

# DEVELOPMENT OF INFORMATION SYSTEM FOR MODELLING OF GRAIN SIZE DISTRIBUTION USING IDEF METHOD

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## ABSTRACT

This paper is the result of a multidisciplinary application of information technology and statistical methods in the function for development of information systems for modelling the grain size distribution. Also, it is an initiative to stimulate the application of information technology and computer science in different scientific fields in order to promote the development of scientific and the general development of society. With regard to the objectives of the research, based on the theoretical basis of grain size distribution, statistical analysis and modelling, this paper presents the development of information systems for functional and information modelling the grain size of sample using IDEF methods.

**Keywords:** *Functional modelling, Information modelling, Database, Objects, Entities, Relationships, Attributes, Activities, Model borders, Context diagram, Decomposition diagram, Activity tree, Grain size*

## 1. INTRODUCTION

Grain size distribution is very important characteristic of primary and secondary materials, but also for the material in pharmacy, agriculture, chemical industry and in many other branches of science. Usually is presented with graphical methods. In the middle of last century, several authors have proposed several different models of analytical presentation of grain size distribution [1, 2] which are based on the principle of graphical determination of these models.

Using computer science, statistical analysis and information technology, we can improve the development of these models and this paper will show the IDEF method for development of information system for modelling the grain size distribution [3, 4]. With this information system can be performs the systematization of data and allows efficient search database for future analysis and theoretical considerations with automation of statistical analysis and modelling.

In BPwin program, functional modelling is done by defining the border of the system model shown

in the diagram context, and sub-activities shown on the activity tree diagram [5]. With program ERwin is performed information data modelling, defining the necessary entities, their attributes and relationships between entities. All together, functional and information data modelling is the basis for defining the physical models and the database that was created in program MS Access [5, 6].

## 2. INFORMATION SYSTEM

Information system is the ordered set of methods, processes and operations to collect information about the real system [7,8], storing and processing these informations in a unique database, processing information in a modified form (new information) and their distribution to the user (Figure 1).

The information system must also contain information about the processes which include actions that generate outputs from the system [9, 10, 11] (in this case, it is principles of statistical analysis and modelling of grain size distribution).

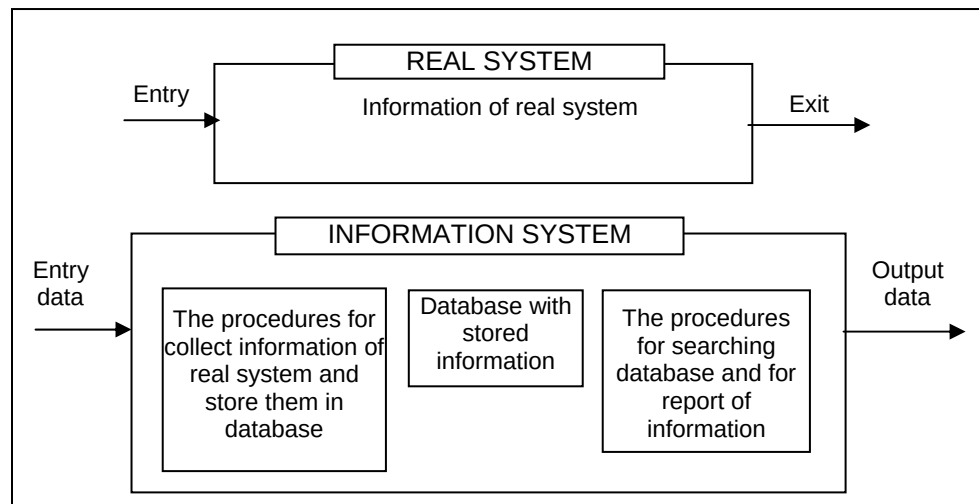


Figure 1 - The real and information system

For designing the system, there are two important stages: logical design, physical design. Logical design is for data modelling and process modelling. The result of the logical design must be understandable to the user and designer, and should be independent of implementation. Physical design is the translation of logical design on specific equipment, specific software and specific database.

The basic thing of any information system is a database or database system with interrelated data objects which are modelled, connections between these objects and the corresponding attributes - characteristics of objects and relationships.

There are many methods for system modelling mainly based on the graphical display, with universal methodologies can be applied to any type of system.

### 3. STANDARDS AS SUPPORT FOR INFORMATION SYSTEMS MODELLING

Information modelling can be understood as an abstract vision of the state of the real system. In other words, this is a simplified representation of the real system through a set of objects (entities), relationships between objects and object attributes.

Modelling and development of information systems is usually with the computer. In the last few years is created a large number of CASE tools (Computer Aided Software Engineering) that can be used for this purpose, but their use is not possible without detailed knowledge of the methodology behind their application.

Technique IDEF (Integration **DEF**inition) modelling has been accepted as the basis for such purposes, where the development of information system is based on **IDEF0** standards for functional modelling and **IDEF1X** standard (eXtend) for information modelling [5, 6]. For the application of these modelling standards have been developed appropriate CASE tools:

- **BPwin** (Business Process for windows) for functional modelling (IDEF0) and
- **ERwin** (Entity Relationships for windows) for information modelling (IDEF1X).

#### 3.1. FUNCTIONAL MODELLING - IDEF0

IDEF0 methodology is used to represent business processes and the decomposition of the system to its basic functions. The syntax of the graphic language IDEF0 is rectangles, arrows and instructions. IDEF0 diagrams are called ICOM diagrams according to the English notation: Inputs, Controls, Outputs and Mechanisms. There are three types of this diagrams, each shows different levels of detail and description: the context diagram, decomposition diagrams and activity tree.

Context diagram - represents the highest level of abstraction of the system with decomposition diagrams translated into a lower level of abstraction. In this way, on Figure 2 is showed context diagram of information system for modelling of grain size analysis which describes the function "A0 - ANALYSIS AND MODELLING OF GRAIN SIZE DISTRIBUTION".

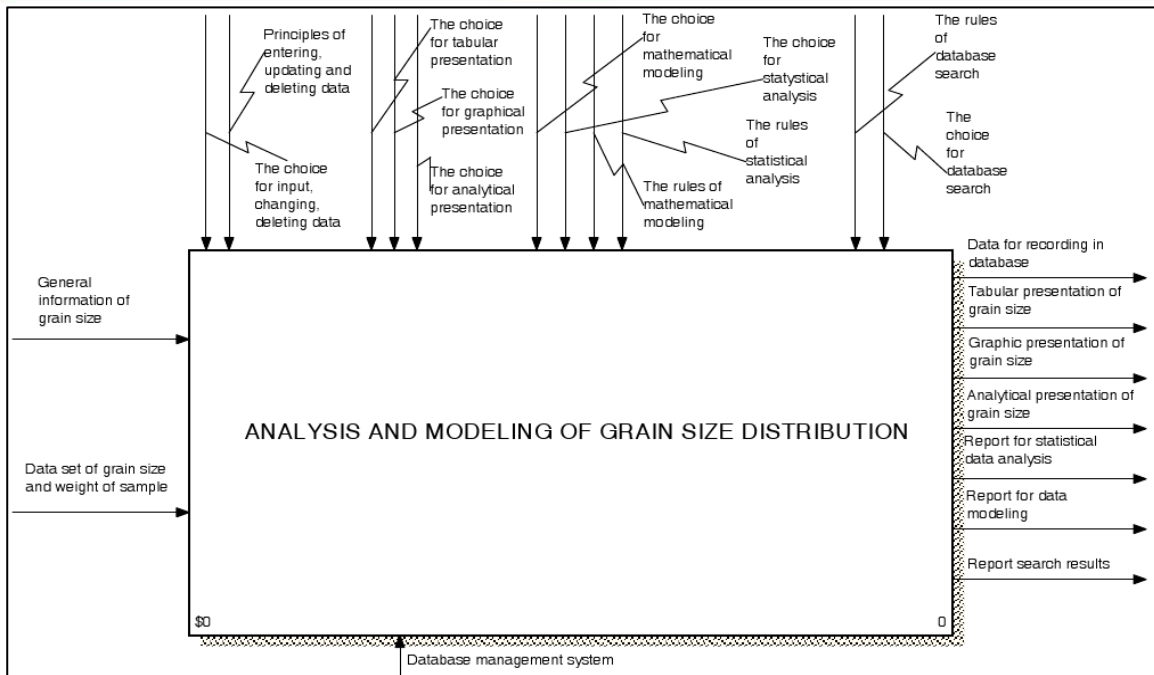


Figure 2 - Context diagram A0 - ANALYSIS AND MODELLING OF GRAIN SIZE DISTRIBUTION

