Software Design of System SMPSL

RADEK NEMEC, STEPAN HUBALOVSKY
Faculty of Education, Faculty of Science, Department of Informatics
University of Hradec Kralove
Hradec Kralove
CZECH REPUBLIC
radek.nemec@uhk.cz, stepan.hubalovsky@uhk.cz http://www.uhk.cz

Abstract: - One of the most important methods in current scientific, technological and educational research is process of modeling and simulation of real experiment as well as modeling and simulation of real experimentally measured data. Modeling and simulation are discipline with its own theory and research and educational methodology. The paper briefly focuses to the theory of the process of modeling and simulation as one of the important educational method. The process of modeling and simulation is step by step demonstrating by creation of user application of system SMPSL. The system SMPSL is a measurement system using computer in the school laboratory. This system was designed as a cheap and flexible interface for recording the values and represents that. The system must be controlled by appropriate software. Therefore research investigation has been conducted to find best user application. Based on the selection of the three options and the comments were selected and modified the most optimal solution.

Key-Words: -Software design, user interface, DAQ, eProDas, data acquisition, experiment, education

1 Introduction

The terms *system*, *model*, *simulation* are important in current approach to scientific, technological and educational practice. Many universities are realizing that modeling and simulation as important tool in solving and understanding numerous and diverse problems.

Modeling and simulation, is becoming one of the academic programs of choice for students in all disciplines – see e.g. [1], [2], [3], [4]. Modeling and simulation is a discipline with its own body of knowledge, theory, and research methodology.

In this paper we first briefly introduce the theory of modeling and simulation as educational method of school laboratory [5], [6], [7].

Secondly we introduce software design of acquisition system for computer measurement in a school laboratory which enables users control, measurements, setup, operation and management of the system itself in the school laboratory [8].

Several versions of the interfaces have been created to increase acceptability for final user. One of the versions has been selected based on opinion research between respondents – final user. The selected software design has been then developed based on other comments of the respondents.

2 Modeling and simulation as educational method

2.1 Modeling

Modeling is a method that is often used in professional, scientific and educational practice in many fields of human activity.

The main goal of modeling is describe the content, structure and behavior of the real system representing a part of the reality as well as sort and described experimentally measured data

The mathematical model must adequately describe the dependency system outputs on its inputs. Models of measured data are usually established as chart dependency output values on input values.

2.1 Simulation

The process of modeling is closely related to the simulation. Simulation can be understood as process of executing the model. Simulation enables graphically representation of the modelled experimentally measured data.

A typical data acquisition simulation model can be written both through specialized software or can be created in standard programming languages. In our paper the user application software for data acquisition is made in Delphi.

Simulation has from the scientific point of view several functions – see e.g. [9]. We will focus in this paper the simulation function from educational point of view. Using the simulation model and visualization of simulation results on the screen, students can better understand the basic processes and systems and develop their intuition. It is also essential that the teaching by means of simulation is much cheaper and faster than the teaching carried by real experiment. In some cases providing the real experiment cannot be feasible.

Despite the fact that experimental education in the laboratory cannot be completely replaced (because students acquire manual dexterity, they learn to work with real laboratory instruments, they learn to plan, implement and evaluate realistic experiment), the simulations is a part and basic methods of scientific knowledge. Students can easily learn theoretical foundations of the laboratory tasks. The simulation model of the real laboratory task can help them to check some of the operations performed in the laboratory. This can reduce the direct lessons in the laboratory only to necessary time for their own experimental measurements. Alternatively, lessons can be realized only by the simulation models. In this case, it is important to note that students are deprived of contact with the real device, so that they will not get a full picture of the implementation of the experimental measurements.

3 Software Design of System SMPSL

The system SMPSL is a measurement system using computer in the school laboratory and created in Delphi. This system was designed as a cheap and flexible interface for recording the values and represents that. The system must be controlled by appropriate software. Therefore research investigation has been conducted to find best user application. Based on the selection of the three options and the comments were selected and modified the most optimal solution. Testing version are labelled A, B and C [10].

The version A is based on separate windows. The version B is based on one multifunction window. The version C displays the most important information in a one window (e.g. in this window the input and output variables are displayed graphically during the measurement.

3.1 Version A

This version is designed as a number of separate windows. For each measured or controlled element is shown separate window.The basis is the part from

which individual programs are executed – see figure 1.

