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Designing Information Systems in Education as Prerequisite for Successful Management Results

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***Abstract*—**This research paper shows matrix technology models and examples of information systems in education (in the Republic of Croatia and in the Germany) in support of business, education (when learning and teaching) and e-learning. Here we researched and described the aims and objectives of the main process in education and technology, with main matrix classes of data. In this paper, we have example of matrix technology with detailed description of processes related to specific data classes in the processes of education and an example module that is support for the process: 'Filling in the directory and the diary of work' and 'evaluation'. Also, on the lower level of the processes, we researched and described all activities which take place within the lower process in education. We researched and described the characteristics and functioning of modules: 'Fill the directory and the diary of work' and 'evaluation'. For the analysis of the affinity between the aforementioned processes and/or sub-process we used our application model created in Visual Basic, which was based on the algorithm for analyzing the affinity between the observed processes and/or sub-processes.

***Keywords*—**Designing, education management, information systems, matrix technology, process affinity.

I. Introduction

ACCORDING to the new education strategy in the Republic of Croatia, all work processes in development of education information systems (IS) were set out as a prerequisite for the implementation of quality assessment in education. Based on the research it was recognized that all stages of development of IS in education which gradually passes through the life cycle of IS development are: (going from) the IS planning and analysis of the education system, logical and detail design of whole IS, (code) development of applications subsystems and their implementation, the introduction (in work) of whole IS in education, (and ending with) maintenance of IS. Under researching the design phase of the IS in education (prior to the stage of making the applications) it can be seen the main work processes are: modeling, decomposition (objectives, structure, functions, processes, activities), matrix technology (for example: in the education system specific activities), optimal architecture of the IS in education, the identification of the need for the computerization of the process of education, the creation of an IS (physically). Phase application consists of the following steps (algorithms, etc.): writing algorithms and design flow chart (data), modeling (model entities, relationships and attributes), creating a relational data model, creating a database. Creating a database can be achieved by any language that works with the database (SQL included). When creating applications written algorithms that are used to write program code (e.g. in Python, C, C ++, Java Visual Basic or/and other programming languages). Testing (testing) work is carried out upon completion of the application. Preparation of documentation (log book and instructions) shall be made at the end of the concrete project. First research hypothesis H1 was: "the highest value information has class data log file". The second hypothesis H2 was: "the percentage of the analysis of the affinity between the process and/or (sub) process (depending on which level was made) 'issuance of debit' and 'making the timetable' is in the range of 75 percent to 85 percent". For the analysis of the affinity between the aforementioned processes and/or (sub) process was used an application in Visual Basic, which is created based on the algorithm for analyzing the affinity between the observed process.

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II. Educational Processes

Here are explained some important aspects about modeling of the educational process in the public institution (school) and improving its efficiency. The word process has its roots in the Latin word "processus" which means "to go forward" [6]. The model is an abstraction and representation of the real system (as generally known). In cases where there is already modeled system, it is necessary to determine the "surrogate" of the existing system modeled on equivalent systems in other organizations or development start by creating a logical model [7]. The aim of modeling the educational process is ultimately improve the performance of the processes that were observed in the public institution (school) and improving its efficiency.

Here is explained only important display process within public institutions. Table I entitled "display process within public institutions" shows the internal and external documents, description documents and the stated number of copies of a single document, which is sent from one subsystem to other subsystems within the same public institutions. The external documents which have an important role include the documents coming from the environment, and can be identified on the basis of the matrix technology. All parameters are given in Table I.