Decomposition diagrams - are composed of rectangles that represent the activities and corresponding arrows. Each activity must have a name, number, at least one control and one output arrow. Numbers are used to identify items of description of activities, and to show how much

detail the activity it contains. Information system for modelling grain size analysis have decomposition diagram "A0 - ANALYSIS AND MODELLING OF GRAIN SIZE DISTRIBUTION (Figure 3).

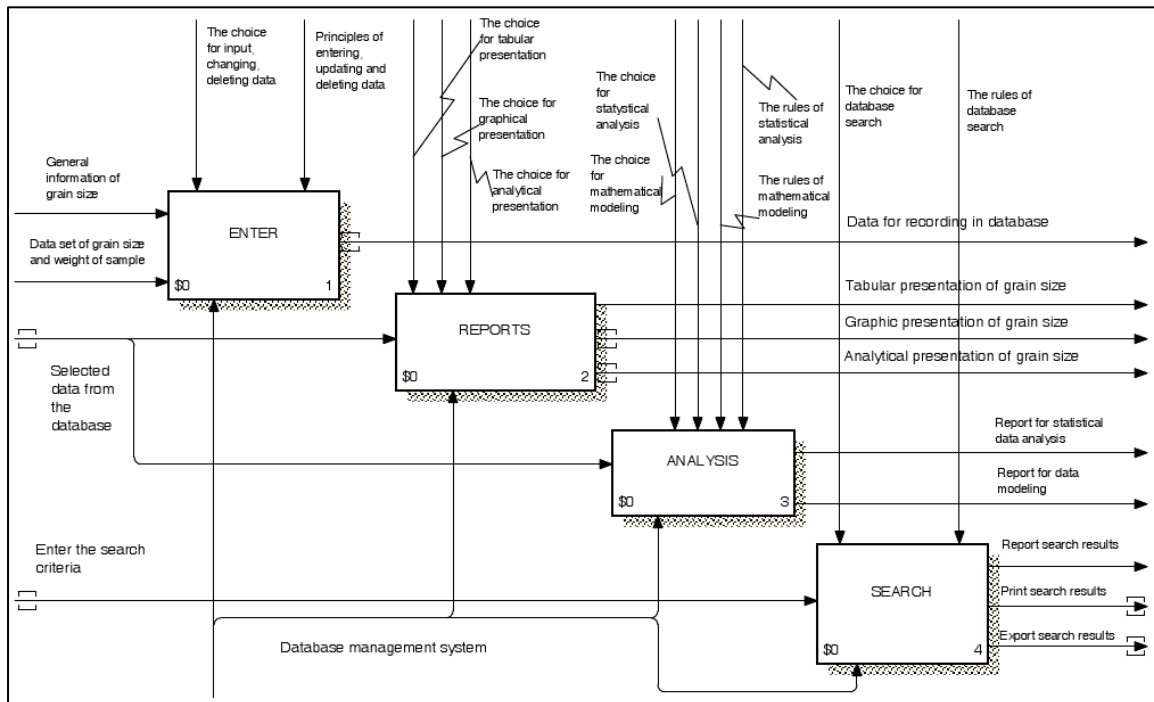


Figure 3 - Decomposition diagram A0 - ANALYSIS AND MODELLING OF GRAIN SIZE DISTRIBUTION

Activity tree - is a hierarchy of these activities and provides a functional decomposition of the system. This diagram is without arrows and has a clear view into the depth of the relationship

between activity. On Figure 4, is showed the activity tree of activity "A0 - ANALYSIS AND MODELLING OF GRAIN SIZE DISTRIBUTION".

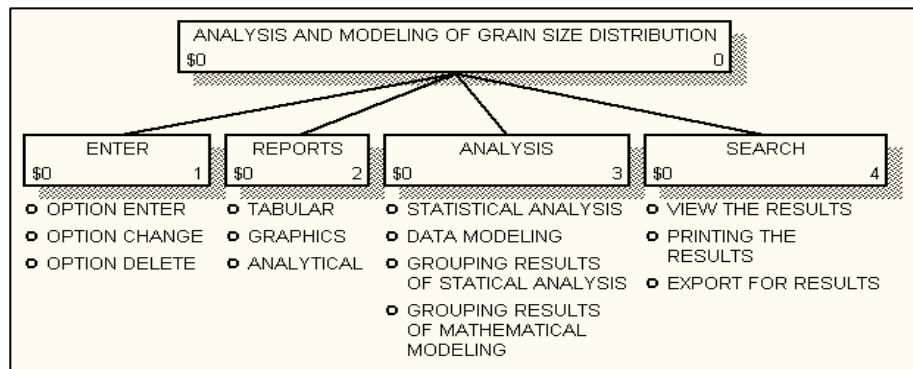


Figure 4 - Activity tree A0 - ANALYSIS AND MODELLING OF GRAIN SIZE DISTRIBUTION

### 3.2. FUNCTIONAL MODEL (BPWIN)

When the basis of information systems is defined, with BPwin tools can be performed functional modelling using IDEF0 standard.

IDEF0 graphical modelling for process make decomposition of the observed sub-processes at the level of primitive actions and defining all the input, output, control and enforcement elements of each sub-activity. In this way, the activity of process is total defined with creating conditions for the development of information data model.

Functional decomposition defines all necessary actions for analysis and modelling of grain size distribution. Functional decomposition is performed through the following sub-activities: defining the border of the model, description of the context diagram, defining a activity tree, defining the requirements and defining the decomposition diagram of activity [5].

Software tool for supports IDEF0 methodology, used in this paper is BPwin 4.0 of company Computer Associates International. Work in this program allows defining a tree decomposition of activities with appropriate diagrams by IDEF0 methodology in accordance with the demands of the problems that are processed - analysis and modelling of grain size distribution.

Performing these activities requires a clearly defined sequence of steps that are defined in sections 3.2.1. to 3.2.5.

#### 3.2.1. DEFINING THE REQUIREMENTS

This is the first step in the development cycle of information system which should satisfy the objectives: analysis and modelling of grain size distribution. Analyzing the real system is proposed a context diagram "Analysis and modelling of grain size distribution" (Figure 2). After this, is made a structured decomposition of complex systems to less complex systems, which are independently produced with their future integration into a one system [3]. Is proposed the following parts of the system presented on the decomposition diagram (Figure 3) and activity tree (Figure 4).

- ENTER
- REPORTS
- ANALYSIS
- SEARCH

#### 3.2.2. ACTIVITY "A1 - ENTER"

This activity is for entry, changes and storing data in the database (Figure 5). Provides a systematization of data and creates conditions for effective management and search the database for subsequent analysis and theoretical considerations. He is adapted to the form and nature of the input data of model for grain size distribution of sample. Activity tree of this activity is showed on Figure 6.