The advantage of this solution is that the user can separate windows placed on the screen at any point. Thus, the user immediately finds required measurement values and he cannot does not look in the main window and search for the correct input and output values.
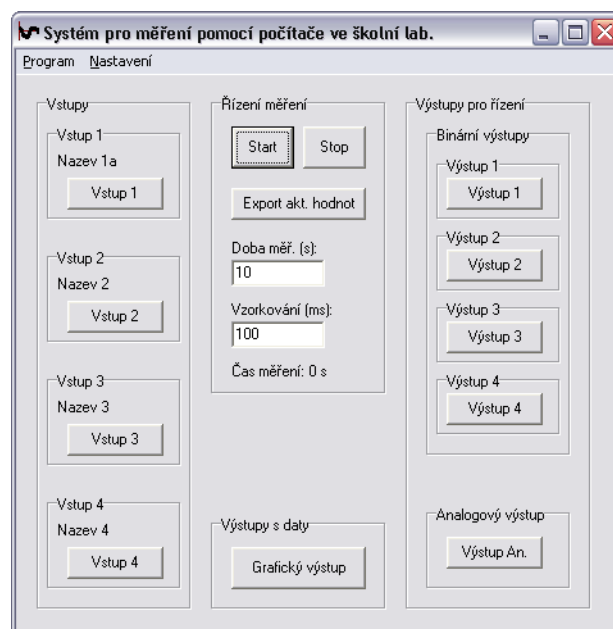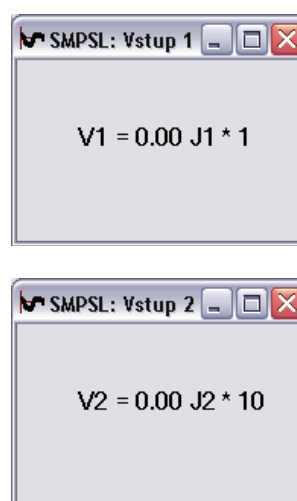

Fig. 1 – Main part – main window

Four separate windows are used for measurement of four analog inputs – see figure 2.There is the possibility compare any individual windows on the desktop.
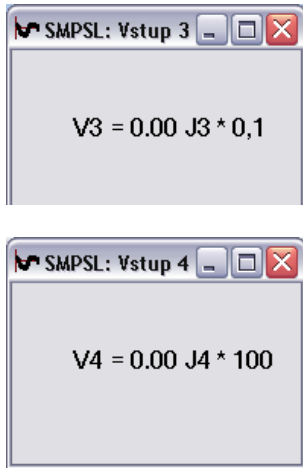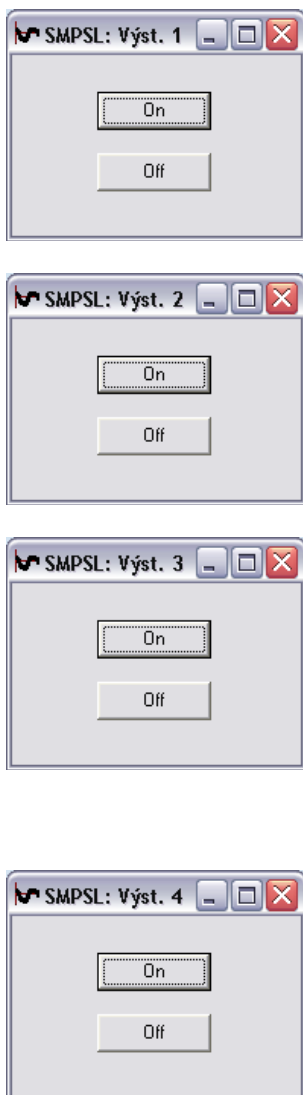
Fig. 3 – Four binary outputs

There are various possibilities for placing the windows. Everyone prefers something else, and this is the main advantage of this arrangement. The user can, for example, compare the inputs on the top of his desktop or on one side of the screen below. Or for high resolution the individual inputs can be placed in the corners of the screen. Another option is to place each input and output together.

One separate window is used for control of the analog output (figure 4). In this program, you can use the scroll bar to set the output value.
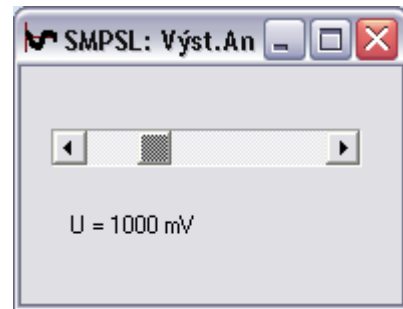

Fig. 4 – Analog output

Fig. 2 – Four analog inputs

Four separate windows are also used for control the four binary outputs - see figure 3.There is again possibility to compare the measuring windows on the computer desktop.