TABLE I
DISPLAY PROCESS WITHIN PUBLIC INSTITUTIONS

Name process	Description of the process	Input	Output
Determining the current situation (Inventory of assets)	Determines the current state of funding.	The invitation to tender, the purchase order.	The list of assets.
The announcement of the public tender and inquiry	Refers to a collection of the best bid for the assets whose value exceeds 70,000 HRK to send queries to obtain accurate information on the cost of purchasing the product.	The list of assets, the log book, the work plan.	Query, invitation to tender, bills for public bidding, the register of the receipt of bids, contract.
Processing bids	Refers to the collection of a large number of tenders, bids choice and draw up a report on the selection of the best bid.	Query, invitation to tender, bills for public bidding, the register of the receipt of bids.	The offer, the record of the selected offer.
Getting materials and energy products (goods, works and services)	Refers to receive materials, encryption and storage, making a complaint, if necessary.	The list of assets, request, invitation to tender, bills for public bidding, the register of the receipt of bids.	The contract, purchase order, notice of conclusion of the contract.
Receipt of materials and energy	Refers to receive materials (teaching aids), encryption and storage, making a complaint, if necessary.	The contract, purchase order.	Reclamation
Registration	The process of enrolling their children in school.	Birth certificate, proof of residence, certificate of employment, confirmation of the social welfare center, certificates of family doctors (school doctor).	Record book
Certificate of debt	Published by the teacher decision on the number of hours of work (teaching) the next school year.	The contract, the timetable, the curriculum plan.	The decision on the debt.
Making timetable	Refers to the creation of the timetable for teachers to be taught in the coming year as well the training room (Hall).	The curriculum, plan, contract.	Timetable
Curriculum development	The process in which define all extracurricular activities, outside the classroom activities, elective courses, extracurricular activities, additional classes, projects institution, (self-) evaluation of educational work.	The decision on the debt, the plan, the log works.	Curriculum
Planning	It refers to the planning of school activities in the following few months.	Contract, Mainstream.	Plan
Binding and filling the directory and work diary	Refers to the registration of subjects, areas of evaluation, personal information for all students and so on.	Registration Form, Mainstream, birth certificate, proof of residence, certificate of employment.	Contacts, the log works.
Determining the date of written test	It refers to the production of time schedule written test and to register the date of written test in time schedule.	Time schedule, the plan.	Time schedule written test.
Teaching and Learning	Learning is an essential process of every education and upbringing (education) as well as socialization and humanization of man. Learning is a process of experience or exercise produce changes in the capabilities of performing certain activities [8].	Contract, the plan, contacts, the log works, preparations, plan works.	Contacts, the log works.
Preparation	Preparation is a process that refers to the definition of teaching hours, the number of teaching hours , called the teaching unit , called themes , objectives , tasks , time.	Contract, the plan, contacts, the log works, preparations, plan works.	Preparations.
Establishing relationships teacher – parent	It refers to the communication of teachers with parents of students of a certain class section to improve the process of education, teaching, learning (education).	Contacts, the log works.	The meeting request.
Assessment/Evaluation	Assessment is a process of judgment student's knowledge in relation to predefined criteria.	Contacts, the log works, Ordinance on assessment.	List rating for parents.
Imposing warnings	The process of imposing a warning is carried out for obstruction of teaching, disturbing the other students in learning and keeping up, negligent behavior with the student's obligations, TRUANCY, violations of the provisions of the house rules school.	Contacts, the log works, Ordinance on pedagogical measures of educational treatment and extended professional treatment.	Warning.
Inferencing	The process of determining and recording the final grade semi-annual or annual work all students.	Contacts, the log works, Ordinance on the methods, procedures and elements of evaluation of students in primary and secondary schools.	Certificates, registration books.
Imposing commendation/praise	Imposing commendation/praise the student is a process that rewards the student's work during the school year in different areas.	Contacts, the log works.	Commendation/praise.
Keeping records of working hours	The process of keeping records of working time refers to the recording of the working classes by day of the week and the month before payroll.	Timetabling, curriculum, schedule, contacts, diary work.	The form for records of working hours.
Payroll	Payroll and benefits payable shall be carried out in the following order: Gross Amount - Contributions From Wages = Pay - Tax And Local Tax (And Other Suspension) = Net Earnings For Payment [9]. The process refers to calculate the total cost of salaries.	Ordinance on timekeeping, the form for records of working hours.	Payroll, R - S form, PK forms, form recapitulation payroll, account for transfer of funds.
Production of statistical reports and analysis of cash reports	It refers to the production of statistical reports for tax administration on the basis of certain data.	The order for the transfer of funds to the current accounts of employees, money order in/out.	Statistics report.
Payment in	It refers to the receipt of payment and money when paying for the kitchen, trips, etc., from secretaries.	Payment slip.	Payment slip.