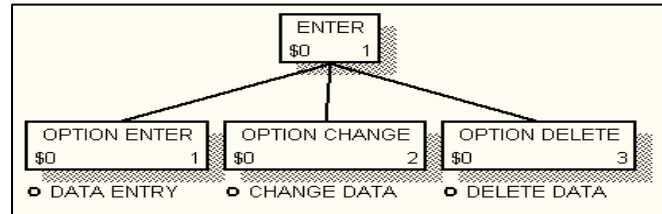


Figure 5 - Decomposition diagram A1 - ENTER

The input data are two sets of data: general data (name of the analysis, date, author, project etc) and paired data grain size/mass of sample which are transformed into output data for recording in a database.

Based on these activities and the rules, is done the system decomposition into smaller activity: option enter, change and option delete (Figure 7, 8, 9).

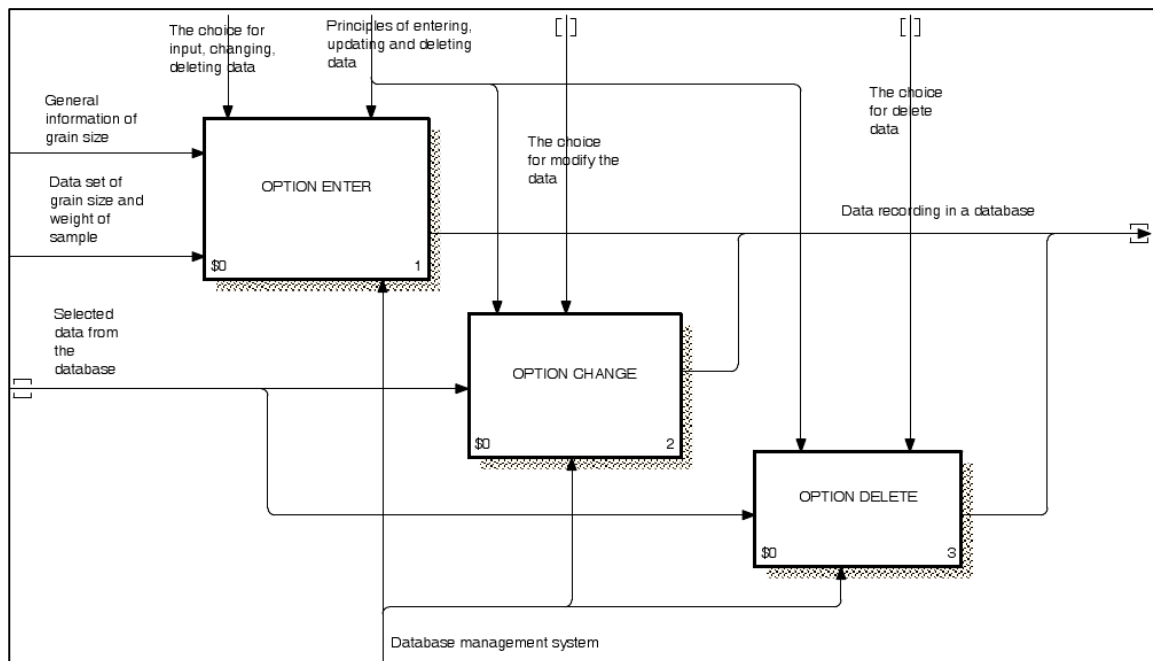


Figure 6 - Activity tree A1 - ENTER

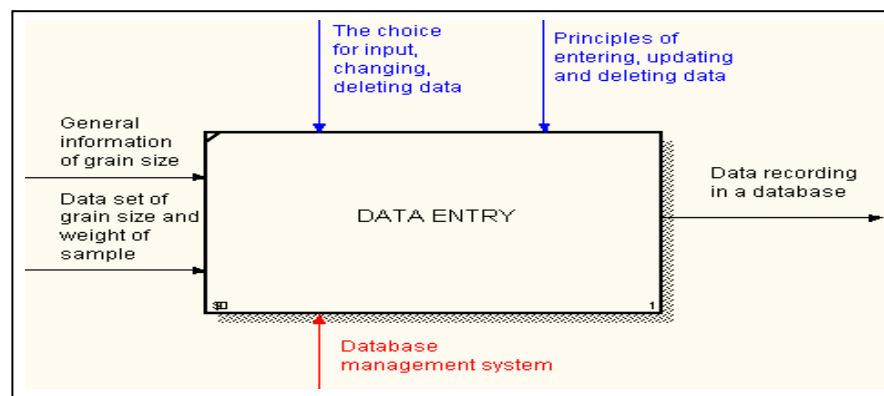


Figure 7 - Decomposition diagram A11 - OPTION ENTER



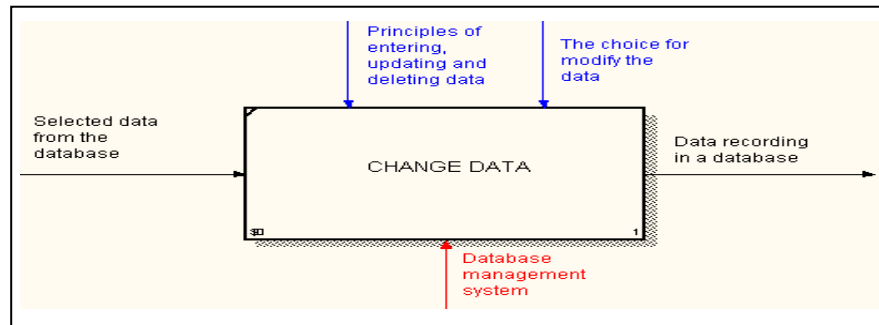


Figure 8 - Decomposition diagram A12 - OPTION CHANGE

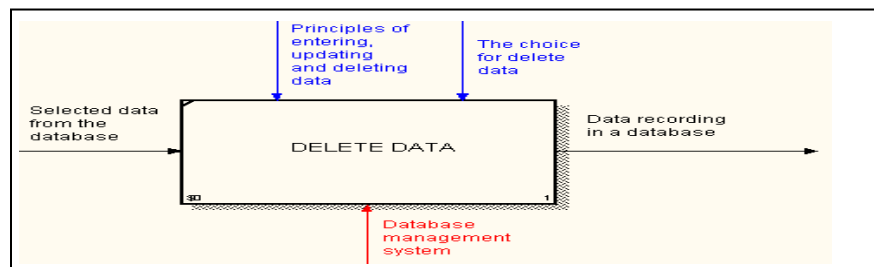


Figure 9 - Decomposition diagram A13 - OPTION DELETE

### 3.2.3. ACTIVITY "A2 - REPORTS"

This activity (Figure 10) which is a activity tree showing on Figure 11, gives the possibility to choose one of three modes presentation of grain size distribution: tabular, graphical and analytical form (Figure 12, 13, 14). The input data of these

activities is recorded data of grain size distribution from the database information system, and control principles is in accordance on the theoretical basis of their construction [1, 2]. Based on these activities and the rules, is made the decomposition of the system.

