

## SOFTWARE DEVELOPMENT FOR ANALYSIS IMPLEMENTATION ORDERS FOR REPAIR OF MINE EQUIPMENT

**Serhii Baran**

Associate Professor, PhD, Kryvyi Rih Economic Institute of Kyiv National Economic University named after Vadym Hetman,

e-mail: baran\_sv@kneu.dp.ua, orcid.org/0000-0002-3232-4072, Ukraine

**Adam Polański**

MA, Polonia University in Czestochowa,

e-mail: polanski\_adam@wp.pl, orcid.org/0000-0002-7364-1832, Poland

**Abstract.** The article presents the results of the database development for accounting orders and the software for analyzing the realization of orders for the repair of mining equipment using modern information technologies.

**Keywords:** orders, mining equipment, database, MySQL, Visual C#.NET.

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### Introduction

Mining and metallurgical enterprises attract outsourcing companies for current and capital repairs. Actual implementation of contract management as well as accounting and analysis of repair orders are of current importance for such companies. To fulfill such tasks it is necessary to apply modern information technologies. It is determined by the large amount of data to be processed. In addition, modern software provides a great opportunity for visual presentation of data. This provides the opportunity for specialists to make well-founded decisions concerning the repair works and to analyze their effectiveness.

One of the main requirements for software is the creation of a single database of orders for repair of mining equipment. This will provide an effective analysis of order execution. At mining enterprises, production equipment subject to current and major repairs is located on many sites. Such sites can be located at rather long distances from each other. Experts who control the process are located on such areas. Therefore, one of the important requirements for accounting and analysis software for repair orders is to provide opportunities for ordering using Internet technologies.

Another requirement is to provide the work of specialists with different levels of access in the system. A team of specialists which manages the repair work on sites should be able to create and edit orders and acts of completed works. At the same time, it is necessary to provide a history of data changes. This is essential for the performance of the control of users' actions. Top managers are located in the central office. They have the opportunity to create contracts which contain data list of repair services and their cost. They also approve the acts of the completed works.

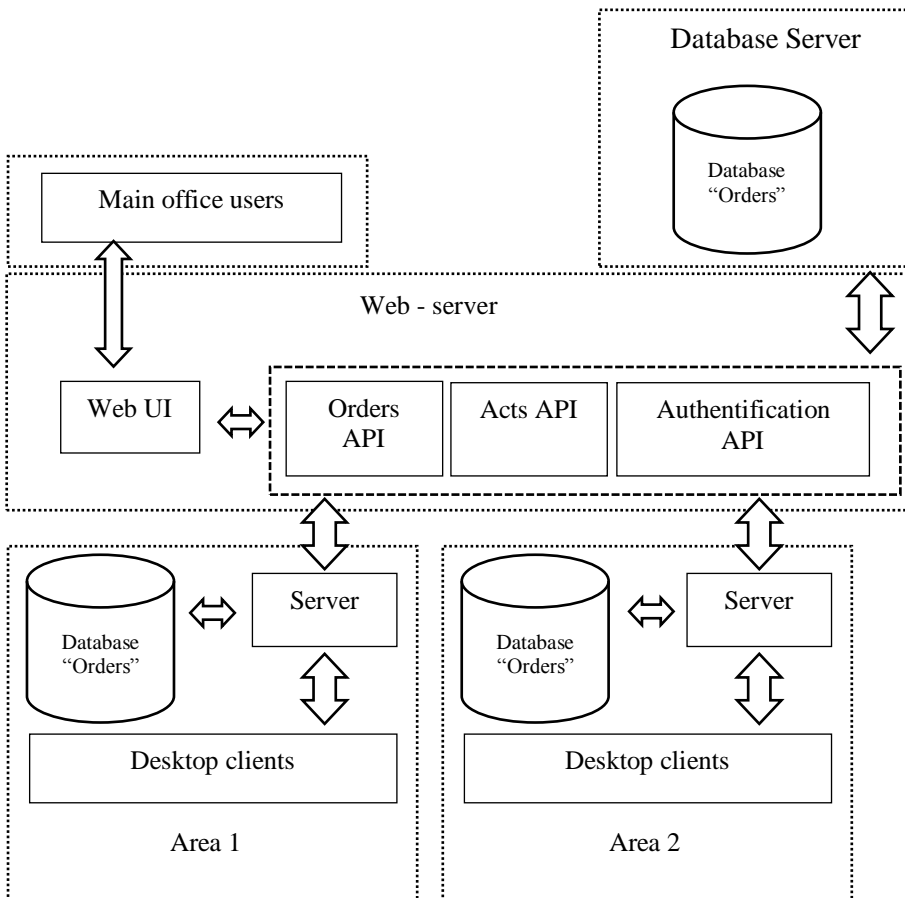
In the software market there is a fairly wide range of free and paid products for such tasks. But the existing software does not meet all the requirements. They are difficult to adapt to the conditions of the organization of processing orders for the repair of mining equipment.