Name process	Description of the process	Input	Output
An order for a business trip	Refers to an order for a business trip.	Order for business trip.	Order for business trip.
Statement of travel expenses	Refers to calculate the total cost of a business trip and issuing a travel account.	Order for business trip, Travel account.	Travel account.
Payment out / Money order out	Refers to the filling, issuing paid out slips and cash withdrawal in the Secretary/Registry. Payment out / money order out printed in blocks of 3 copies.	Money order out.	Money order out.
Making cash reports	It refers to the creation of cash reports based on that slip. The amount paid and paid out slips, i.e. the amount paid.	Money order in/out, Treasury report.	Treasury report.
Making the plan work	Refers to draw up a plan of work to be realized in a given period.	The plan, work book	The plan works.
Issuance of annual leave	It refers to the determination of annual leave for employees of public institutions.	Agreement	Decision on vacation.

(Table source: Processing of authors based on business rules observation of public institutions and the available documents.)

Processes\ Data Classes	Property inventory	Request/Inquiry	Call for tender	Bill to public tender	Register to receive offers	Offer	Record about selected offer	Contract	Order form	Note about contract assignment	Complaint	Registration form	Certificated solution on the debt of teachers	Hour schedule	Curriculum	Plan	Contacts	Log works	Time schedule written tests	Preparations	The meeting request	List rating for parents	Warning	Certificates	Registration books	Commendation/praise	The form for records of working hours	Payroll	R-S form	PK forms	Form recapitulation payroll	Account for transfer of funds on accounts of employees	Statistics report	Payment slip for money order in/out	Order for business trip	Travel account	Treasury report	The plan works	Birth certificate	Proof of residence	Certificate of employment	Confirmation of the social welfare center	Certificates of family doctors (school doctor)	Ordinance on the methods, procedures and elements of evaluation of students in primary and secondary schools	Ordinance on pedagogical measures of educational treatment and extended professional treatment	Ordinance on the form for records of working hours for school employees
Determining the current situation (Inventory of assets)	C R U D		R						R																																					
The announcement of the public tender and inquiry	R	C R U D	C R U D	C R U D	C R U D												R																		R											
Processing bids		R	R	R	R	C R U D	C R U D	R																																						
Getting materials and energy products (goods, works and services)	R	R	R	R	R	R	C R U D	C R U D	C R U D																																						
Receipt of materials and energy							R	R	C R U D																																						

Fig. 1 (a) Table Example (part 1): Matrix technology for public institutions – schools (LEGEND: "C" = "Create"; "R" = "Read", "U" = "Update", "D" = "Delete", "CRUD" = "Create; Read, Update, Delete")