Separate window is also created for graphical representation of the measured values in graph as well as for text output and for export to a text file. Graphical output is presented in a graph that shows the set input values [10]. List of the measured values can be exported to a text file (Figure 5).

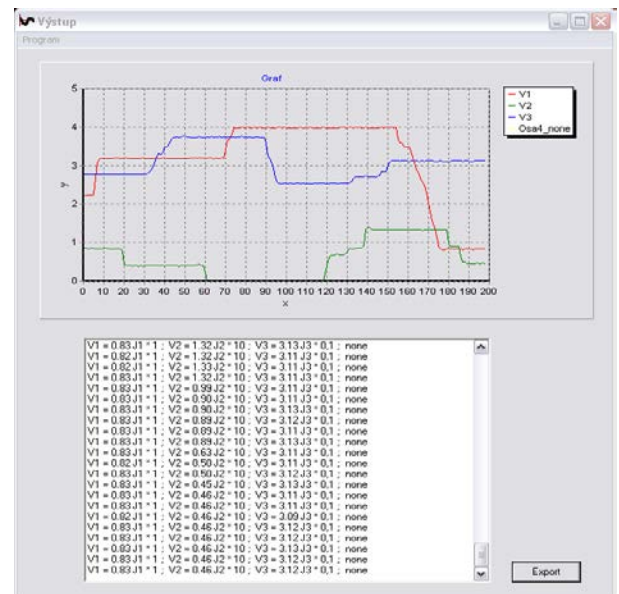This window can be surrounded by separate windows showing the current values.

Fig. 5 – Graphical representation and text output

Setting runs in two levels. The first, it is set the display of items of inputs and outputs executed from the program menu (Figure 6). The second setting is for the configuration of inputs. There is possibility to specify the names of inputs, name of quantity, name of unit and its conversion to the input 0 ... 5. The third is setting the axes of the graph. Finally it is possible to calibrate x axis according to the settings of axis or by time (Figure 7).
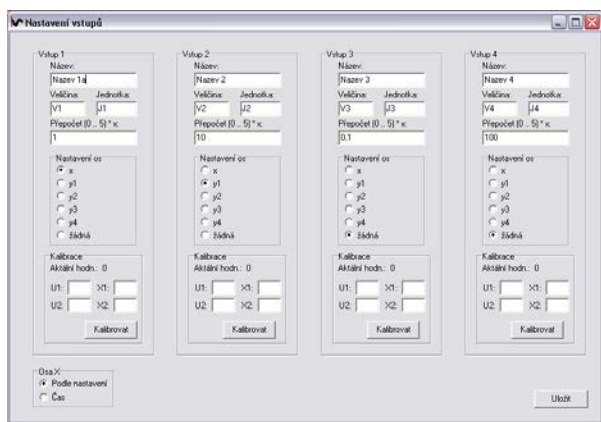

Fig. 6 – Display settings

Fig. 7 – Input settings

3.2 Version B
This concept is created as one single window. All four analogue inputs at once, all four digital outputs at once and one analog output are displayed in this window. There is also displayed graphical output in the form of a graph and text output with export to text file with the settings is displayed values - see. Figure 8.

This solution is designed as "all in one". The advantage is that the user does not tediously place each window on the screen. Immediately after starting the software has all the bright fixed

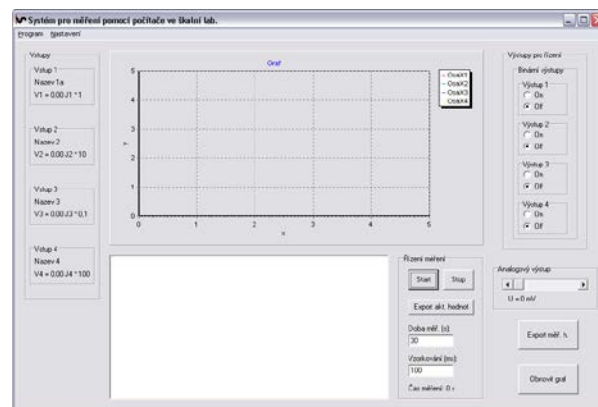location. So every time can be seen the same program.

Fig. 8 – SMPSL – version B

The settings are the same as in the previous version - version A.