One of the possible options is to purchase corporate information systems such as SAP R / 3, 1C: Enterprise, etc. But for small outsourcing companies which carry out repair work, the cost of acquiring licenses, training, adapting such systems is quite high.

Thus, there arises a necessary to develop the architecture of the system of accounting and analysis of orders for the repair of mining equipment, the database of orders and acts of completed works, and also the creation of software which would allow to analyze the implementation of orders for effective solutions.

**Database and software development for accounting and analysis of the realization of orders**

The architecture of the system created according to the requirements is presented in Fig. 1.



**Fig. 1. Architecture of the system of accounting and analysis of repair orders**

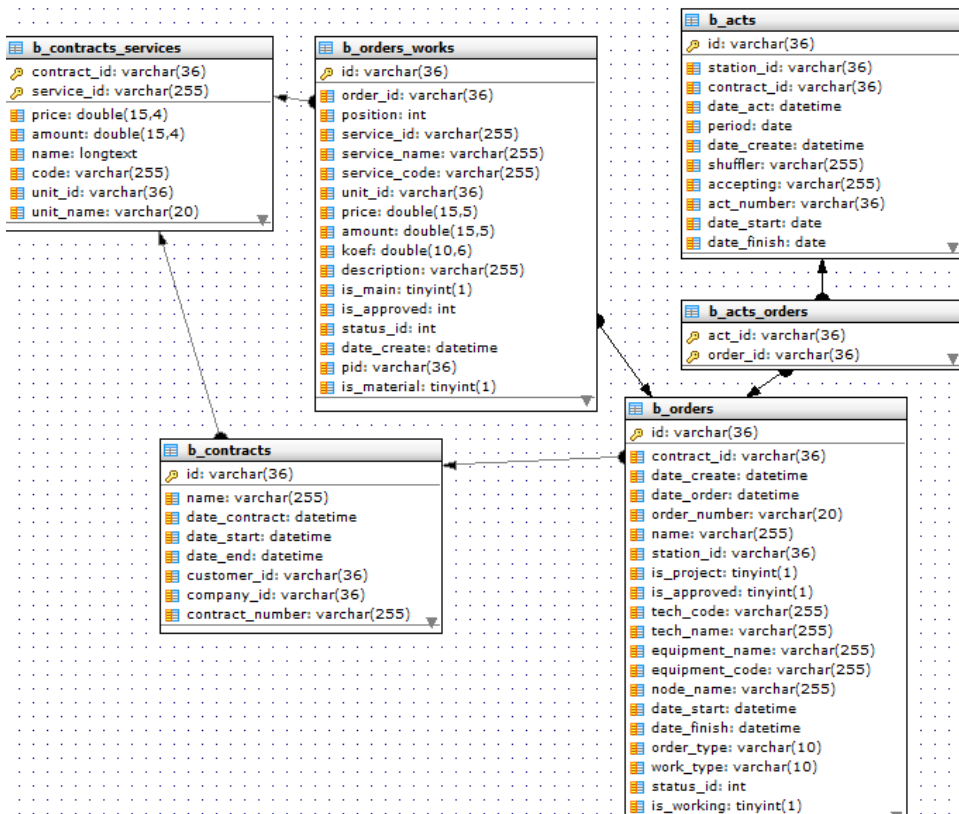
On the web server there are server applications, the main ones of which implement the interface for storing and processing data of orders, acts of completed works, contracts and