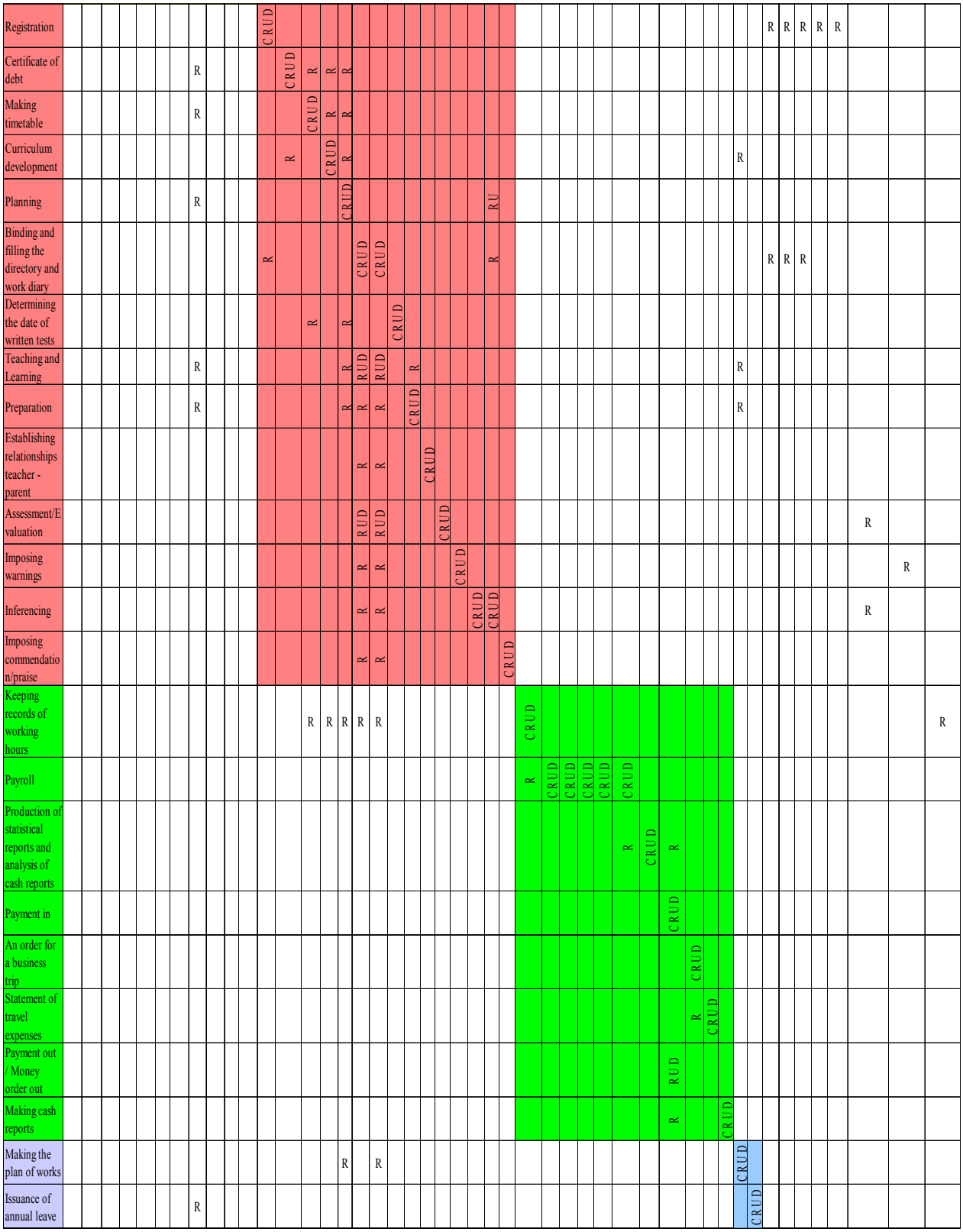

Fig. 1 (b) Table Example (part 2): Matrix technology for public institutions – schools (LEGEND: "C" = "Create"; "R" = "Read", "U" = "Update", "D" = "Delete", "CRUD" = "Create; Read, Update, Delete")

III. The Matrix Decomposition Process in Schools and the Value of Class Data

The decomposition process is a breakdown in the process (sub-processes) which can be broken down by activity, activity on the tasks and the tasks are broken down into steps. This section describes the processes that take place in the public education school (Fig. 1). In this the aim is for execution of the process in a specific period of time defined by the organization from the environment. If the processes are performed in the appropriate (pre-defined) time, in an effective manner and under labor law and regulations within the public institutions can be said that the management processes successfully.