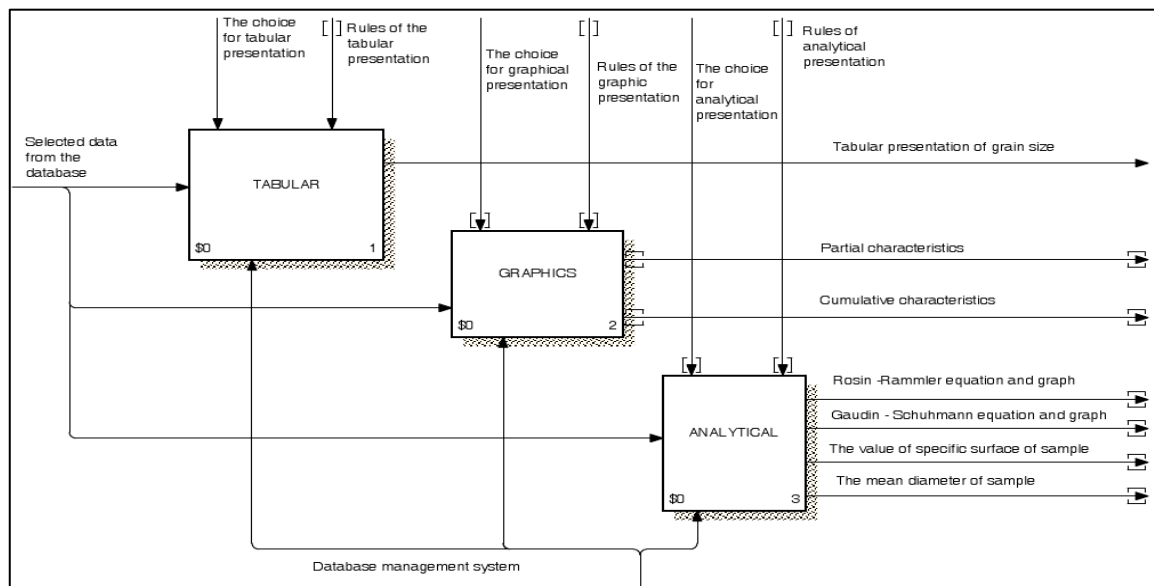


Figure 10 - Decomposition diagram A2 - REPORTS

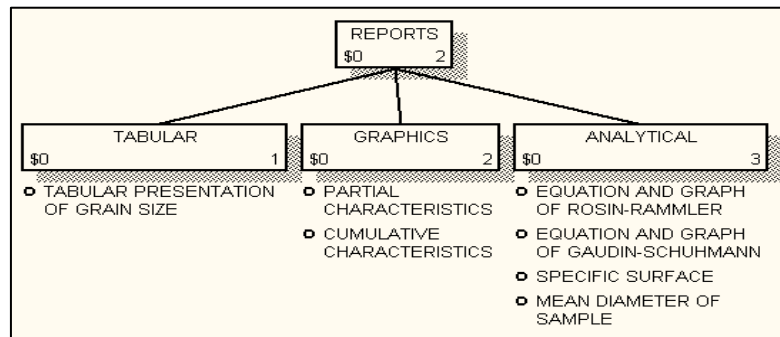


Figure 11 - Activity tree A2 - REPORTS

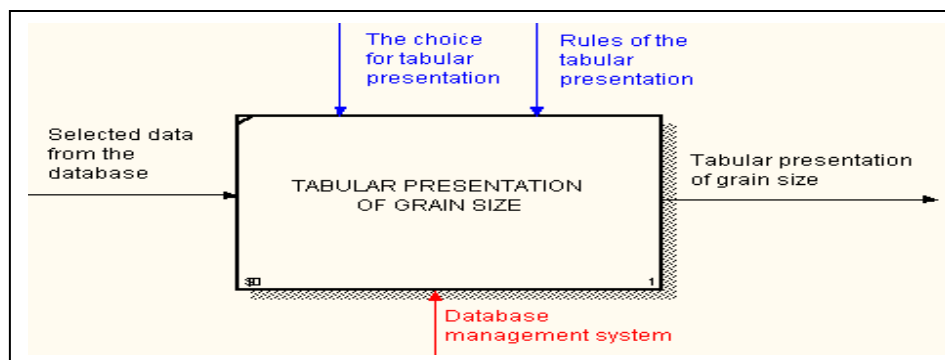


Figure 12 - Decomposition diagram A21 - TABULAR

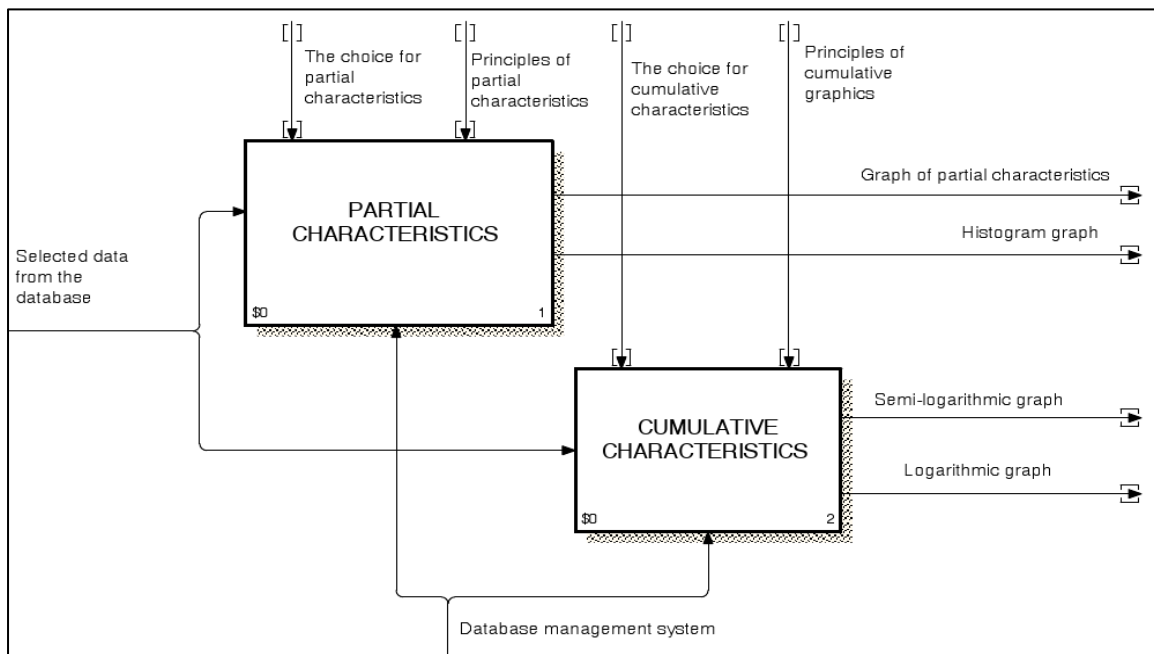


Figure 13 - Decomposition diagram A22 – GRAPHICS

For a graphical report (Figure 13) is made the decomposition of the partial and cumulative characteristics (Figure 14,15). Partial characteristics have a decomposition diagram: graph of partial characteristics and histogram graph. Cumulative characteristics also have two decomposition diagrams: semi-logarithmic and logarithmic graph.

Analytical report (Figure 16) contains activity: Rosin-Rammler equation, Gaudin-Schuhmann equation, specific surface and mean diameter of sample.