authorization of users. All data are stored in the main database on the server. The access of managers from the head office to the order data is fulfilled through the web interface. That is, the manager can use the browser to open the web site of the system. After authorization, depending on the level of access, they will be given the opportunity to review orders, data of contracts, acts of completed works and reports. The manager with the maximum level of access has the right to create contracts, edit their data and approve acts of completed works.

Each of the sites where the repair works are carried out has its own workplaces and the server. The order data are accumulated in the database of each site. The server of a specific site exchanges data with the main server. At the same time, only the documents which have been changed are transferred to the main server. The possibility of autonomous operation of the site for processing orders is realized even in the absence of the Internet connection.

Each site can also work through a web interface. Users of the site with the maximum access level can create and edit orders and acts of completed works within their site. Acts of completed works and orders are not available for editing after the approval by the office managers.

To fulfill this task the database was created. This database contains the following basic guides: unit of measurement (b\_units), workspaces (b\_stations), services (b\_services). The contract table (b\_contracts) contains the signatories, the date of conclusion, and the linked table "b\_contracts\_services" contains the types of repairs agreed upon with the customers. The relational connection between the main tables is shown in Fig. 2.



### Fig. 2. Relationship between database tables

The order details are in the «b\_orders» table. When an order is creating, the contract number (contract\_id) and the area number (station\_id) are indicated. The order table also contains the name and code of the repair equipment and the unit, the date of the introduction of the equipment into operation, etc. Each of the orders can be in three variants: the project (is\_project), the working (is\_working) and the approved (is\_approved). The table "b\_orders\_works" contains data on the completed works (services) for each order. When adding work (service) to an order, the presence of such work in the contract is checked (table "b\_contract\_services"). When adding a service, the price, volume, name, unit of measurement are saved. Price, volume and other parameters may be different in project, working and approved version of the order. Changes in the value of orders works indicators (price, status, volume, comment) by a particular user are saved in the table "b\_orders\_works\_history". For each order or work, you can attach images or documents confirming the fact of the works for the customer. Such data contains the table "b\_orders\_works\_images". Each order passes a certain approval procedure by different departments, each step of which is fixed in the table "b\_orders\_levels".

On the basis of one or more orders, an act of completed works is created, the data of which is saved in the tables "b\_acts", "b\_acts\_orders". The table "b\_acts" contains general information about acts of completed works: approval date, financial period, signatories. The table "b\_acts\_orders" contains the order numbers for each acts. Financial reports based on data from the tables of acts and orders. The database also contains user data, their permissions. There are tables that contain user access rights to certain areas and contracts.

