THE ERP SYSTEM RATING

Before initiating the ERP system's estimation it is necessary to make a review of system's requirements and system's specification, it includes information that should be complete and accurate and allow to estimate dependability. If in any phase of estimation it appears, that

information is incorrect or there is no needed information, it is necessary to contact authors of documents of system's requirements and specification in order to ask questions that help to remove doubts. The dependability qualities that are required by every task should be singled out from the system's requirements document in qualitative and quantitative form, factors that influence the required dependability qualities should be put down in order to single out system's inputs and outputs and to define system's tasks (Fig. 3) [7].

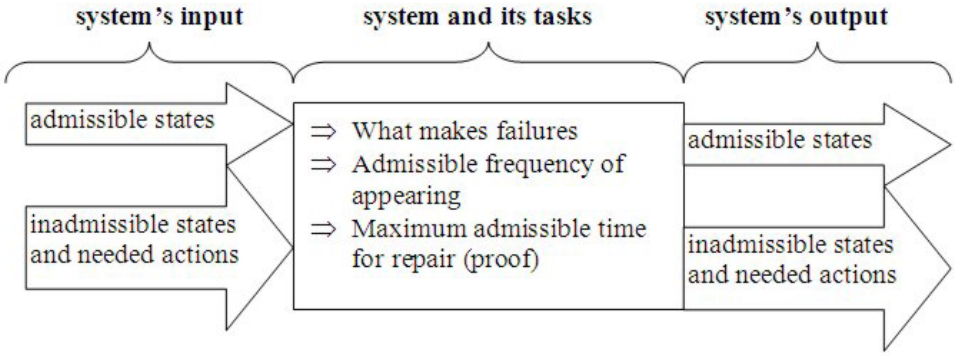

Fig. 3. Describing the system by its inputs, outputs and tasks

All information about dependability requirements and data about system's dependability should be put together and compared in order to define precisely following matters [6]:

- system's functional limits;
- system's positions where requirements are not fulfilled;
- functions that allow to fulfill required tasks and alternate tracks of data transfer, the data couple functions that help required tasks;
- allocation of functions to system's modules and elements, each function is completed with data about its dependability qualities;
- total initial knowledge and range of dependability qualities estimation.

Procedure of testing the ERP system's dependability in the context of its estimation (it is one of the most important points of dependability test) needs defining the following matters [6]:

- specifying the estimation object;
- specifying actions during estimation;
- defining the estimation program.

Complete list of estimation objects decreases by applying following filters:

- the task priority for realizing system's mission;
- level of trust on the basis of existing knowledge, it is based on previous successes of the system in realizing similar or identical missions, experience of implication firms, user's experience with the ERP systems;
- system's maturity that is defined on the basis of the system's novelty grade, number of functioning reference systems, standardization grade, interfaces, operating systems and program languages;
- level of correlation of different functions, number of interfaces, repeated use of different functions in different tasks.

After defining estimation objects it is possible to begin defining actions during system's dependability estimation. Following matters are parts of those actions [6]:

- analysis type and required tests;
- knowledge and skills required to every analysis;
- limits in estimation schedule resulting from the long time of some tests;
- accessibility of chosen staff;
- tools and service required to analysis and tests;
- estimating the costs and time of every analysis and every test;
- level of priority of every action during estimation.

While defining the estimation program it is necessary to pay attention to following list of actions [6]:

- deductive qualitative analysis of the system's dependability;
- criterions that they should pay attention to;
- actions during estimating;
- failures modes that should be analyzed and defined, expected results;
- attendance and protections mechanisms that are made accessible by the system;
- estimation schedule, lasting tests should be taken into consideration.

4. CHOSEN TECHNIQUES OF ASSIGNING THE ERP SYSTEM DEPENDABILITY

Techniques of defining the ERP system's dependability can be divided into quantitative and qualitative ones, the system's dependability defining can be combination of both techniques.