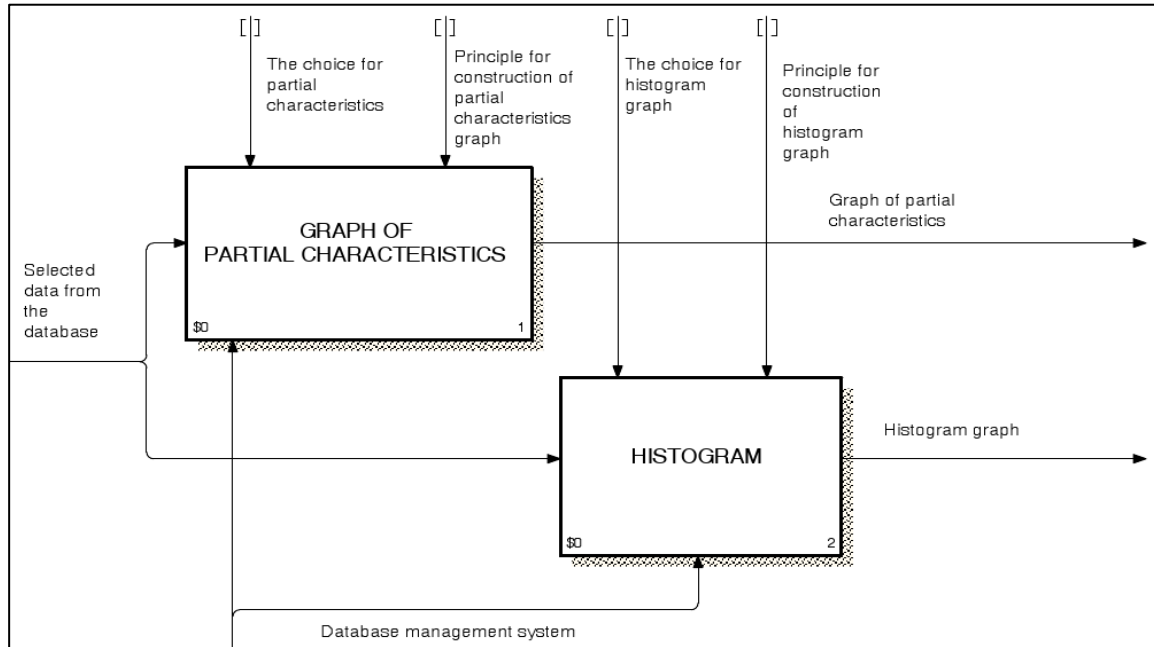


Figure 14 - Decomposition diagram A221 - PARTIAL CHARACTERISTICS

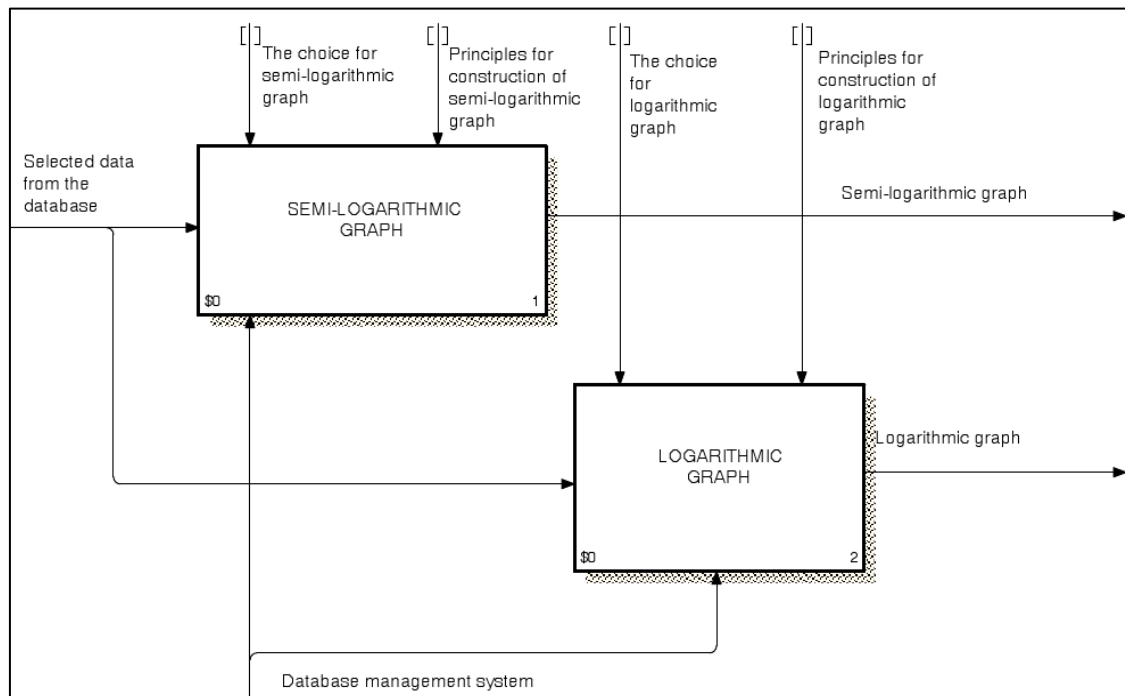


Figure 15 - Decomposition diagram A222 - CUMULATIVE CHARACTERISTICS



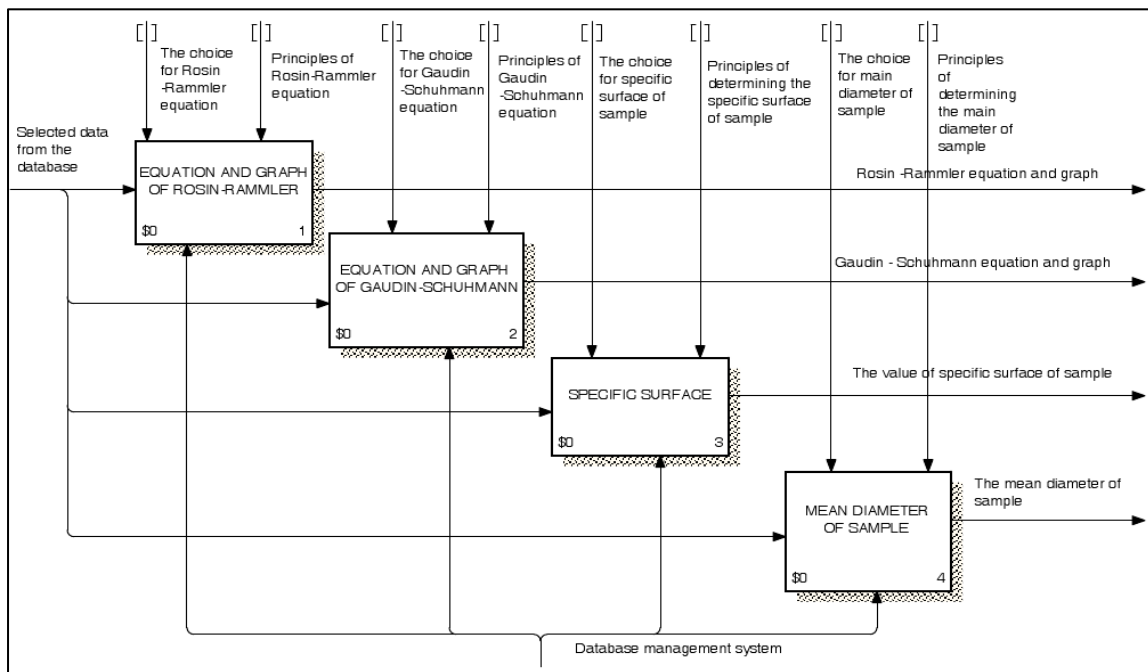


Figure 16 - Decomposition diagram A23 - ANALYTICAL

### 3.2.4. ACTIVITY "A3 - ANALYSIS"

This activity (Figure 17) is responsible for statistical analysis and data modelling. Tree diagram of this activity is showed on Figure 18. The input data of these activities is recorded data of

grain size distribution from the database information system, and control activities is the rules of statistical analysis and modelling. Based on these activities and the rules, is made the decomposition of the system.