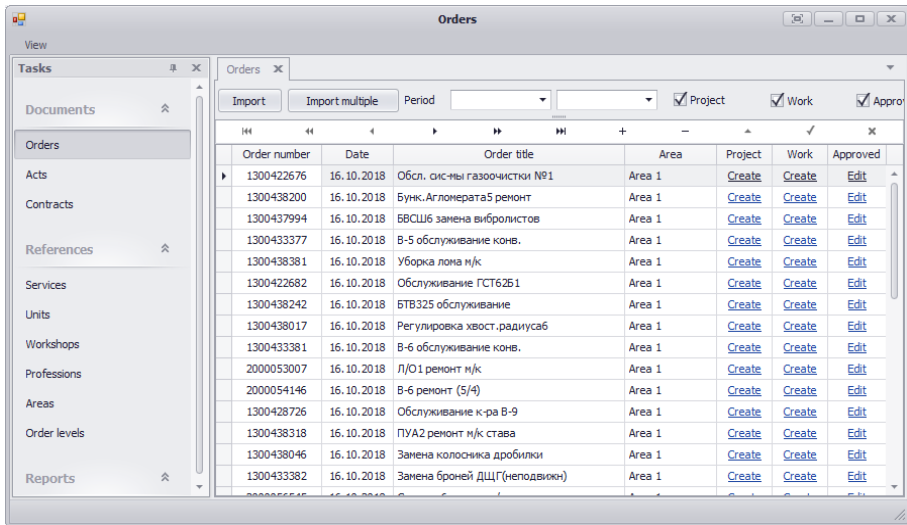
The database is created using MySQL. MySQL is a solution for small and medium applications. Flexibility MySQL DBMS is supported by a large number of table types. Main advantages of MySQL: multithreading, support for multiple simultaneous queries; fixed and variable length of records; flexible system of privileges and passwords; flexible support for numeric formats, variable length strings and time stamps; fast work, scalability; compatibility with ANSI SQL; free; good support from hosting providers; fast support for transactions through the InnoDB mechanism. Also, the advantage of MySQL is its fast work. In MySQL, multithreading is implemented, which guarantees a high speed of the database. For all that, the DBMS is safe. It is important to note its openness. The code that is used by MySQL is open, which allows you to add any functionality without any obstacles.

For specialists who manage repair work on areas, software in Visual C # .NET with using Windows Forms was created. Windows Forms - Application Programming Interface (API), which is responsible for the graphical user interface and is a part of Microsoft .NET Framework. Microsoft .NET Framework provides users with the ability to get more convenient, elegant, flexible applications that work with different data sources. Integration of data in a user-friendly form with the help of Microsoft .NET Framework allows to obtain the general principle of information processing on all versions of Windows. With Windows Forms can develop smart clients. Smart clients are graphically rich applications that are easy to deploy and update, can work when they are connected to or disconnected from the Internet, and can access resources on the local computer in a more secure manner than traditional Windows-based applications. DevExpress's library of components was used for development.

DevExpress WinForms is a software package that includes over 120 powerful controls and libraries for WinForms. Optimized tools of this solution allow programmers to develop highly customizable applications that meet specific business objectives. DevExpress

WinForms offers clickable controls, more than 40 themes for applications, and also characterized by increased performance.

The interface of the developed software is shown in Fig. 3.



**Fig. 3. Orders view interface**

The user has the opportunity to view, edit and create such documents: acts, orders and contracts. It also provides the opportunity to view and edit services (works), units of measure, areas, etc.

The user is given the opportunity to view the list of orders. During viewing any catalogs or documents, the user has the ability to filter and sort by various parameters. So order can be selected for a certain period and filtered by status. The possibility of creating an order is realized. In this case, the user must specify a orders number, choose a contract and area for order.

The most important point is the ability to import orders from an Excel file. This is an important point as the customer sends approved orders by e-mail. The import interface is shown in Fig. 4.