Analytical techniques described below are based on models. Those models cannot precisely represent such complex true system as the ERP system is.

Errors that are inserted to the system during designing, specifying and manufacturing influence the system's dependability. It regards both to equipment and software. Those errors can be detected only by pedantic control of ever action correctness.

In addition, inserting hypothetical defects or errors is a significant technique in increasing level of final confidence of the ERP system's dependability that is obtained during all phases of designing, specification and implementation with customization. Those techniques of inserting defects (using equipment and special software that adapt the system to the customer needs. implemented during customizing) are used to detect general consequences in performing system's tasks that are caused by such hypothetical defects and errors.

However it is important to remember, that in practice increasing the level of confidence is limited because number of tests is limited by number of all possible errors and defects that can be predicted and inserted [8] [9].

4.1. Qualitative techniques of assigning the ERP system dependability

Qualitative dependability defining bases on predictive analysis or on examinations.

In both cases it is necessary to begin dependability defining from the analysis of the system's functional structure and from performing tasks by the system in the context of functions being realized by the system for the customer.

They consider the modes of appearing failures of all elements of the system – both software and data base. They define the results of the modes for the system's tasks dependability together with the influence on attendance requirements.

Qualitative analysis can be performed with application of one of the following methods or applications:

Inductive analysis: the modes of appearing failures are identified at the level of module or function and the results of each failure on the system's tasks dependability at the nearest higher level are analyzed. Results of analyzed failures determine modes of appearing failures at the nearest higher level.

Those approach "from the basis" is a lasting method that gives the result of identified effects at all system's levels caused by all modes of appearing failures that were considered in the analysis.

Deductive analysis goes from hypothetical failures at the system's highest level (task's failure) to lower levels.

The nearest lower level is analyzed in order to identify modes of appearing failures and failures connected with them that could result in identified failures at the highest level – the task's level.

The analysis is repeated when it goes to the lower tracks of the system functioning as long as the analysis does not give enough information about dependability (together with attendance) in order that estimation is undertaken.

The deductive analysis does not give information about modes of appearing failures that are not counted as an event. However it is temporary effective in application of complex systems, in their case it is easier to describe all failures or correct system's functioning than to consider all possible modes of appearing failures of the ERP system's components.

4.2. Quantitative techniques of assigning the ERP system dependability

Quantitative dependability appointing can base on prediction analysis and calculations or examinations.

In both cases, it is necessary to start dependability appointing with functional analysis of the system's structure and the way of the ERP system's tasks performing.

Quantitative analysis can be performed by applying one of the following methods or their combinations:

Predictive dependability appointing: it bases on the qualitative analysis completed with the system's elements quantitative expression of failures' intensity, it can regard both with faulty software and with incorrect data base. I order to quantitative expressing of failures' intensity during the system's tasks performing it is necessary to use the predictive analysis method.

That method is orientated mainly towards analysis of success (of two states: it works – it doesn't work) and is ineffective in the cases of complex strategy of repairs and service and also in multiple-status situations.

I order to help calculations of failures' intensity, different mathematical tools can be used e.g. Boolean algebra, truth tables, analysis of paths and intersections, method of Markov analysis that becomes a complex method when there are many states to consider. In that cases it is very efficacious to apply the Markov analysis to calculating data of failures' intensity of analyzed models' sub-networks that are obtained by one of other methods e.g method of "tree of unfitness analysis" [1].

The system's properties, attendance, protections and inviolableness depend on designed qualities of the system and that is the reason why the grade of their existing cannot be calculate in the probabilistic way. It is necessary to consider failures' intensity of elements that are used to assure protections and inviolableness. Methods used to those elements' failures' intensity evaluation can be similar to methods used in the case of elements and modules adjusting main functions of the ERP system.

5. TESTS TO ASSIGNING THE ERP SYSTEM DEPENDABILITY

Possibility of measuring failures' intensity and readiness of any system similar to the ERP system by analyzes at the system's level is neither practical nor cheap. Usually the complex system is unique (thanks to customization applied during implementation of the system in an enterprise).