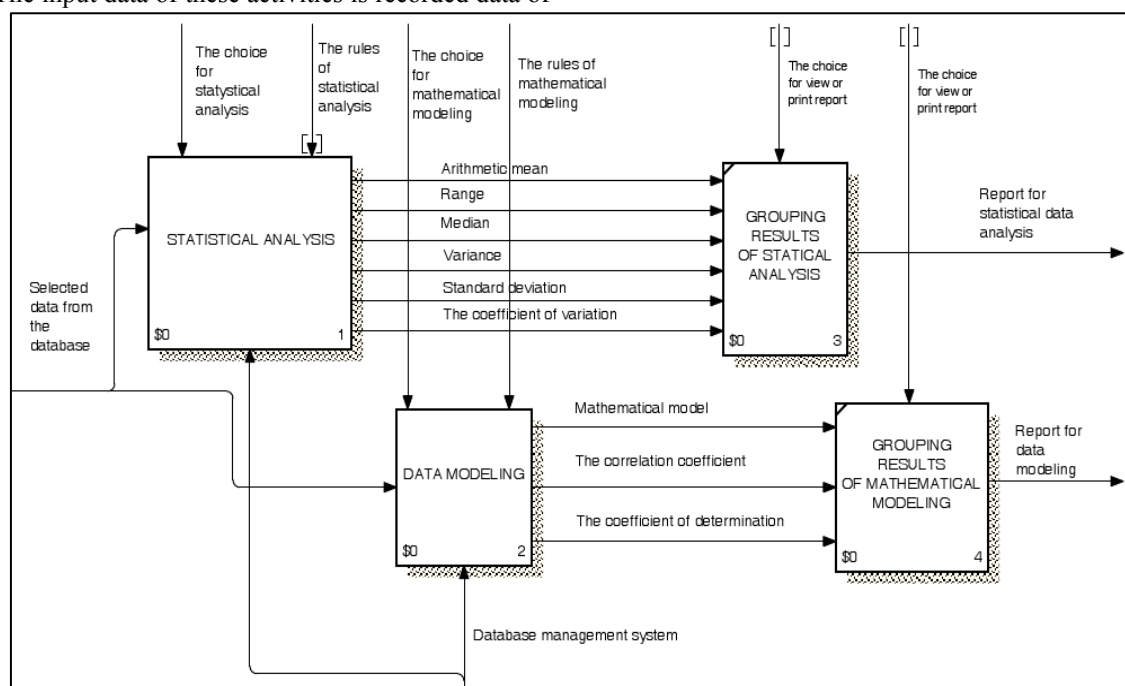


Figure 17 - Decomposition diagram A3 - ANALYSIS

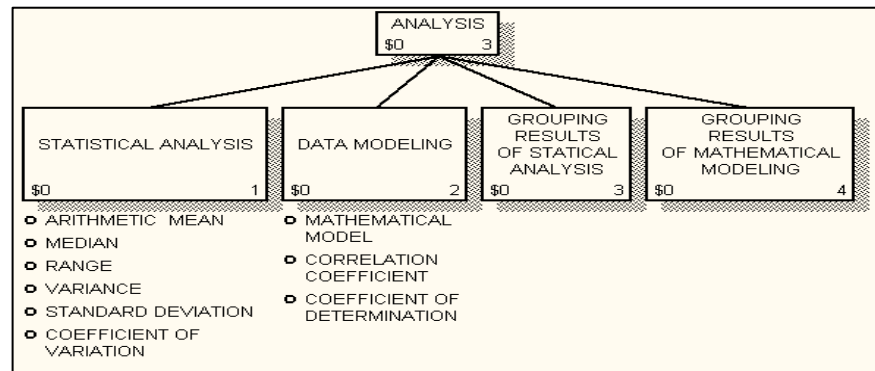


Figure 18 - Activity tree A3 - ANALYSIS

Statistical analysis (Figure 19) has a decomposition diagram: arithmetic mean, median, range, variance, standard deviation and coefficient of variation.

Data modelling (Figure 20) has a decomposition diagram: mathematical model, correlation coefficient and coefficient of determination.