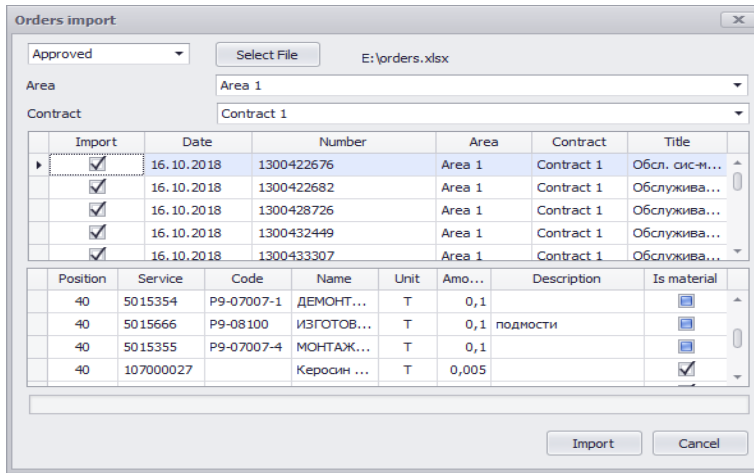


Fig. 4. Orders import interface

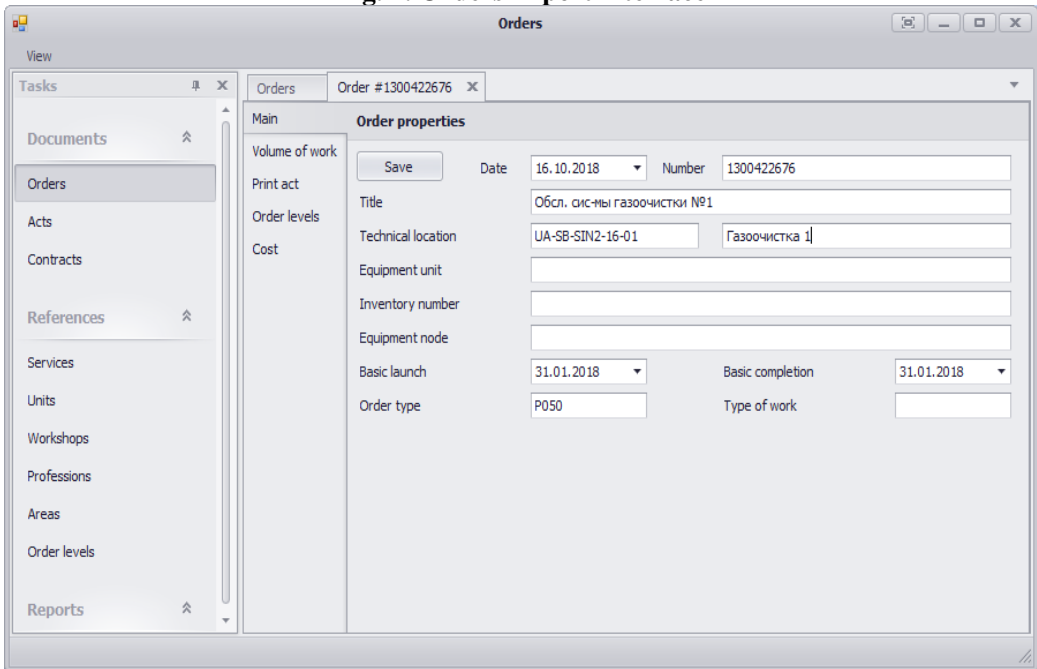


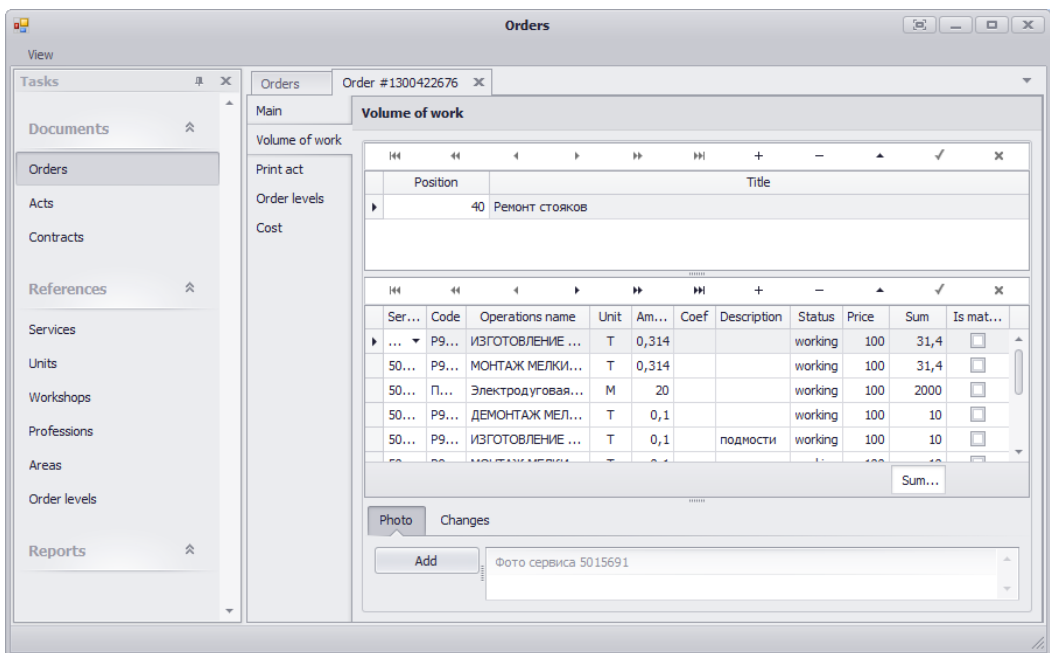
Fig. 5. Order properties edit interface

Import is possible in two different formats. There is an option in fig. 4, where there are many orders in one file. In order to import, you must select a file, contract and area, to which the order belongs. During importing an order thorough data validation happened. The user has the ability to view orders data before importing them. He is given the opportunity to select all or specific orders to import them from the file. The developed interface significantly reduces the time spent on creating orders.

Fig. 5 demonstrates the ability to edit the properties of the order. On a separate tab, the user can receive an Excel file that contains a draft act of works, an order for materials and

other necessary forms. On the "Orders levels" tab, user can see approval order history by different customer departments.

The most labor-intensive stage is the input list of order works and materials that fig. 5 demonstrates. The specialist must input rows with types of repairs into top table with columns "Position" and "Title" (fig. 6). Each of the completed work is related to a certain type of repair. In the lower table, the user is able to add rows with services. At the same time, the user can add some services from the contract in two ways. The first involves searching for a service by code. The second option is the dialog when you click the button in the "Operation name" column. The dialog shows the services from the contract order. In this case, the user has a wide range of services to search by name, code and other characteristics. It provides a flexible interface for inputting works. After the service (work) is selected, the price of the contract is automatically filled in. User can not edit this field. The customer may cancel a certain work. After this, the specialist in the "Status" field must select the option "Canceled". When the work is completed, the status changes to "Completed".