What is more, that tests are out of necessity very restricted because of time intended for examinations. However in case of the ERP systems that have already begun functioning, those tests deliver valuable information both to firms of implementation and to institutions and firms that implement the given system.

The real data obtained in that way are useful to:

- suggestions about improving implementations, system's structure, redesigning or replacing software that is subjected to defects;
- comparing characteristics that are expected or given in specification with real data;
- data base creating, that can be useful to future dependability predictions.

The main reason of the system's test' performing is appointing the system's behavior in the presence of any defect (of software or data base) or by unauthorized or incorrect input (inviolableness and protections).

In order to observe the system's behavior it is necessary to define the representative task or set of tasks and for each considering task it is necessary to define the failure (e.g. outputs' state).

Examining with the technique of defects' inserting. Before examining tha consists in defects' inserting it is necessary to verify the ERP system's specification in order to define:

- inviolableness measures that are taken to avoid spreading defects both in the system and in data base;
- protections' measurements that are taken to avoid faulty or unauthorized inputs to data base that the ERP system bases on;
- making accessible the diagnostic properties.

In order to be temporary efficient, the system's examination project should base on the qualitative analysis and it should use diagnostic properties that are being made accessible by the system and delivered to it. Most of the ERP systems including the MS Axapta are equipped with such tools that make possible monitoring both server and customers. It is necessary to pay attention to the fact, that when those diagnostic qualities are necessary to assure the system' s dependability then it is recommended that they are examined independently.

While the modules, elements and components are being examined, defects can be inserted in order to observe if:

- the system's outputs are not fully efficient or are fully efficient;
- the defect's signaling takes place or not.

While the protections are being examined, defects (or unauthorized information) can be found at the system's limit, that is: incorrect input, human mistakes in operative actions or service.

It is necessary to be sure, that some simultaneous examinations of inviolableness and protections are undertaken. One of the defect's results inside the system can be enabling the defect's output detecting.

Tests by environment conditions changes. Some changes of influencing conditions can switch over mechanisms of protections. That is why it is recommended to change chosen conditions that influence around their normal values in order to test mechanisms of protections.

6. EVALUATION AND WRITING OUT THE REPORT

It is recommended that report on the ERP system test have the following elements:

1. a plan of the test with indispensable departures;
2. statement on the basis of the system's requirements document and system's specification document, information about system's tasks, dependability requirements, environment conditions, work and service etc.;
3. system's analysis:
   - physical and functional structure of the whole system, stresses that act on a data base, system's module;
4. models' adaptation :
   - models' adaptation when it is necessary for prediction aims, taking into consideration nedeed accuracy;
5. data gaining, e.g. sources used in mathematical models;
6. it s recommended that calculations are presented with results accuracy;
7. making following tests:
   - test's description and choice of tests justification
   - simulating of defects modes
   - expected behavior resulting from qualitative analysis
   - expected frequency that results from quantitative analysis of defects that can appear
   - type of defects that are supplied to the system in order to inviolableness and protections testing, data base's damages simulating e.g. defects supplied by input/output elements, defects resulting from human mistakes (e.g. as the result of service action), defects supplied as the mistake's result
   - type and level of influencing factors that are supplied to the system's limits
   - time of defects' recognizing
   - defect's insulation (defects' distribution)
   - time of defects' localization
   - on-line checking the diagnostic's correctness e.g. if false alarms, system's defects that are essential with regard to process's functioning etc. are recognized correctly
8. list of operations by testing recommended to further analysis and tests.

7. REVIEW OF THE MS AXAPTA SYSTEM FROM THE POINT OF VIEW OF CHOSEN ELEMENTS' OF SYSTEM FUNCTIONING DEPENDABILITY

MS Axapta is a computer system of the ERP class designed for the large and average firms acting in the international environment which expectations are connected with elastic computer filing of their activity.