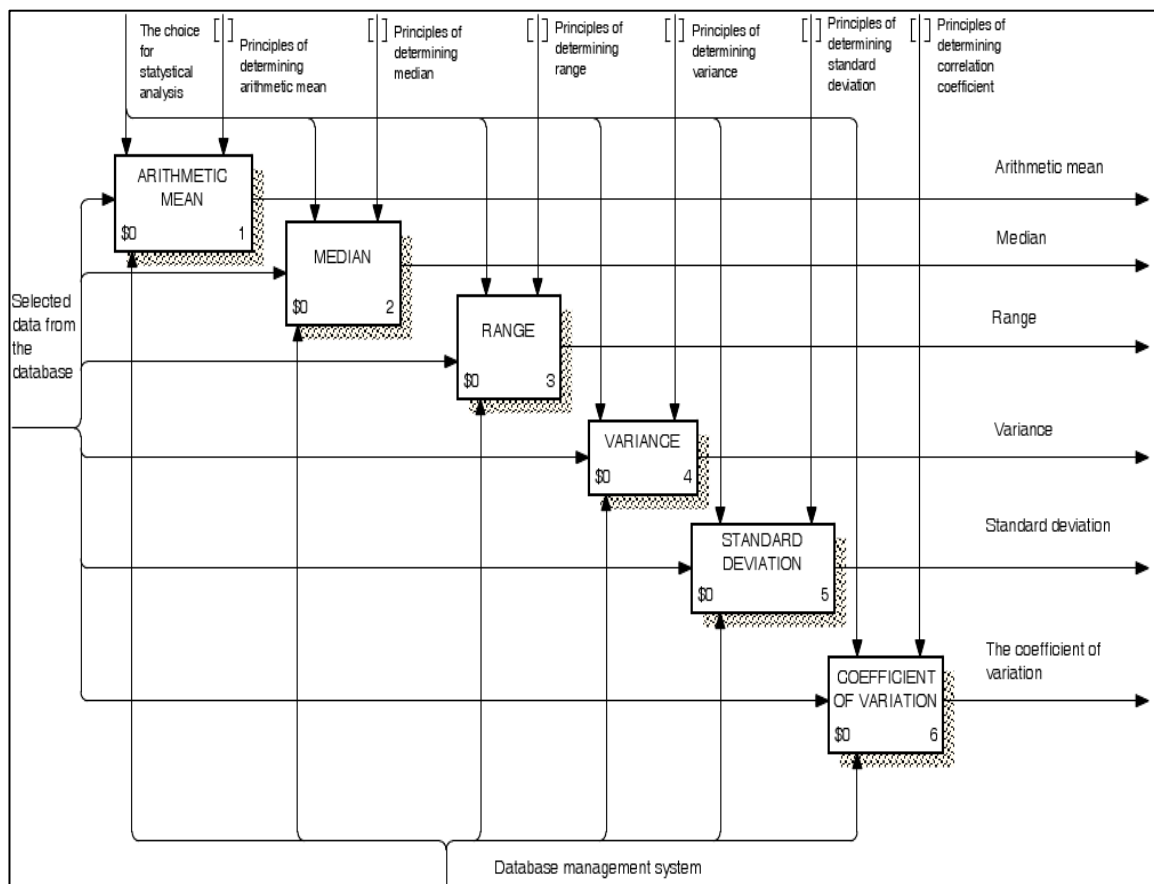


Figure 19 - Decomposition diagram A31 - STATISTICAL ANALYSIS

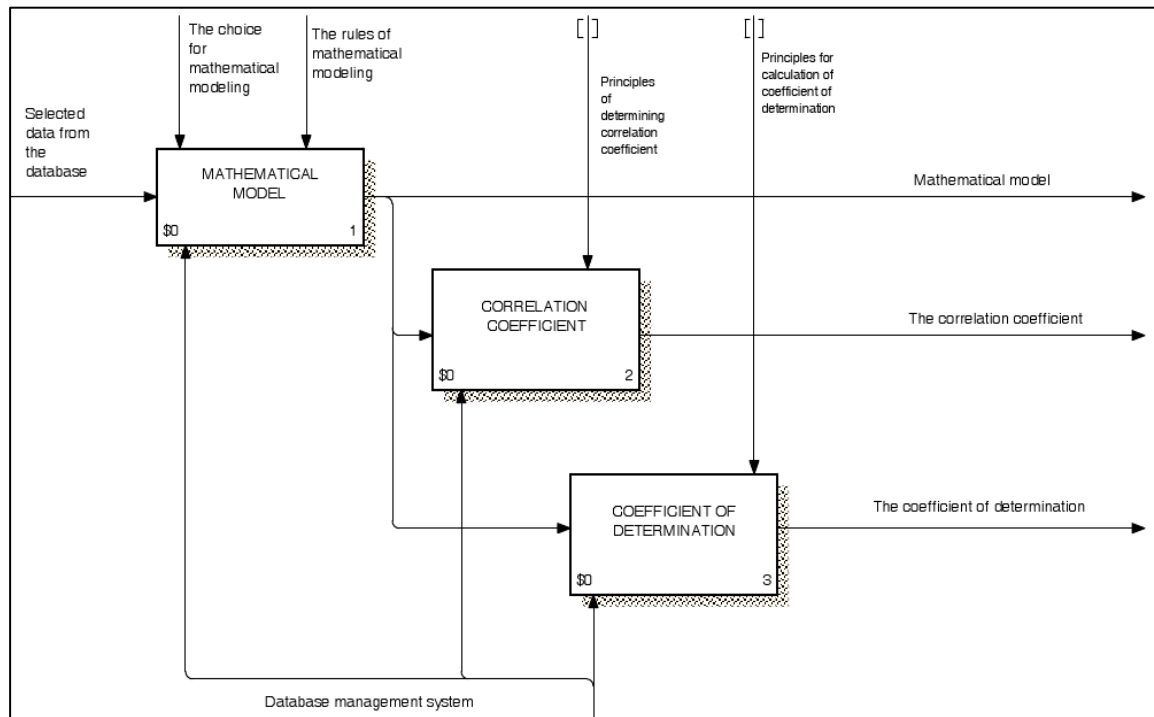


Figure 20 - Decomposition diagram A32 - DATA MODELLING

### 3.2.5. ACTIVITY "A4 - SEARCH"

This activity (Figure 21) allows efficient search database for future analysis and theoretical

considerations. Based on imported criteria for search, is make a report that can be examined, print or export to file. Tree diagram of activities is showed on Figure 22.

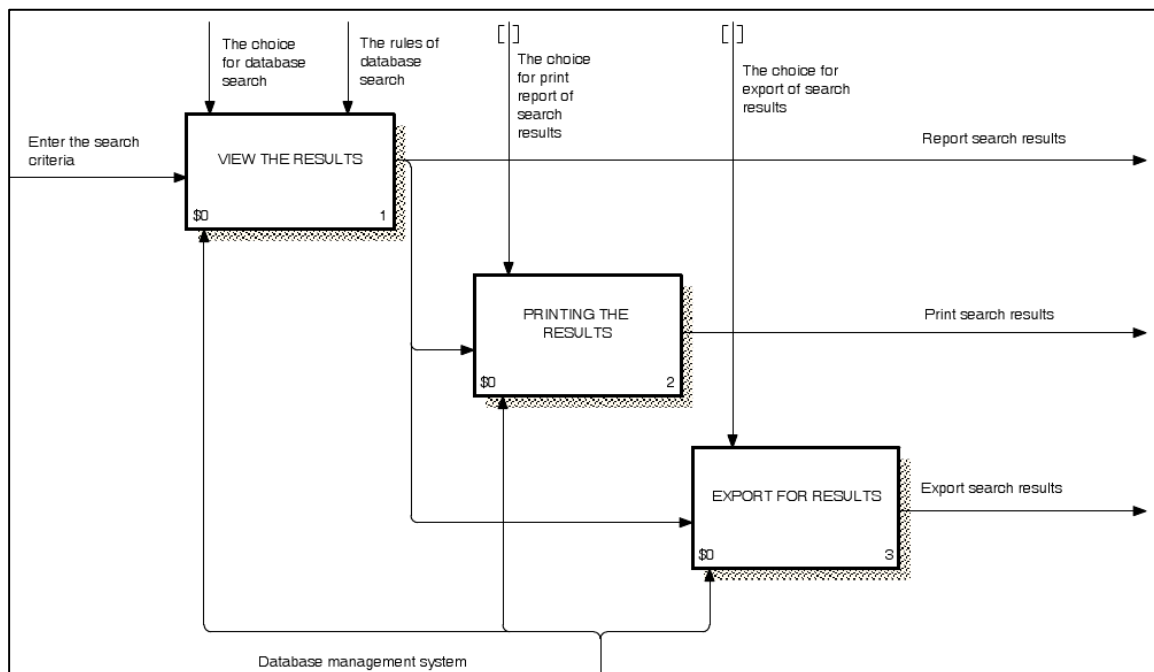


Figure 21 - Decomposition diagram A4 - SEARCH

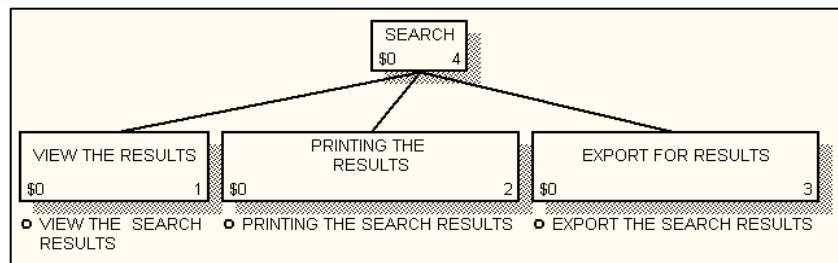


Figure 22 - Activity tree A4 - SEARCH

### 3.3. INFORMATION MODELLING - IDEF1X

Designing the information system using IDEF methods have information modelling with IDEF1X standard. This is simplified representation of the real system through a set of objects (entities), relationships between objects and object attributes.

Choosing the right CASE tool for IDEF1X method is the formal character, while the modelling of the real system depends on the skills, knowledge and experience of programmer.

In this paper are used ERwin software tools to define the information data model "grain size of sample". Data model completely determine the structure of data - static characteristics of the system (a description of the entities, attributes and relationships) and in the literature is defined as the ER model (Entity Relationship).

In accordance with this, is defined entities and their attributes and then the relationship between the entities [12, 13, 14] shown in Figure 23 that represents the logical data model "grain size of sample" [3].

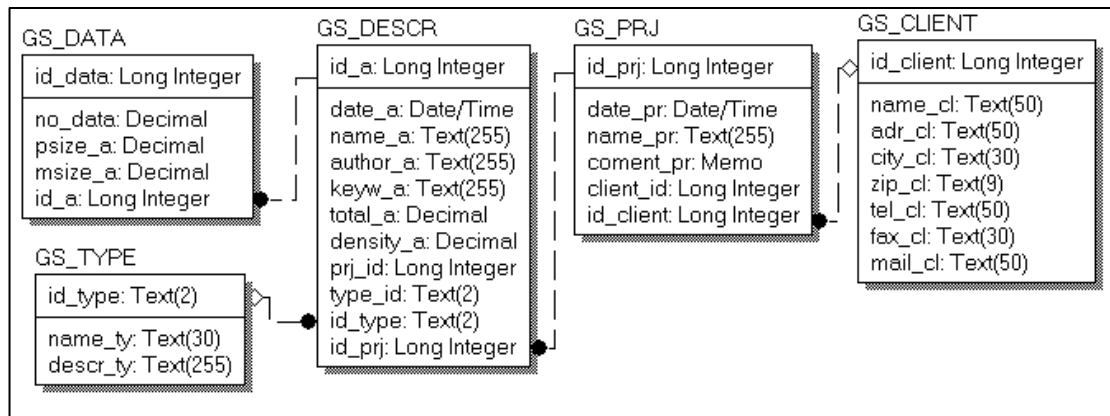


Figure 23 - Logical data model "grain size of sample"

Entity GS\_DESCR has attributes that define the general data of grain size analysis (analysis name, author, date, name, key words). Entity GS\_DATA have attributes that define paired data set of grain size (mm) and weight of sample (g).