Technology matrix (Fig. 1) a public institution (school) is clearly defined mathematically show the number of processes ((way) of the process) and the class of data that can be applied to all public organizations. Class information is logically designed and linked set of data, which refers to one guise or entity, while the process of collection of activities that are related to each other in order to achieve a specific output. Based on the Fig. 1 you can see that matrix technology contains the same (way) processes as well as individual companies in the public interest because it is also in the public institutions employees must comply with existing laws and regulations which require them (for example the Law on Public Procurement). Public institutions are also using process and (way) process (as well as companies in the public interest) creates a class of data.

Fig. 1 is development of authors and it is based on business logic of a public institution and ordinances, according to sources: [1]-[4]. Based on matrix technology (Fig. 1) it was shown that public institutions have more of the same (common) process or sub process and data class as a public company. In addition to the above process the same public institution that deals with education must respect the Law on Education and many other regulations (such as e.g. pedagogical measures, regulation on the registration of working time, etc., for more see [1]).

Fig. 2 shows the value of class data as the information carrier, which source is processing of authors based on business logic, public institutions and documents in the system and the formula for calculating the value of information from the original scientific work [10]. While it comes to calculating the value of information that has a single class of data, information has a maximum value of class data log file while it is followed by a class data plan. After exploring the set (hypothesis) H1 is proven - the highest value information has class data daily work. The value of information 243 has class data contract while the lowest value (1) has 16 classes of data.

Processes\Data Classes	Contract	Note about contract assignment	Complaint	Plan	Contacts	Log works	Time schedule written test	Meeting request	List rating for parents	Warning	Certificates	Commendation	Payment list	R-S form	PK forms	Recapitulation form for payment lists	Statistical report	Travel account	Accounting report	Decision on vacation
Number of business areas	3	1	1	4	2	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Number of user of information	9	1	1	9	9	11	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Value of information:	243	1	1	324	162	484	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Fig. 2 Table Example: Matrix value of class data as the information carrier

IV. The Algorithm for the Analysis of Affinity between Processes in Schools

It is well known that the algorithm is a series of steps which perform real time leads to a certain result. This section presents the algorithm to analyze the affinity between the processes taking place within the school. The steps of the algorithm are:

1. Identify number of input data classes used (sub)process P_{in}
2. To determine the number of output classes of data arising from the (sub)process P_{out}
3. Calculation of efficiency (sub)process $U_E = P_{out} / P_{in} * 100$
4. If efficiency (sub)process U_E is equal to 0
   then
   (sub)process should be eliminated from the upgrade matrix technology
   else
   (sub)process to keep within the matrix, and go to step 5
5. Add up the number determined by the input and output data classes: n (pi) = (Pin U Pout),
   $(P_{in} \cup P_{out}) = (P_{in}) + (P_{out})$, uses and creates a single (sub)process $(n(p_i) = \sum_{(P_{in}, P_{out})})$
6. Establish and count the number of common data classes that have the (sub)processes p_i and p_j (p8, p9). $n(p_i) = 4$.
7. Calculate the ratio of affinity between the two (sub)process
8. Coefficients converted into percentages
9. If the affinity between the two (sub)process is equal to 0
   then
   two (sub)processes p_i and p_j not use any common data class and between them there is no affinity
   else
   1 two (sub)processes p_i and p_j use at least one common class of data, that is, to confirm that there is an affinity between them
10. If coefficients are calculated affinity
    then
    write the calculated odds affinity matrix in interdependence (sub)process and at item 11
    else
    at item 5 and execute an instruction
11. If the pair (sub)process with a high coefficient of affinity (affinity coefficient > 0.80)
    then
    form the core of a subset of (sub)processes
    else
    non-core.