Axapta consists of many modules which during co-operating make the management of all enterprise elements possible. The MS Axapta system co-operates with the data base of MS SQL. Program environment MorphX in Axapta is used to develop and customize of software (Fig. 4).

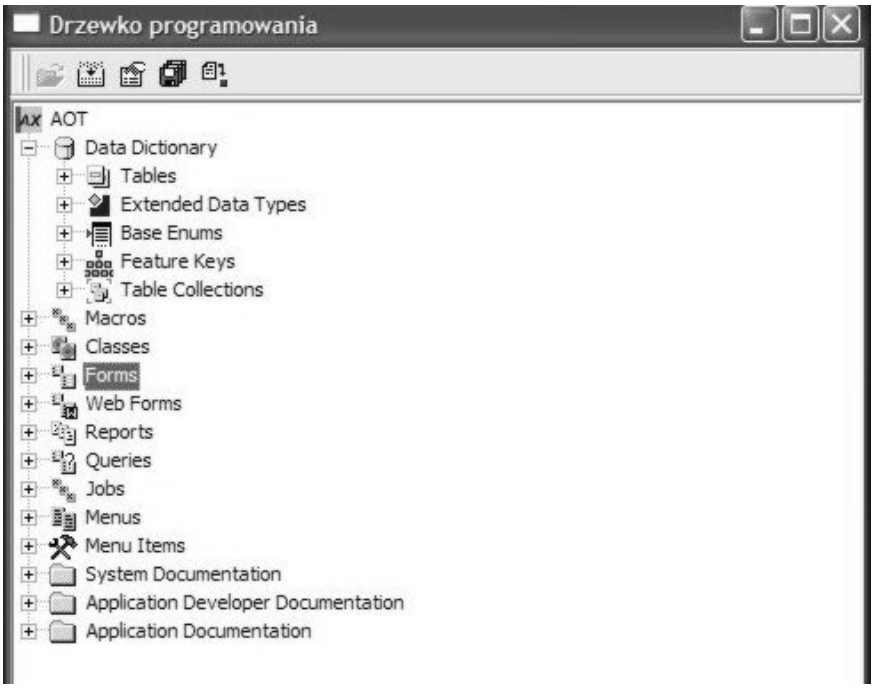

Fig. 4. Program environment MorphX

MorphX Development Suite is the main tool which allows to find solutions in the system. That intelligent environment is used to creating the application, it gives possibility of adaptation to the of the needs on the stage of implementation.

In the MorphX Development Suite the business logic was written in X++ program language. That language is object orientable and optimized to business solutions creating. The X++ syntax is close to Java and SQL syntax, therefore most programmers know it.

The system's dependability testing depends on the directive lines presented in first part of the article. The part of testing connected with system's dependability analysis and concerning the ERP system's readiness to functions fulfilling will be presented. Testing of failures'

intensity and attendance will be part of that readiness. Possibilities of creating software for the system that is to be used in customizing process will be presented.

The Axapta system and other similar ERP systems enable changes in software, the aim of this is to adapt software for customers' needs.

Basic elements which have an effect on system's dependability deterioration are connected with errors that are load in the system during designing process and software specification. It concerns in particular new software. The program environment of the MS Axapta enables correct compiling hardware and software (Fig. 5). Owing to it, possible program errors can be detected during designing.