Entity GS\_PRJ contains attributes that define information about the project for whose needs is performed grain size analysis (project name, date, notes, customer ID). Entity GS\_CLIENT has attributes that define basic information of clients for

projects (ID client, name, address, city, zip code, phone, fax, email).

Entity GS\_TYPE contains attributes that define the type of grain size analysis (ID type, name) example "sieve analysis", "microscopic analysis" etc.

Based on this information model is created the structure of MS Access database "UniModBase" for grain size of the sample (Figure 24).

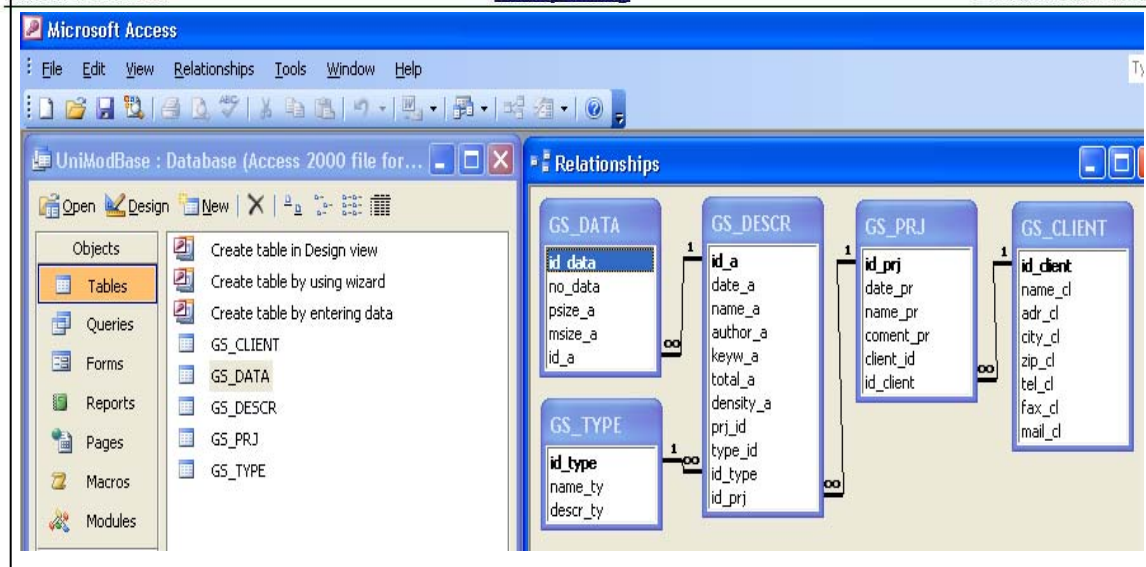


Figure 24 - Database "UniModBase" structure of grain size

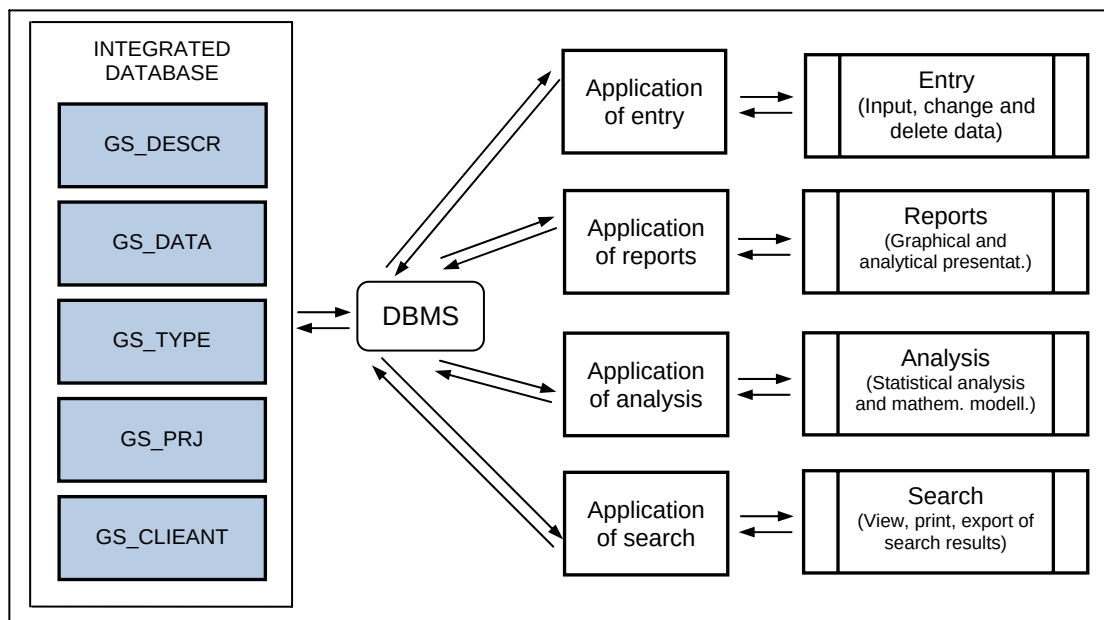


Figure 25 - Block diagram of the information system for modelling of grain size

Database files: GS\_DESCR - general data of grain size analysis, GS\_DATA - paired data set of grain size and weight of sample, GS\_TYPE - type of grain size analysis, GS\_PRJ - information about the project, GS\_CLIEANT - information of clients for projects

Information system for analysis and modelling of grain size distribution is shown in block diagram on Figure 25, and have three levels: integrated database, **DBMS (Database Management System)** and application modules: for data entry, reports, analysis and for database searching. These modules have their own sub-options and work by means of DBMS systems process data from a database or application perform mathematical operations on

them in order to obtain adequate report. For example, the module "Reports" has sub-option "histogram display" which uses data from the database, perform the processing based on defined algorithms that are based on them, and make a graphic histogram display of grain size of sample.

To create these application modules is propose to write programs in a some programming language [15]. There are a many programming languages,



and selection of some of them is depend on the developer experience, his knowledge and capabilities of a programming language to meet program requirements for the solution of the problem. For proposed modules of information system for analysis and modelling of grain size distribution, it suggested XBASE syntax of programming language that allows making information system with relational databases using Windows - form (Form) and the visual objects and controls such as Button, Menu, ListBox, CheckBox, RadioGroup, TextBox etc. Using these methods and principles, for the doctoral thesis the author of this paper is created a freeware Windows® programming system "UniModBase®" for analysis and modelling of grain size distribution [3].

#### 4. CONCLUSION

Based on the theoretical principle of information systems and statistical analysis, this paper show the IDEF method for creating the information systems for modelling of grain size distribution using the program BPwin 4.0 for IDEF0 functional modelling and program ERwin for IDEF1X information modelling. Using the IDEF methodology, this paper gives a solution to the set objectives of the research:

- define a model of grain size analysis for the development of information systems for modelling grain size distribution;
- development of the database and table of information system under the proposed model of grain size analysis.

As the recommendations and suggestions for further development of this information system, would be the development of WEB versions. With such information system is can be possible exchange of information between researchers on a global scale via the Internet 24 hours a day. This future version of the information system would be work on a some freeware server, using its resources for storage data and would be available for everyone. Database of this information system can be store the data of grain size analysis made by researchers around the world.

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