Within displayed algorithms used are: instruction "if" and the instruction "else". Instruction is the smallest unit of an executable program logic blocks. Instruction "if" is instruction for conditions. If the condition is satisfied are carried out instructions in (under) a block of instructions that follows, otherwise execute the first next instruction at the same level. Instruction "or" may follow the "if-then" instruction. That shall be executed if and only if the corresponding "if-then" instruction did not work. This instruction on it may have a condition so then its meaning was "otherwise - if-then". Such "else" instruction may be more in a row, and then each additional can only be performed if not executed any previous [11]. Given the level of the algorithm, the algorithm can be shown to illustrate. The following is an illustration of the branching if-then-else [11]:

0. Algorithm (Level 0)
1. Instruction (determine) ((Level 1))
2. Instruction (determine) ((Level 1))
3. Instruction (calculated) ((Level 1))
4. Instruction (if-then) ((Level 1))
    5. (Under)instruction (eliminate) ((Level 2))
    6. (Under)instruction (update) ((Level 2))
7. Instruction (Otherwise) ((Level 1))
    8. (Under)instructions (keep) ((Level 2))
    9. (Under)instruction (go) ((Level 2))
10. Instruction (add up) ((Level 1))
11. Instruction (count) ((Level 1))
12. Instruction (calculated) ((Level 1))
13. Instruction (turn) ((Level 1))
14. Instruction (if-then) ((Level 1))
    15. (Under)instruction (not used) ((Level 2))
    16. (Under)instructions (not applicable) ((Level 2))
17. Instruction (Otherwise) ((Level 1))
    18. (Under)instruction (used) ((Level 2))
    19. (Under)instruction (confirm) ((Level 2))
20. Instruction (if-then) ((Level 1))
    21. (Under)instruction (insert) ((Level 2))
    22. (Under)instruction (go) ((Level 2))
23. Instruction (Otherwise) ((Level 1))
    24. (Under)instruction (go) ((Level 2))
    25. (Under)instruction (execute) ((Level 2))
26. Instruction (if-then) ((Level 1))
    27. (Under)instruction (form the core subset) ((Level 2))
    28. (Under)instructions (entering) ((Level 2))
29. Instruction (Otherwise) ((Level 1))
    30. (Under)instructions (not make) ((Level 2))
    31. (Under)instructions (not included) ((Level 2))

(Under)instruction 5 and 6 constitute a separate block (sub)instruction that is executed if the condition is met instructions 4. If this condition is not met then executes a block of 8 and 9 belonging instruction 7 (under)instruction 15 and 16 make separate block (sub)instruction that is executed if the condition is met instructions 14. If that condition is not met then executes a block of 18 and 19 belonging instruction 17 (floor) instruction 21 and 22 constitute a separate block (sub)instruction which is executed if the condition is met instructions 20. If that condition is not met then executes a block of 24 and 25 belonging instruction 23 (floor) instruction 27 and 28 constitute a separate block (sub)instruction that is executed if the condition is met instructions 26. If this condition is not met then executes a block of 30 and 31 belonging to the instruction on the 29.

V. The Program for Analysis of Affinity between the (sub)Processes Taking Place in Schools

The program is a series of commands that are performed in the appropriate order. In this section programming code is shown which allows you to analyze the affinity between the two processes that take place in an educational institution.

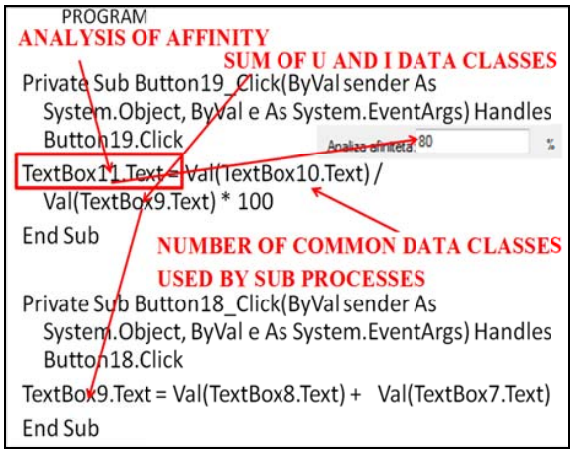

Fig. 3 Program example: Analysis of affinity between the 2 processes in education (in terms of in-ram)

Processes \Data Classes	Property inventory	Request/Inquiry	Call for tender	Bill to public tender	Register to receive offers	Offer	Selected offer	Contract	Order form	Note about contract assignment	Complaint	Registration form	Certificated solution on the debt of teachers	Hour schedule	Curriculum	Plan
Certificate of debt								R					CRUD	R	R	R
Making timetable								R						CRUD	R	R