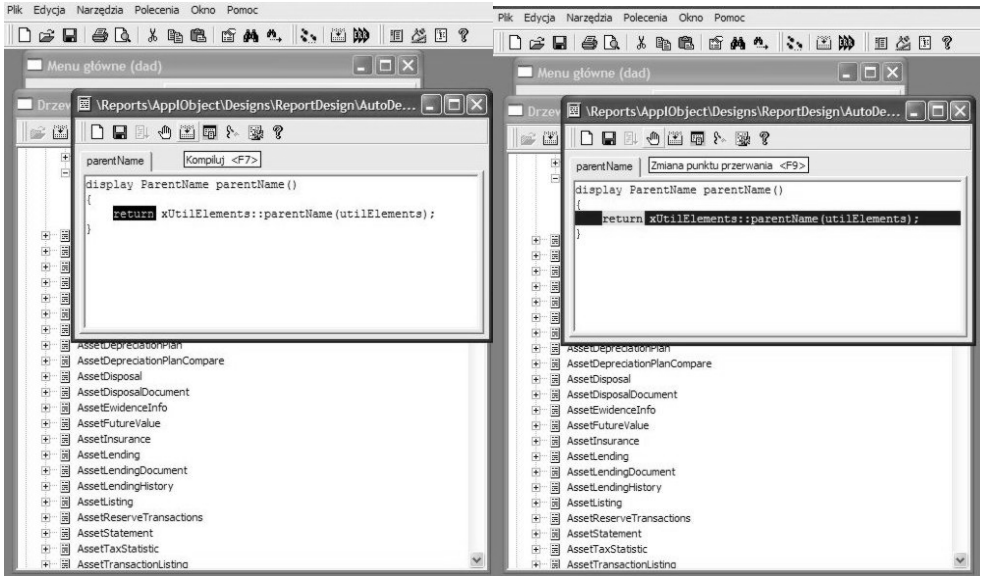

Fig. 5. Program environment of the MS Axapta system

The supplementary convenience of program environment Axapta is the messages window which helps in software for customers creating (Fig. 6).

In order to define possibilities of Axapta testing, review of system's yield should be undertaken by means of implemented diagnostic modules which are made accessible by the system. Fig. 7 presents tools which enable defining the system's yield level, in particular the main server. It is also possible to write complex reports which answer a question, how the system and the server are loaded in longer period of time (Fig. 8).

During the MS Axapta system reviewing from the point of view of some elements of system's functioning dependability, using the tools implemented in MS Axapta, they pay attention to the fact, that diagnostic mechanisms which are necessary to system's dependability assuring, should be sifted in an independent way. Testing correctness of diagnostic mechanisms working was performed with technique of defects inserting. The system and the server were loaded in different ways, at the same time the system's yield was monitored with reports generating. Tests showed that implemented diagnostic mechanisms in MS Axapta worked correctly.