**Fig. 6. Orders works edit interface**

The whole history of changing the parameters of a particular work is saved in the database. This can be seen on the tab "Changes". Specialist may attach a photo or a document file that confirms the fact of the completed work. This is done on the "Photo" tab (fig. 5). Such files are stored in a database with a link to the completed work. On the "Cost" tab, a specialist can analyze orders data. The expert can see diagrams and charts for these orders. The user is given the possibility of tabular input of technical parameters of equipment, parameters of its adjustment and plotting on such indicators. The visualization data is attached to the acts of the completed works as confirmation of the efficiency of the repairs performed.

The specialist is creating acts of completed works on the basis of approved orders data. To do this, user selects the orders which will be included in the act. The form of the act includes only works with the status "Completed". On the basis of created acts, a periodic closure document is created monthly. Based on the data of the approved acts, managers can generate reports. The user is given the opportunity to choose the parameters for grouping and sorting data in reports. The Report Designer allows you to save the selected parameters. Reports can be saved in Word, Excel, PDF formats. User can see charts which are based on cost indicators and other characteristics. Developed software provides flexible tools for creating reports and making effective decisions by specialists.

On the servers of each area, software is used to exchange data with the main server. When data is saving into a database, a queue is automatically formed. The queue includes identifiers of updated documents. The server software downloads the changed documents to the main office database in automatic mode. Employees of the main office form data on contracts. When the contract parameters are changing, the server of each area automatically downloads the contract data into own database. The employees of the main office through the web interface can edit the contract data and user rights for each area.

Thus, in order to ensure the effectiveness of the analysis of orders for repairs, a database and software package were developed. The software meets the modern requirements, because it is created using the latest technology. The developed software allows to effectively manage orders. It has flexible tools for creating orders, acts and reports based on them. Visualization of the analysis results in the form of charts and diagrams allows specialists to make grounded decisions.

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