3.3 Version C
This interface represents a system in which the main part shows a set of measured values, setup of binary outputs for controlling, setup for display of analog output and basic setup for measurements with the possibility to display graphical output – see figure 9.

This solution is combination of both above mentioned solutions. From the B version is fixed display of location of each input-output control (binary outputs, and analog output has its fixed place). From the A version is then retained options display graphical outputs demonstrating each value in separate window (not always is required to see progress. Display separate window of controlling of analog and binary output is useless in some cases too.
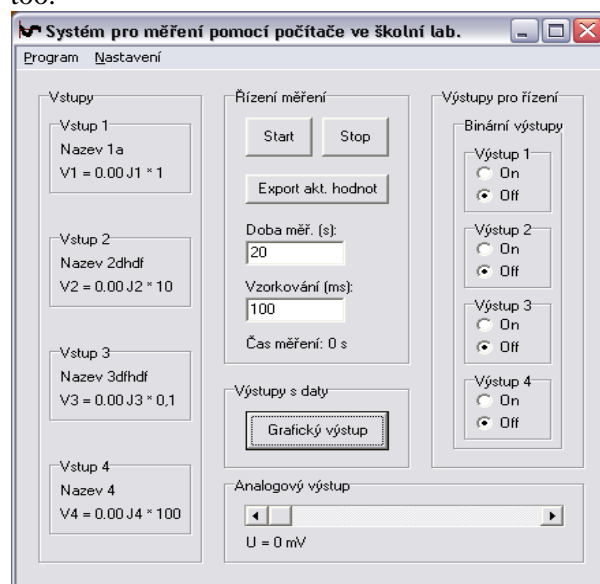

Fig. 9 – Main part of version C

Graphical output represented by graph that shows the setup of value input and list of measured values that can be exported to a text file is the same as in version A.Setting is the as in version A.

4 Research investigation

The research was conducted as a presentation of all three versions of the user interface (A, B and C) by projection technology. The differences of the versions and, sample of data measurement graphical representation of the data in the form of figures and graphs were shown.

Discussion was held after the presentation of each version and questionnaires were handed over.

4.1 Questionnaire

The questionnaire consisted of eleven questions investigating appropriate user interface. The first half of the questions was asked mainly by marshalling system with invitation to justify thesort. The second half of the questions consisted of questions with open answers.

The versions are in questionnaire briefly described for simplicity in one sentence:

A   each part in a separate window;
B   all the parts in one box;
C   the main part in one window, graph and list of the values in the second window.

4.2 Evaluation of the questionnaire

The questionnaire was submitted to the respondents who had some experience with similar systems, and can competently answer the questions [10]. It was the students of distance learning of University of Hradec Kralove, Faculty of Education, Department of Physics, specialization of Physical measurements and technical computing.

Evaluation is done by:
- displaying of the questions
- the percentage statistics
- graphical output
- the justification of the responses and their commentary.

Which version is the most comprehensive? Sort by best.

Table 1 – Most, less and least transparent version

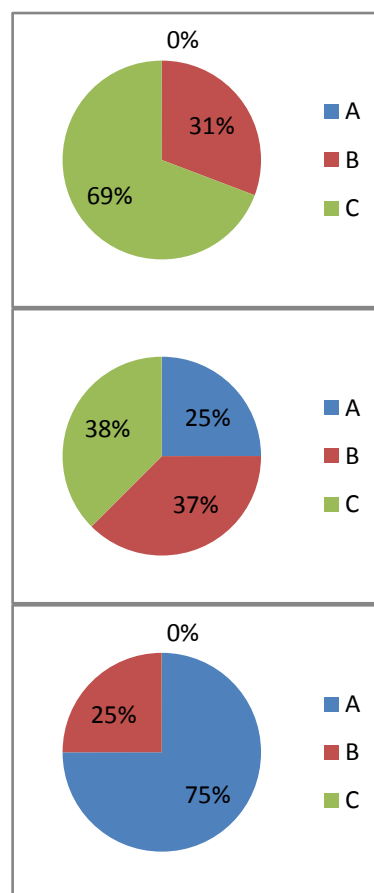| A	0%		A	25%		A	75%
B	31%		B	37%		B	25%
C	69%		C	38%		C	0%

Fig. 10 – Most, less and least transparent version

Respondents seemed most clear version C. Justification is its variability, transparency, rationality and practicality. The second clearest version was the version B because during the measurement the values are display all in one window. The least clear version is version A.

Which version is more comfortable to operate? Sort by best.