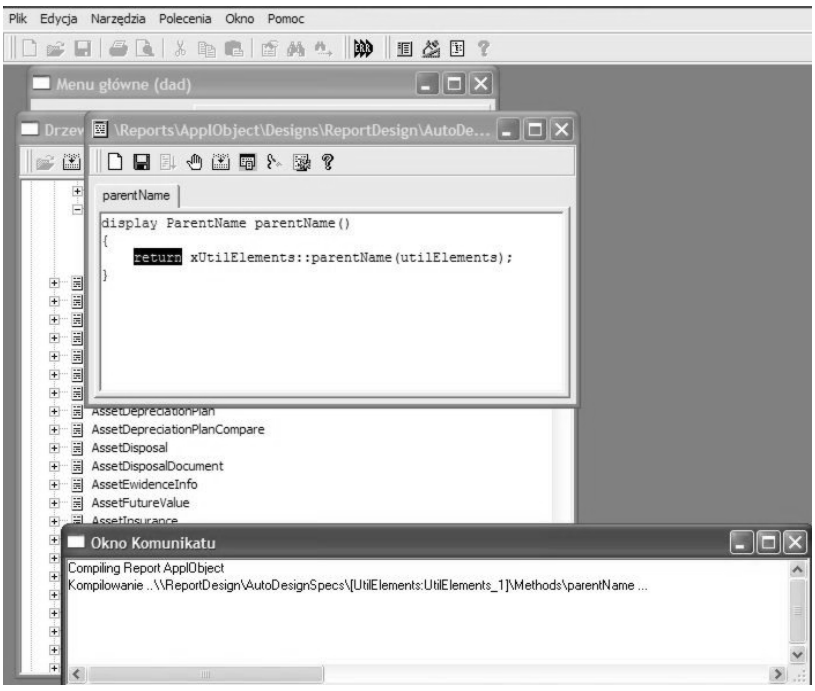

Fig. 6. Projection of the message window under the compiler

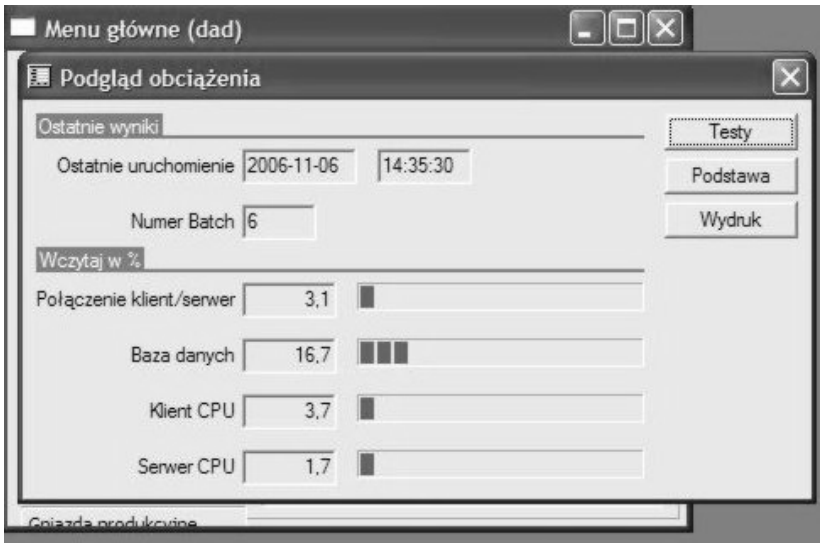

Fig. 7. Testing on-line system's and server's yield

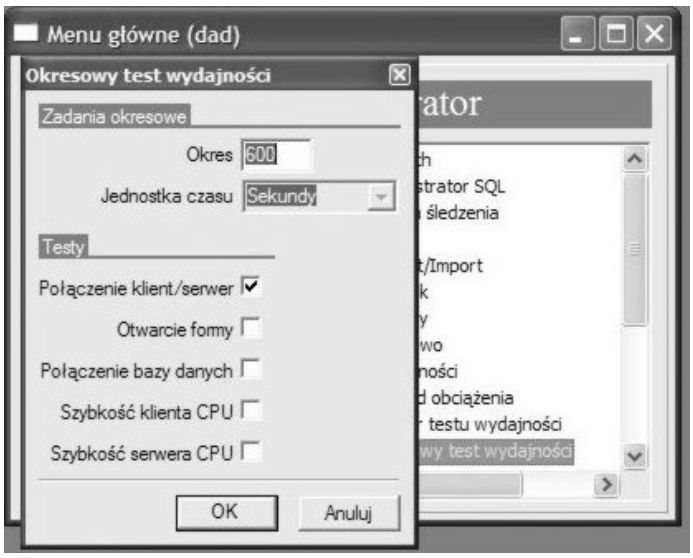

Fig. 8. Window of preparing the report of system's and server's field in the MS Axapta

8. SUMMARY

The possibility of testing of ERP systems dependability is a subject characterized by great complexity, which exists both within the software which carries out the system's functions, as well as within its database.

The paper presents the main points which allow for an interpretation of the elements of the system, which should be tested, as well as the ways in which are correctly planned testing of the ERP system should be carried out.

The dependability testing has been mostly based on the PN-EN 61069 Standard: *Industrial-process measurement and control. Evaluation of system properties for the purpose of system assessment. Part 5: Assessment of system dependability*, thanks to which testing for different firms is carried out using the same normalized procedure, which allows for comparison of results and may be used to improve the process of implementing and functioning of the ERP systems within an enterprise.

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