Fig. 4 Table Example: Matrix of processes involved in the analysis of affinity

Fig. 3 shows a Visual Basic programming code for the analysis of the affinity-in this respect, which is created (processed by authors), based on the algorithm. Based on Fig. 3 shows that the calculation of the sum of the input and output

data is presented in class TextBox9.Text. TextBox10.Text shows the number of common data classes used by sub processes and/or processes. TextBox11.Text program presents an analysis of the affinity between the (sub)process and / or processes.

With the help of developed applications (Figs. 3 and.1), hypothesis (H2) which reads as a percentage analysis of affinity between processes and/or (sub) process (depending on which level is done watching) issuance of debt and the process of drafting the timetable (Fig. 4) is in the range of 75% to 85% is established as the analysis of the affinity between the aforementioned (path) of the process is 80% as the reference interval.

VI. Good Example of Implementation of Similarly Projected New IS in Germany (ULM-Baden Wurttemberg)

The following is a brief description of example of the successful implementation of the project of a new IS observed through hardware, software, netware, lifeware and orgware, which refers to the local government of the city of Ulm in the German state of Baden Wurttemberg (which organized its own service for information technology).

The city of Ulm has "Internet access services" and "Support network infrastructure" as only two external service providers for the city. One of the main tasks of city service for information technology is to provide the necessary hardware and software to end-users in urban institutions. It is 1,300 client and about 40 server devices. Since the institutions of the city administration, schools, and kindergartens are scattered all over the city, the city administration of Ulm opted for a centralized distribution of applications due to savings in time and costs. The city administration of Ulm with the service for information technology is constantly improving management IS usually by installing the latest version of the Windows operating system and by installing the latest versions of the system used previously "Enteo NetInstall v6" from company "Enteo Software GmbH" [5]. The integrated IS of the city of Ulm and now works flawlessly and modernized.

The quality of the implemented new IS the city of Ulm and its contribution to the effectiveness of the city administration and the satisfaction of users of its services faithfully testifies average rating by the citizens of Ulm gave its city administration in a survey conducted in late 2012, when the results of the survey amounted to an average of 6:48, on the scale range from 1 to 7. Consequently, at the end of 2013 in the city administration of Ulm were under way for the introduction of Windows 8 operating system.

VII. Conclusion

The research work was based on life cycle development of IS in education with more detailed reference to the creation of an algorithm to analyze the affinity between the observed processes that take place in schools as public institutions and the phase of software application that is made on the basis of the algorithm for the analysis of affinity in Visual Basic (Fig. 3). The research paper presents the development stages of the IS according to the specific order. First shown identified processes within the educational system, and describes the activities i.e. models within the processes. Table I (called display processes within public institutions) and matrix technology is shown how individual process creates and reads the data classes (i.e. shows the number of input and output data classes). After the presentation and description of processes and data classes educational institutions, calculated by the value of each class of data as bearers of information from a set of observed data classes. The greatest value is the information carrier class data log file if it is followed by a class data plan. After exploring the set (hypothesis) H1 (as the highest value information has classes of data the log) was proved. The value of information (243) has a class data contract, while the minimum value of 1 (the same value) has 16 classes of data. Diary of labor as a class data in the educational system has a maximum value as an information carrier because it mostly used by other processes within the educational system. With the help of developed applications (Fig. 3), H2 (hypothesis) was proved, as a percentage analysis of affinity between processes and/or (sub) process (depending on which level is done watching) issuance of debt and the process of drafting the timetable is in the range of 75% to 85% is established as the analysis of the affinity between the aforementioned (path) of the process is 80% as the reference interval. At the end of the article we explain a successful example of similar implementation of a new IS in the German educational system, which was initiated and implemented by the City Administration of the city of Ulm federal state of Baden Wurttemberg.

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