Table 2 – Most, less and least version for control

A	0%
B	54%
C	46%

A	8%
B	46%
C	46%

A	92%
B	0%
C	8%

Which version is easier to understand? Sort by best.

Table 3 – Most, less and least comprehensible version

A	8%
B	42%
C	50%

A	0%
B	50%
C	50%

A	92%
B	8%
C	0%

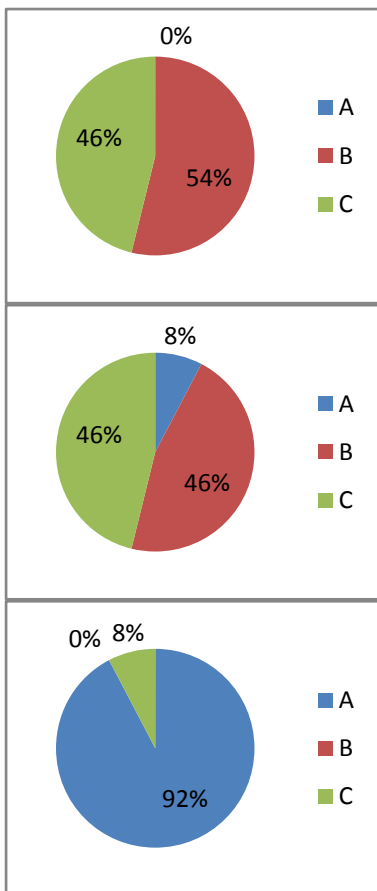

Fig. 11–Most, less and least version for control
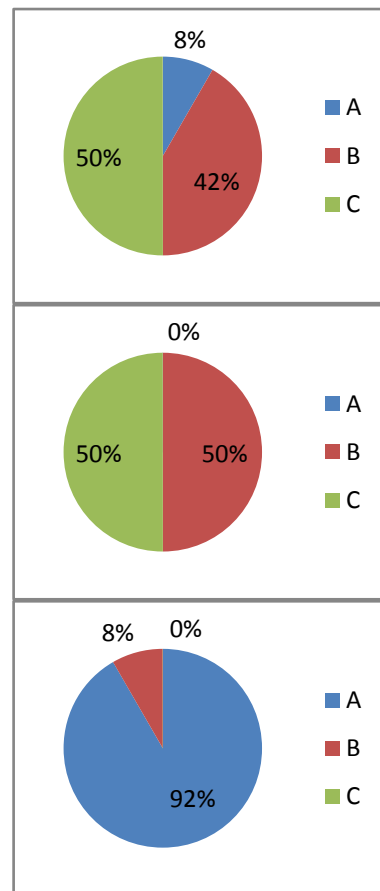
Fig 12 – Most, less and least comprehensible version

The best version for control was by respondent selected versions B and C because of the clarity and visibility during all measurements in one window. The least suitable version is version A.

The most comprehensible versions are versions and B. The least comprehensible version is version A.

Which version is more intuitive?
Sort by best.

Table 4 – Most less and least intuitive version

A	0%
B	54%
C	46%

A	8%
B	38%
C	54%

A	92%
B	8%
C	0%

Which version is aesthetic?
Sort by best

Table 5 – Most, less and least esthetic version

A	0%
B	38%
C	62%

A	8%
B	54%
C	38%

A	92%
B	8%
C	0%

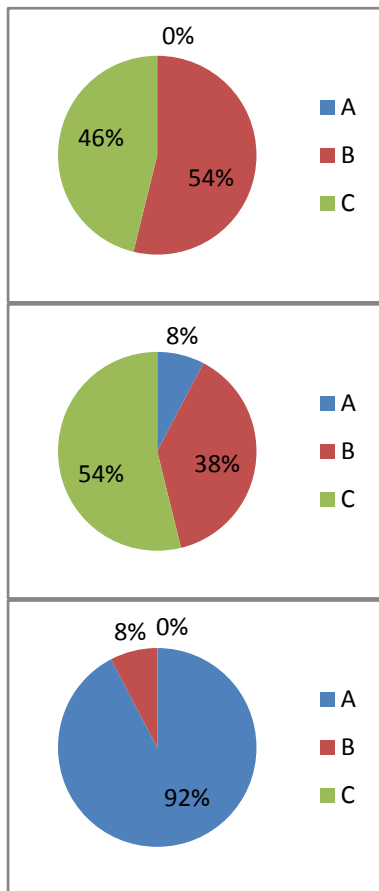
Fig.13 – Most less and least intuitive version

Fig. 14– Most, less and least esthetic version

The most intuitive versions are again versions B and C. Version A is again the least intuitive. Result respondents justified by subjective feelings.
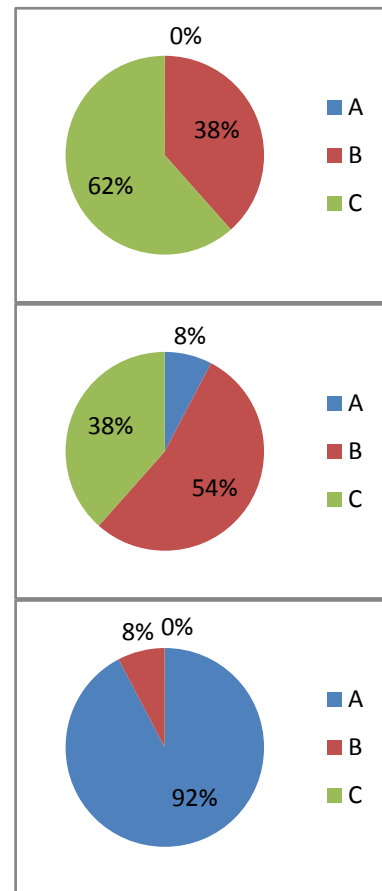
The most esthetic is version C due to the logical and comprehensible arrangement. Less esthetic is version B. The least esthetic is version A.

Is the layout of the controls user-friendly? Mark as at school.

Table 6 – Marking of the layout of button

A	2,62
B	1,92
C	1,46

Fig. 15 – Marking of the layout of button

The best version is version C with a final average mark 1,46, followed by version B with average mark of 1,92 and the worst version is version A with an average mark of 2,62.

What functional improvements would you suggest?

Respondents mostly answered:
- No objections;
- Greater variability;
- Resolution of the START and STOP buttons;
- More options of settings of control;

Based on these observations the resolution of START and STOP buttons and options of configuration control have been changed.

Which control improvements would you suggest?

Respondents mostly answered:
- No objections;
- Greater variability;
- The option switch off the individual measured values in graphic display;

- Better place of button "Refresh" button in the graphical output;
- Color-distinguish control elements

Based on these observations the option switch off the individual measured values in graphic display and color-distinguish control elements have been changed.

What graphical improvements would you suggest

Respondents mostly answered:
- No objections;
- Possibility to change the color of individual quantities;
- Color of the application;
- Color of buttons

Based on these observations we have improved only possibility to change the color of individual quantities.

What else would you improve?

Respondents mostly answered:
- Full Czech
- Nothing

Based on these observations the English word has been fully changed to Czech.

Do you prefer to place all controls in one screen or split into multiple windows by function and why?

Respondents mostly answered:
- according to the type and complexity of the task.

The respondents answered according to the type of measurement. They emphasized the organization into one window for clarity, but at the same time they underlined a more complex measurement arrangement in multiple windows.

5 Conclusion

The research investigated that the best version on the basis of clarity, control, intuitiveness, esthetics, layout of control elements is version C with percentage of 55% followed by the version B with percentage of 44%. The least

version is version A with percentage of 1% - see table 7 and figure 16.

Table 7 – Final research result

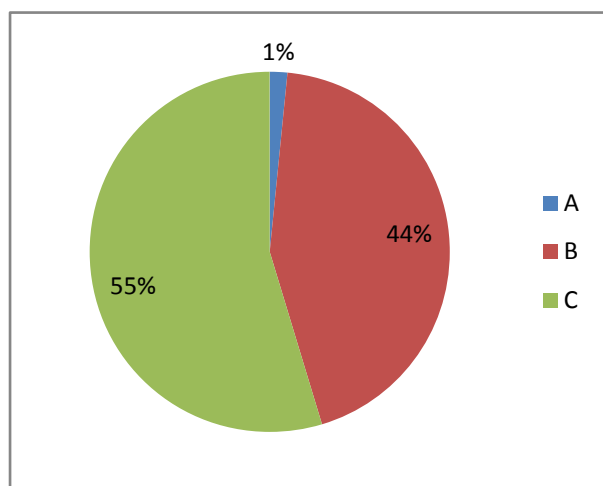| A	1%
B	44%
C	55%

Fig. 16 –Final research result

On the basis of the research investigation the C version has been chosen with of the requirements listed in issues 7 to 11 [10].

Acknowledgement

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